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EDITORIAL

English serves as a cornerstone in medical writing and scientific inquiry, acting as the de facto language for communication in these areas. Mastery of English is not just beneficial but essential for researchers who need to disseminate their findings effectively and engage with the latest advancements. Using English as a medium, health professionals can expose their research to a diverse, international audience, greatly enhancing the potential for interdisciplinary and cross-cultural collaboration.

The benefits extend further: publishing scientific papers in English significantly boosts their visibility. This not only increases the citation rate—a key metric of impact—but also ensures that new discoveries reach the widest possible audience. Such visibility is crucial for attracting funding and collaboration opportunities, which are often necessary for further research and development.

Moreover, English facilitates a more comprehensive understanding of global medical issues. By standardizing scientific communication in English, researchers ensure that critical information, breakthroughs, and methodologies are accessible to a worldwide community of scientists and healthcare professionals. This widespread accessibility is imperative for addressing global health challenges effectively and promptly.

Ultimately, English is not merely a means of communication but a vital instrument for advancing medical science. It allows for seamless knowledge transfer, enhances educational opportunities, and assures that important research can influence global health outcomes. As such, English proficiency remains a critical, invaluable skill for any medical researcher aiming to make a significant impact on the world stage.

Pr. Jalal BOUKHRIS

Journal Director

SUMMARY

FOCUS

Footballer's pubalgia : From Diagnosis to Management

Y. Chagar, I. Chagar, M.J. Mekkaoui R. Bassir, M. Boufettal, M. Kharmaz, M.O. Lamrani, M.S. Berrada

ABSTRACT

Footballer's pubalgia is a condition affecting all locomotor structures in the anterior part of the pelvic girdle. Its distribution is universal, almost exclusively male. There is yet no consensus on the nosology and therapeutic management of pubalgia. The aim of our study is to present recent literature data on pubalgia, especially regarding diagnostic and therapeutic strategies.

- Keywords: Pubalgia, Diagnosis, Treatment, Rehabilitation, Prevention

INTRODUCTION

pubalgia is a painful syndrome of the inguino-pubic region affecting high-level athletes, especially footballers. It is an overuse pathology expressed in a specific anatomical and biomechanical context. pubalgia was described by Spinelli nearly a century ago in fencers. Athlete's pubalgia, initially described mainly as a symphysis affliction, becomes, for some, a disease of the adductors, and for others, solely a defect of the inguinal canal wall. As decades pass, no consensus emerges on the nosological, diagnostic, or treatment strategy front. It seems preferable to evoke an overuse syndrome of a biomechanical entity, the inguinopubic crossroad, specific to certain sports activities, of multifactorial causes, and with varied clinical expressions. It manifests in isolation but very often combined in four clinical forms: Pubic osteopathy; Parietal and neurological affections of the inguinal canal without systematically detectable hernia; Lesions of the abdominal rectus insertion; Myotendinous lesions and insertion of the adductors (1).

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ANATOMY AND BIOMECHANICS

Footballer's pubalgia evolves in an anatomical and mechanical "lumbo-pelvi-femoral" ensemble extending from the lumbar spine to the hips. At the front of this ensemble is the pubic symphysis. Each edge of the pubis is the union of the ilio- and ischio-pubic branch and measures 3 to 4 cm in depth for 1.2 cm in height. It is an arthrodia without synovial membrane whose surfaces are elliptical, covered with hyaline cartilage. The edges are separated by a disc of fibrocartilage (4 mm) within which a physiological slit or raphe may exist (2). Its movements are very limited. It is stabilized by powerful ligaments, anterior, posterior, and inferior arcuate (3), which are intimately linked to the enthesis of the abdominals above (recti, aponeurosis of the external oblique) and of the long adductor below (4). The secondary ossification centers of the symphysis fuse late, at the age of 18 to 26 years (2). The symphysis is richly innervated by branches of the pudendal and genitofemoral nerves (3).

The muscles that insert on the pubis are broad, their tendons are very brief, their entheses are special (fibrocartilaginous) and intertwined (adductors and rectus

abdominals) (5). The interactions are therefore complex between the muscular forces developed on either side of the symphysis. Above the symphysis, the right and left abdominal rectus muscles are inserted separated by the white line and, further outside, the internal and external obliques and the transverse. The abdominal musculature, immediately outside the symphysis, allows the formation of the inguinal canal (6). It runs obliquely downwards, inwards, and forwards, just above and parallel to the inguinal ligament. The base of the external oblique aponeurosis forms the anterior wall and floor of the inguinal canal. The roof and part of the posterior wall of the canal are formed by the conjoint tendon (more or less complete union of the internal oblique and transverse). The deep orifice of the inguinal canal and the other part of the posterior wall of the canal are constituted by the transversalis fascia, a structure devoid of muscle fiber. Thus, at this level, there exists a point of weakness in the abdominal wall described by the French anatomist Fruchaud.

The canal allows various vessels a relationship between the abdomen and the testicle. But branches of the ilioinguinal and iliohypogastric nerve, stemming from the L1 root, also run through it, distributing terminal sensory branches to the inguinal canal, pubis, and scrotum. These two nerves are subject to numerous anatomical variations complicating the semiological analysis. Below the pubis, the six adductor muscles (obturator internus, pectineus, gracilis, long, short, and great adductors) insert. They direct downwards and outwards, fan-like, towards the femur. But only the long adductor inserts on the symphysis through a tendinous fixation superficially and muscularly in depth (5), the others on the adjacent osseous tissue. This insertion is special because it is composed of 62% by the direct union of muscle fibers in front of the arthrodia. Five of the six adductor muscles are innervated by the obturator nerve, stemming from the L4 root. Exiting the obturator foramen, the obturator nerve divides into anterior and posterior branches.

The anterior branch runs between, on the one hand, the pectineus and, on the other hand, the long and short adductor. Although antagonists, there exists a continuity of connective and muscular tissue between the origin of the adductors below, those of the rectus abdominals above, and the ligaments uniting the arthrodia. Some of these connective fibers even undergo a decussation when crossing the symphysis (3).

This intimate relationship between the long adductor, the abdominals, and the pubic symphysis constitutes the anatomical substrate for the conception of a single biomechanical ensemble ensuring the anterior stability of the pelvis and the transmission of forces on either side of the pubis. This "confluence" of anatomical elements explains the frequency of associated affections between the different clinical forms and encourages a unitary conception of the diagnostic and therapeutic management of footballer’s pubalgia.

EPIDEMIOLOGY

It is a pathology of the young footballer, almost exclusively male (7). Indeed, no female series has been described to date except for a level 4 case series in 2018. Over three seasons and 197 athletes seen for pubic pain, 18 are women (9%). However, nine of them suffered from an acute traumatic lesion of the common insertion of the adductors and rectus abdominals, one of the acute clinical forms of pubalgia. The others presented with an inguinal, femoral, or obturator hernia, whose connection to typical groin pain can be debated. It is rather footballers at the extremes of their career (8), either between 17 and 18 years old or between 30 and 35 years old who are preferentially affected, the incidence, significant, still increases between 2003 and 2009 (9). pubalgia affects 5 to 18% of athletes, across all sports (10); 58% of

footballers have a history of pubic pain. In football and hockey, pubalgia can reach 10 to 20% of a squad over a season.
Footballer's pubalgia is all the more prolonged and difficult to cure as the precise lesion diagnosis is late (7). It is diagnosed between six weeks and five years (on average 20 months) after the first symptoms. It is particularly recurrent when the pathophysiological factors are not corrected. 50% of pubalgia remain more than 20 weeks after the first symptoms (11). The recurrence of pubalgia remains significant, especially in professional team sports where it can reach 32 to 44% (12). Thus, a history of groin pain doubles the risk of a new episode and this risk is tripled if it is a professional footballer.

ETIOPATHOGENESIS

The origin of this pathology is still obscure and debated. Certain sports predispose more particularly to pubalgia; this is the case with football, which is the most commonly encountered sport. For Christe (13), there exists in footballers an imbalance between adductors and oblique muscles of the abdomen. The hypertonia of the adductors is explained by the constant use of these muscles in ball handling, lateral passing, inside shooting, but also to stabilize the pelvis in unipodal support during the strike. Tackling is a predisposing gesture because it causes forced adduction with tensioning of the adductor longus and gracilis, but also a posterior tilt of the pelvis with tensioning of the rectus abdominis.
For Renström (14), the cause of pubalgia is an injury to the adductor longus in 62% of cases. Lovell (15), who studied 189 cases of chronic groin pains, found, in 30% of cases, adductor lesions and in 20% of cases an osteitis pubis. For Biedert (16), pubalgia is the consequence of a weak groin with an anomaly of insertion of the rectus abdominis with a small attachment area on the pubis and a deficiency of the posterior wall of the inguinal canal without signs of hernia. The external inguinal ring is open, the aponeurosis of the obliquus externus and the transversalis fascia are weak. Footballers complain of lateral pain to the sheath of the internal rectus abdominis to the inguinal ligament that occurs when peritoneum moves in this dehiscence due to hyperpressure during sports activity. For Meyers (17), the painful component on the adductors in pubalgia finds its cause in the lesions of the lower insertion of the rectus abdominis which will lead to an anterior tilt of the pelvis, increasing the stresses on the adductors. He mentions hyperpressure in the adductor compartment. That's why, according to him, the surgical repair of the abdominal belt usually makes the pains on the adductors disappear.

DIAGNOSTIC APPROACH

Functional signs : Pain

This is the main form of expression of the pathology. Its form of appearance is variable. Most often (in 70% of cases according to Gilmore) (18) it sets in progressively, without a specific triggering factor, insidiously. At the end of training or a match, the patient feels a discomfort that will gradually increase. Conversely, but more rarely (30% of cases), there is a notion of triggering trauma with a precise date of appearance of painful phenomena and a more abrupt entry into symptomatology. This abrupt onset occurs during a forced adduction–external rotation movement, or during a change of direction, or a ball strike. Typically, these are groin pains occurring on effort, most often unilateral, radiating towards the abdomen, the antero-internal face of the thighs, the testicles, the perineum. The footballer feels stiffness and pain in the pelvic region in the morning, and at the beginning of physical activity; then stiffness and pain disappear to reappear at the end of the activity. The pain is increased by coughing, the Valsalva maneuver, unipodal support, accelerations, changes of direction, ball striking, tackling.

Physical examination

Inspection:

This pathology is preferentially expressed in footballers with a short-statured morphotype, an attitude of hyperlordosis, an anterior pelvic tilt, abdominal hypotonia centered on the obliques, and hypertonicity of the thighs with strong and retracted adductors. A Malgaigne sign should be sought, that's to say a bulge above the crural arch appearing during the Valsalva maneuver, indicating a dehiscence of the anterolateral wall of the abdomen.

Palpation and mobilization:

This allows for the search for painful areas through direct palpation or by performing tests soliciting the abdominals, the pubis, or the adductors. The examination of the pelvis seeks pain in the compression of the pubis, and in the maneuver of spreading and bringing together the iliac wings. The examination of the abdominal wall searches for pain at the distal insertion of the rectus abdominis, the external and internal obliquus during the testing of these muscles in concentric and eccentric. Palpation of the external orifices of the inguinal canal is paramount. After inverting the scrotum, an examining finger is placed in the inguinal ring and its width (normal or increased), sensitivity, and behavior during coughing and pushing efforts are noted. The examination of the adductors searches for pain on palpation of the high insertion, during maximum stretching and during concentric and eccentric contraction. The examination ends with the examination of the lumbar spine and hips. The mobility of the spine and its painlessness are appreciated. The examination focuses more particularly on the dorsolumbar junction in search of signs described by Maigne (19), in the context of the cellulotenomyalgic syndrome. The examination of the coxofemorals searches for a limitation of rotations and pain in flexion internal rotation.

IMAGING

X-Ray:

Arguments must be sought to eliminate an associated anomaly such as a difference in leg length or certain differential diagnoses: coxopathies, stress fracture, tumor lesion, or, in an acute context, an avulsive bone injury (fracture avulsion). In symphyseal forms, following the work of Brunet (20), there exist different radiological stages with notably erosions, geodes, pseudo-widening, condensation of the edges (21). (Figure 1)

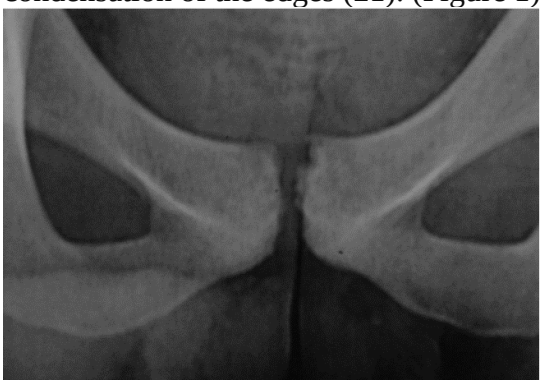

Fig.1: Microtraumatic symphysial osteoarthropathy

Ultrasound:

Ultrasound can show, in relation to tendon and muscle insertion zones:

- Tendinopathy with diffuse or localized hypoechoic areas of the tendon.
- Partial detachment characterized by a hypoechoic fluid area at the bone-tendon interface.
- Complete rupture with a diastasis between the bone and tendon, the extent of which depends on tendon retraction. The tendon stump often takes on a very characteristic bell-clapper appearance. Comparative dynamic ultrasound (22) , performed standing and during abdominal pushing efforts, also allows for the search for a possible differential diagnosis, especially a true inguinal or crural hernia.

MRI:
MRI is the reference imaging technique for sports-related pubalgia (23). It enables a comprehensive assessment of lesions in cases of chronic pain with unclear etiologies that only partially respond to medical treatment. MRI can refine surgical strategy by identifying adductor enthesis associated with abdominal wall insufficiency. **(figure 2 et 3).**

Fig.2: Axial PD STIR MRI slice. Enthesopathy of the right adductors

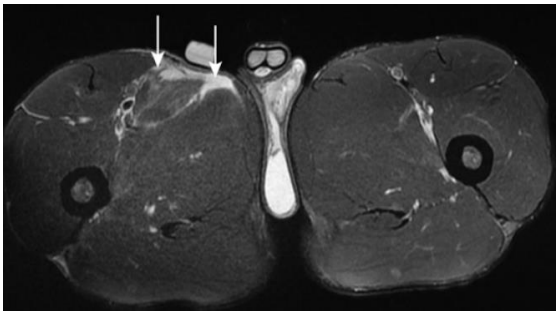

Fig.3: Axial PD STIR MRI slice. Complete detachment of the right long adductor.

DIFFERENTIAL DIAGNOSIS

The diagnosis of pubalgia is primarily a diagnosis of exclusion (24) . Clinical signs lack specificity due to the complex anatomy of the pubic region and its rich innervation. Pathologies of the abdominal wall (crural and inguinal hernias), inflammatory or infectious bone pathologies, genitourinary system disorders, peripheral neurological pathologies (nerve compressions), tumors, referred lumbar pain, early coxarthrosis pain, and local musculotendinous pathologies must be ruled out.

THERAPEUTIC STRATEGY

MEDICAL TREATMENT:
The consensus in the literature is that medical treatment is the first-line approach for pubalgia. Conservative treatment leads to healing in 80 to 85% of cases (25).
- Pain elimination or reduction: is paramount, as pain serves as the sole indicator for quantifying rehabilitation progress. Pharmacological options may include analgesics, NSAIDs, muscle relaxants, and corticosteroids. Some authors propose corticosteroid injections at the insertion points of the adductors or the pubic symphysis (symphysis screening technique). This therapeutic approach is highly debated in terms of its indication and long-term consequences. Sedative rehabilitation techniques are widely employed, incorporating deep transverse massages, cryotherapy, sedative physiotherapy, and electrotherapy.
- Elimination of Pain Triggering Factors: Movements causing repetitive stress on the tendons inserting into the pelvis should be avoided. Improving hip mobility and flexibility of periarticular muscles in a pain-free manner is essential. Hip rotation limitations, especially internal rotation, and a tendency toward hip flexion are common. If stretching is painless, stretching of adductors, iliacus, iliopsoas, pelvic floor muscles, hamstrings, and quadriceps should be performed. This involves long-duration stretching (30 to 60 seconds) using techniques like contract-relaxation.
- Improvement of Local Vascularization: Local blood flow increase in injured muscles or tendons enhances local metabolism and the healing process. Local vascularization can be improved through various physical means: ultrasound, local heat, massages, shockwave therapy, as well as low-intensity physical activity and local muscle work with low loads and multiple repetitions (30 to 40) with a recovery period between contractions double the contraction time.

- Abdominal Girdle Strengthening: Some pubic pains are associated with weakness of the abdominal wall in general, and specifically the obliquus abdominis. This abdominal girdle deficit is often associated with extensor weakness of the spine. Strengthening these muscles while avoiding hip flexor engagement is crucial. Pectineus, adductor brevis and longus, as well as portions of the adductor longus arising from the ischiopubic ramus, are both adductors and hip flexors. Therefore, abdominal workout amplitude should be limited to avoid parasitic contraction of hip flexors and consequent adductor engagement that may perpetuate pain.
- Adductor Strengthening: Progressive exercises form the basis of adductor muscle strengthening. Begin with resistance-free exercises aimed at improving local vascularization. Adductor positioning during exercises is important, starting with a less demanding position (hips and knees flexed) and progressing to the most demanding position (hips and knees extended).
- Overall Joint Maintenance, General Physical Preparedness: Partial joint immobilization due to pain affects surrounding joints. Lower limb injury reduces potential in the affected limb as well as the contralateral limb. Therefore, comprehensive maintenance of the injured lower limb and the contralateral limb is necessary. Reduced physical activity affects cardiovascular and psychological aspects, diminishing the athlete's ability to cope with painful symptoms.

SURGICAL TREATMENT:

In cases resistant to well-conducted treatment over approximately three months, surgical intervention may be considered. Ultrasound or MRI should be systematically performed before surgery to confirm the diagnosis and assess whether the lesion is unilateral or bilateral. There are two variants of surgical interventions (26): either relaxation of the adductor muscles, which are considered too strong, or tensioning of the abdominal wall muscles, considered too weak. Adductor relaxation can be achieved through percutaneous tenotomy or direct surgical approach to excise fibrotic lesions. This surgical technique is currently less favored due to its perceived invasiveness for high-level athletes. Nesovic described a rebalancing intervention through abdominal plasticity aimed at addressing oblique muscle and inguinal canal insufficiencies to stabilize the pubic symphysis against predominant adductor action. This intervention resembles but differs from inguinal hernia repair according to Bassini. The procedure involves dissection, typically revealing longitudinal fissures in the external oblique aponeurosis and a gap between the conjoint tendon and the crural arch (27), and repair, including a deep layer termed by Nesovic as myofascioplasty, suturing the lower end of the rectus abdominis and the conjoint tendon to the periosteum of the ipsilateral pubis, and a superficial layer involving aponeurosis suture without excessive tension. **figure 4.5 and 6)**

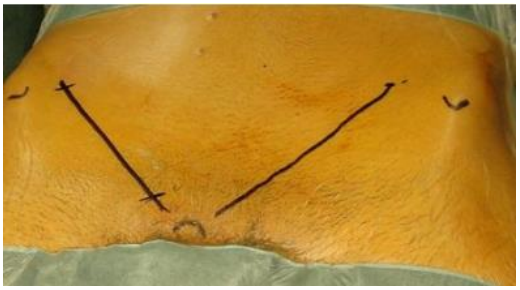

Fig.4: Incision outline for Nesovic's procedure intervention.

Fig.5: Deep myofascioplasty

Fig.6: Superficial fascioplasty

Postoperative Care: A patient undergoing surgery for pubalgia typically leaves the hospital on the same evening or the day after the procedure, with step 1 and 2 analgesic treatment combined with a non-steroidal anti-inflammatory drug (NSAID), and local care to be performed. Postoperative protocols have been established by some teams, week by week (28), which can be summarized as follows:
Week 1: Rest, activities of daily living, walking, cryotherapy, local care.
Weeks 2–3: Massage (scar tissue detachment, deep adductor massage), balneotherapy, postural and isometric work of the supra- and sub-pubic sectors (paravertebral, psoas, hamstrings, quadriceps).
Week 4: Initiation of proprioceptive work, low-resistance eccentric work, recovery of hip and lumbopelvic hinge mobility, osteopathic assessment.
Weeks 5–6: Intensification of isometric and eccentric muscle work, concentric work, cycling, core strengthening, proprioceptive weight-bearing work.
Weeks 6–8: Cardiovascular retraining, "explosive" muscle strengthening, short-distance running.
Weeks 8–12: Re-athleticism: intensification of muscle strengthening, plyometrics, re-adaptation to the sport practiced.

PREVENTION

Preventing pubalgia has been the subject of numerous studies since 1970. The importance of primary or secondary prevention is confirmed by recent studies. More recently, Holmich (29) (2009) demonstrated, in 977 footballers, that a prevention program could reduce the incidence of pubalgia by 31%. Under the same author's guidance, a Spanish team showed, in 303 footballers (average age: 23.4 years), that weakness of the hip adductors and a history of pubalgia lasting more than six weeks in the previous season exposed to a high risk of a new episode of pubalgia (30) . Verrall's team evaluated 52 Australian footballers through clinical examination and MRI to define an at-risk population. Therefore, we recommend systematically evaluating preseason weaknesses regarding strength, flexibility, coordination, with the establishment of a "profile" highlighting strengths and weaknesses (31). These athletes, as well as those with a history of pubalgia, benefit from individualized preseason and mid-season work (easing stiffened areas, strengthening weak sectors, coordination work). It is also important to measure individual internal load to avoid prolonged overload periods that exacerbate weaknesses.

CONCLUSION

Certain sports predispose individuals more particularly to pubalgia; this is the case in football, where the incidence rate per season is very high, although studies still lack scientific rigor. They are more based on authors' clinical experience and the empiricism of rehabilitative techniques rather than scientifically valid evidence. Further studies are necessary to confirm the diagnosis of this inguinal-pubic overuse syndrome in high-level athletes, its frequency, pathophysiology, and treatment. This remains a challenge for medical teams caring for high-level athletes. Finally, ongoing education for coaches, physicians, and physiotherapists is necessary for them to embrace this preventive approach.

REFERENCES

1- Pubalgie du sportif ; M. Bouvard , C. Kajetanek et O. Bonnefoy , Appareil locomoteur, 2020-05-01, Volume 34, Numéro 2, Pages 1-19

2- MeyersWC, Foley DP, GarrettWE. Management ofsevere lower abdominal or inguinal pain in high-performance athletes. Am J Sports Med 2000;28:2–8.

3- Davies AG, Clarke AW, Gilmore J. Review: imaging of groin pain in the athlete. Skeletal Radiol 2010;39:629–44.

4- Robertson BA, Barker PJ, Fahrer M. The anatomy of the pubic region revisited. Sports Med 2009;39:225–34.

5- Robinson P, Salehi F, Grainger A, Clemence M, Schilders E, O'Connor P, et al. Cadaveric and MRI study of the musculotendinous contributions to the capsule of the symphysis pubis. AJR Am J Roentgenol 2007;188(5).

6- Harmon KG. Evaluation of groin pain in athletes. Curr Sports Med Rep 2007;6:354–61.

7- Farber AJ, Wilckens JH. Sports hernia: diagnosis and therapeutic approach. J Am Acad Orthop Surg 2007;15:507–14.

8- Benazzo F, Mosconi M, Viola E. Groin pain in athletes. Sports Med Arthroscopy Review 2000;8(1).

9- Tyler TF, Silvers HJ, Gerhardt MB. Groin injuries in sports medicine. Sports Health 2010;20:1–6.

10- Jansen JA, Mens JM, Backx JG. Treatment of longstanding groin pain in athletes: a systematic review. Scand J Med Sci Sports 2008;18:263–74.

11- Fon LJ, Spence RA. Sportsman hernia. Br J Surg 2000;87:545–52.

12- Robertson BA, Barker PJ, Fahrer M. The anatomy of the pubic region revisited. Sports Med 2009;39:225–34.

13- Christel P, Djian P, Middleton P. Pubalgie. Encycl. med. chir. Paris: Elsevier; 1997 Appareil locomoteur, 14-323-A-10, 6p.

14- Renström P. Tendon and muscle injuries in the groin area. Clin Sports Med 1992;11:815–31.

15- Lovell G. The diagnosis of chronic groin pain in athletes: Review of 189cases. Aust J Sci Med Sport 1995;27:76–9.

16- Biedert R, Warnke K, Meyer S. Symphisis sydrome in athletes: surgical treatment for chronic lower abdominal, groin, and adductor pain in athletes. Clin J Sport Med septembre 2003;13:278–84

17- Meyers C, Foley D, Garett W, Lohnes J, Mandlebaum B. Management of severe lower abdominal or inguinal pain in high-performance athletes. Am J Sports Med 2000;28:2–8.

18- Gilmore J. Groin pain in the soccer athlete: fact fiction and treatment. Clinic sport med 1988;17:787–93.

19- Maigne R. Le syndrome de la charnière dorso-lombaire. Lombalgies basses, douleurs pseudoviscérales, pseudodouleurs de hanche, pseudotendinite des adducteurs. Sem Hop Paris 1981;57:545–54.

20- Brunet B. La pubalgie, un syndrome « fourre-tout ». [thèse médecine], Lyon 1, 1983.

21- McIntyre J,JohsonC, SchroederEL.Groin pain in athletes.Curr Sports Med Rep 2006;5:293–9.

22- Orchard JW, Read JW, Neophyton J. Groin pain associated with ultrasound findings of inguinal canal posterior wall deficiency in Australian rules footballers. Br J Sports Med 1998;32:134–9.

23- Lischuk AW, Dorantes TM, Wong W, Haims AH. Imaging of sportsrelated hip

and groin injuries. Sports Health 2010;3:251–9.

24- Caudill P, Nyland J, Smith C. Sports hernias: a systematic literature review. Br J Sports Med 2008;42:954–64.

25- Berger A. Approches diagnostiques et thérapeutiques de la pubalgie du sportif. Genève: Thèse Méd 10157; 2000

26- P.L. Puig et al. / Annales de réadaptation et de médecine physique 47 (2004) 356–364

27- Jaeger JH. La pubalgie du sportif : le traitement chirurgical. J Traumato Sport 1984;1:56–9.

28- Hemingway A.E., Herrington L., and Blower A.L.: Changes in muscle strength and pain in response to surgical repair of posterior abdominal wall disruption followed by rehabilitation. Br J Sports Med 2003; 37: pp. 54-58

29- Hölmich P., Larsen K., and Krogsgaard K.: Exercise program for prevention of groin pain in football players: a cluster-randomized trial. Scand J Med Sci Sports 2010; 20: pp. 814-821

30- Esteve E., Rathleff M.S., Vicens-Bordas J., Clausen M.B., Hölmich P., Sala L., et al: Preseason adductor squeeze strength in 303 Spanish male soccer athletes: a cross-sectional study. Orthop J Sports Med 2018; 6:

31- Garvey J.F., Read J.W., and Turner A.: Sportsman hernia: what can we do. Hernia 2010; 14: pp. 17-25

FOCUS

Management of Soft Tissue Sarcomas of Limbs : A Contemporary Perspective

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ABSTRACT

Soft tissue sarcomas (STS) are a rare type of cancer, representing about 1% of all cancer cases. Diagnosis often relies on finding a soft tissue mass larger than 3-5 cm or located beneath a fascia, leading to further examination. While ultrasound is a useful initial screening tool, magnetic resonance imaging (MRI) is considered the best method for characterizing the lesion. About one in every five such masses turns out to be an STS. Referring patients to specialized centers promptly is recommended for comprehensive care, including staging and biopsy, with careful attention to biopsy placement in collaboration with the surgical team. Treatment strategies often involve a combination of surgery, radiotherapy (RT), and sometimes chemotherapy. Poor management increases the risk of the cancer coming back locally and reduces overall survival. Notably, care at specialized centers significantly improves patient survival rates. This summary highlights the important clinical considerations and treatment approaches for STS, underscoring the crucial role of specialized center care in improving patient outcomes.

Conflict of interest: The authors declare no conflict of interest in connection with the writing of this article.

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KEY WORDS : Soft Tissue Sarcomas , Limbs, Management.

I. INTRODUCTION

Soft tissue sarcomas (STS) are rare cancers of the soft tissues within the musculoskeletal system. Despite their rarity, approximately one in five deep-seated masses exceeding 5 cm in largest dimension (under a fascia) is diagnosed as a sarcoma (1). Clinical presentation and imaging characteristics of STS vary widely, ranging from a palpable subcutaneous nodule to a large deep-seated mass with delayed clinical impact.

It is recommended to promptly refer any patient with a potentially suspicious STS lesion to a specialized center. Given the inherently multidisciplinary nature of managing these lesions, collaboration among various specialties such as oncology, medical imaging, pathology, genetics, and radiotherapy is essential. While adequate surgery remains the cornerstone of STS treatment, many tumors necessitate multimodal therapy involving surgery, radiotherapy, and/or chemotherapy following multidisciplinary oncology consultation. Evidence demonstrates that specialized sarcoma center care improves survival prognosis and reduces the risk of local recurrence in these patients (1).

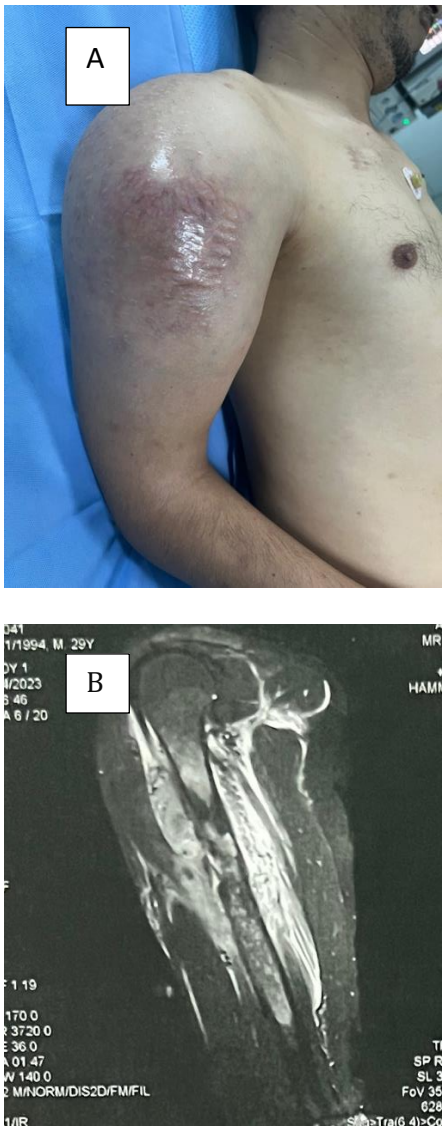

Figure N°1 : A: Clinical case, Y.Z., a 34-year-old patient, admitted to our department for the management of a rapidly evolving malignant-looking tumor mass at the upper end of the right humerus. B: MRI image of the same mass.

I. Epidemiology :

Sarcomas are rare accounting for less than 2% of solid cancers (2). There is a slight male predominance. Unlike bone sarcomas, STS are primarily adult pathologies with an incidence that increases with age. Indeed, STS account for only about 6% of pediatric cancers (e.g., embryonal and alveolar rhabdomyosarcomas and non-rhabdomyosarcomatous STS such as fibrosarcomas and synovial sarcomas, for example). These pediatric STS are managed and treated differently from those in adults, similar to Ewing's sarcoma of soft tissues.
STS are ubiquitous. However, three-quarters of them affect the limbs, particularly the thigh. Less than 10% of these lesions are localized in the trunk and retroperitoneal space.
The histopathological classification of sarcomas is extremely complex and regularly revised. More recently, technological advances in immunohistochemistry, molecular biology, and genetics have led to the subdivision of several lesions previously classified as undifferentiated pleomorphic sarcoma. With more precise classifications, the incidence and prevalence of each of these entities are expected to evolve, with follow-up increasingly tailored to lesion categories (3). Currently, this comprises a heterogeneous group of tumors including over 80 different histological types.

II. ETIOLOGY

The majority of cancers encountered in the population are carcinomas: these are malignant tumors arising from epithelial tissues. In contrast, sarcomas are cancers that originate from connective tissue. This explains the highly heterogeneous nature of this group of tumors. Indeed, any supportive structure (bone, cartilage, blood vessels, muscles, adipose tissue, nerves, etc.) can give rise to a sarcoma. In most situations, no clear etiology is found to explain the emergence of a sarcoma. In rare cases, predisposition may exist: identification of certain genetic mutations (e.g., Li-Fraumeni syndrome (4), Von Recklinghausen neurofibromatosis (5), etc.), exposure to ionizing radiation, or exposure to chemical carcinogens (pesticides, agri-food industry, etc.).

III. MANAGEMENT PRINCIPLES

While surgery remains the cornerstone of treatment for adult soft tissue sarcomas (STS), the management of these entities is

inherently multidisciplinary. For high-grade STS, inadequate or delayed management significantly impairs patient survival chances (6). Therefore, any patient suspected of having a sarcoma should be promptly referred to a specialized sarcoma center for management (7). Treatment requires the expertise of radiologists, pathologists, geneticists, oncologists, radiotherapists, sarcoma-specialized surgeons, and nuclear medicine physicians (8).

Each patient case should undergo **multidisciplinary oncology consultation**. This facilitates appropriate treatment decision-making for each encountered lesion. Consequently, no treatment should be initiated without a diagnosis and assessment of local and distant extension (1).

Unfortunately, patients are often referred too late or after inadequate diagnostic or therapeutic intervention. This can render subsequent management particularly complex, potentially compromising patient survival chances .

It is crucial to remember that any soft tissue mass, even subcutaneous, may potentially be a sarcoma. Ideally, any superficial mass not consistent with a lipoma or cyst on imaging and any deep-seated mass located beneath deep fascia (9) should be promptly referred to a specialized sarcoma center.

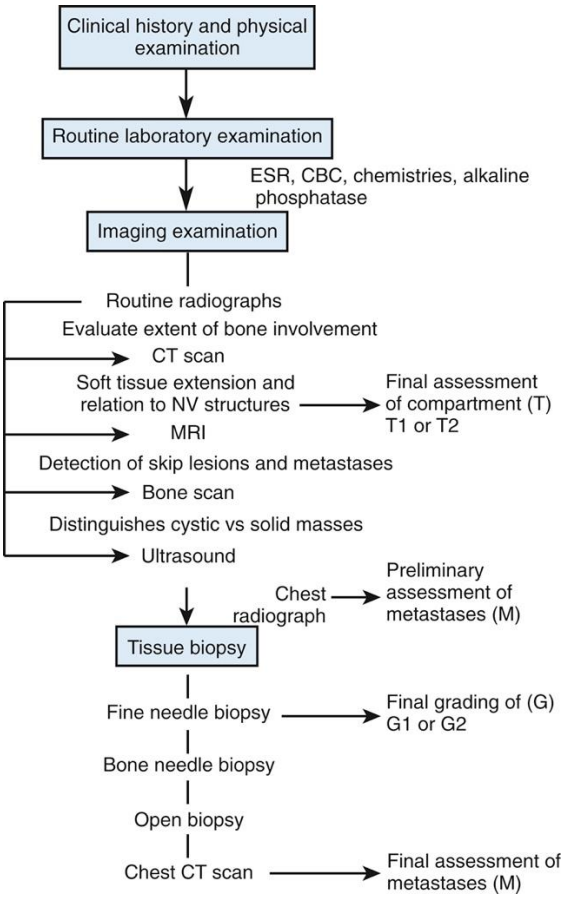

Figure N° 2 : This diagram serves as a visual representation outlining the sequential steps involved in diagnosing and managing a potentially concerning mass located in the limbs. It provides a structured overview of the diagnostic pathway, including initial evaluation, imaging studies, biopsy procedures, pathological analysis, and subsequent treatment decisions. Such a comprehensive visual aid facilitates clear communication among healthcare providers and ensures a systematic approach to patient care (27).

1. Medical History and Clinical Examination :

The clinical history of soft tissue sarcoma (STS) often involves a painless mass that the patient notices incidentally. However, it is essential to inquire about the patient's medical history and family history. Oncological history is particularly crucial, especially regarding previous radiation therapy (radiation-induced sarcomas). It is not uncommon for patients to report a history of minor trauma leading to the discovery of the lesion or a sudden increase in its size. These tumor tissues are often necrotic and may easily bleed internally.

Patients should be questioned about factors such as the growth rate of the lesion and associated symptoms (pain, tenderness, nocturnal awakenings, etc.). Rapidly progressing lesions should raise suspicion. There are situations where patients present with tumors that can evolve from day to day (Fig.).
However, one should not underestimate masses that have been present for a long time. It is still possible to have a low-grade cancerous lesion that grows locally slowly.
Clinical examination of the lesion is crucial (10).

Relevant elements include :

- Cutaneous appearance: aggressive or large masses often exhibit venous dilatations or associated skin involvement (redness, skin thickening, etc.) that may indicate local invasion. In more advanced situations, ulcerated skin lesions may be present ;
- Localization of the mass: superficial, deep, limb root, etc.;
- Consistency of the mass: soft, indurated, fluctuant, etc.;
- Adherence to the deep plane: a deep mass adherent to the fascia is less mobile on palpation;
- Pain: a rapidly growing tense mass may be painful to palpate, especially if inflammatory;
- Pulsatility: some masses are pulsatile. This can be auscultated or palpated. This clinical sign may be found in masses of vascular origin such as arteriovenous malformations or pseudoaneurysms;
- Neurological signs: percussion of certain masses may cause an electric shock sensation (Tinel sign) when the tumor originates from a nerve trunk (schwannomas, malignant peripheral nerve sheath tumors, etc.) or compresses a nerve pathway;
- Palpation of lymph nodes: lymph node enlargement may be found in inflammatory diseases, infectious phenomena, but also in the case of transit metastases in sarcomas or other types of solid or liquid cancers (Fig.).

2. Locoregional Assessment :

Although the majority of soft tissue masses are benign, a certain number of them may be cancerous. Inappropriate resection of a soft tissue sarcoma (STS), especially without prior imaging, can have disastrous consequences. Locoregional imaging is essential and is primarily based on ultrasound for superficial lesions and magnetic resonance imaging (MRI) for deep lesions. The distinction between malignant and benign pathology is not always clear and straightforward, even for sarcoma-specialized radiologists. Therefore, imaging interpretation should be done in conjunction with the patient's clinical examination and symptoms.

a) Ultrasound

Ultrasound is the preferred examination for the **initial** assessment of superficial soft tissue tumors. The B-mode allows for the localization of the lesion, assessment of its echotexture, and evaluation of its relationship with adjacent tissues, particularly deep fascia. The use of Doppler mode enables analysis of the lesion's vascularity and its environment. Ultrasound is an accessible technique that has no contraindications and allows for an initial differentiation between benign masses and suspicious lesions requiring further investigation (11) (12) . The radiologist can identify the most common benign tumors of superficial soft tissues, such as lipomas and synovial cysts (mucocele cysts of soft tissues), as well as epidermoid cysts (epidermal cysts) and nodules of palmar fibromatosis (Dupuytren's disease) and plantar fibromatosis (Ledderhose disease) when their ultrasound appearance is typical. In cases where the lesion does not correspond to a lipoma or cyst on ultrasound, or presents with a doubtful or

suspicious appearance, highly vascularized lesions on Doppler mode, incompletely imaged lesions, or lesions extending deep to the deep fascia, further investigations should be considered, including MRI . Finally, ultrasound can also guide percutaneous biopsy.

b) Radiography Standard

radiography has limited utility in the evaluation of soft tissue masses. It may show intraluminal calcifications (13). It can also identify a venous malformation by the presence of phleboliths. Finally, it can identify bone involvement/reaction associated with the tumor and assess potential fracture risk in cases of osteolysis/tumor invasion.

Figure N° 3: Standard profile X-Ray of a femur eroded by an osteolytic mass, thereby increasing the risk of fracture.

c) Computed Tomography (CT) Scanner

Similar to X-Ray , computed tomography (CT) scanning can be used to evaluate bone involvement , fracture risk, or intraluminal calcifications. CT scanning has low contrast resolution for deep soft tissue masses in the extremities when they do not contain fat, as their tumor tissue density is generally similar to that of muscles. In cases where MRI is contraindicated, intravenous injection of iodinated contrast agent can enhance lesion visualization. It can also facilitate the performance of angiography to precisely delineate tumor relationships with vascular structures. CT scanning is also used in interventional radiology to guide percutaneous biopsies.

d) Magnetic Resonance Imaging (MRI)

MRI is the imaging modality of choice for assessing soft tissue tumors of the extremities. It allows for precise localization of the tumor and evaluation of its relationships with surrounding anatomical structures. The lesion's location, contours, signal characteristics, and contrast enhancement after intravenous injection of gadolinium-based contrast agent can, in some cases, provide information about its nature . High-quality MRI is crucial for both oncological assessment of the lesion and surgical planning for resection.

3. Staging

Oncological staging performed in the evaluation of a suspicious soft tissue mass aims to exclude the presence of metastatic secondary lesions. The imaging modalities used for this staging are capable of detecting macroscopic lesions (detection threshold approximately 3–4 mm). At present, it is not possible to detect microscopic metastatic disease. Unfortunately, it is not uncommon for patients to develop metastatic disease in the years following treatment for their sarcoma despite reassuring initial staging. This shows the importance of systematic oncological and radiological follow-up of patients at the end of their treatment.

Thoracic CT remains an essential basic examination according to international recommendations, as the lungs are the preferred site for STS metastases (1). Depending on the histological diagnosis, this examination may be supplemented, notably by abdominal CT. This is relevant for certain types of sarcoma that may metastasize to abdominal organs, such as myxoid liposarcoma, clear cell sarcoma, or angiosarcoma. Similarly, brain MRI is useful in clear cell sarcoma, sometimes associated with the presence of brain metastases.

18-fluorodeoxyglucose positron emission tomography (18 FDG-PET)–CT is widely used in solid cancers. Its use is considered **optional** in the staging of sarcomas according to current international recommendations from the European Society for Medical Oncology (ESMO) (1). However, several scientific societies have integrated it into their routine practice because many advantages have been demonstrated in using this examination for sarcoma staging (14). Among these, noteworthy are the detection of occult metastatic disease, characterization of heterogeneous tumors, or identification of areas of interest within a tumor to guide biopsy (15). It is important to keep in mind that its effectiveness is limited in weakly metabolic tumors or in lesions with a myxoid component such as myxoid liposarcoma.

Whole-body MRI is another modality that can be employed in the staging of certain sarcomas. Its usefulness has been suggested as an alternative to 18 FDG-PET-CT to reduce exposure to ionizing radiation in the pediatric population (16). Whole-body MRI can also be useful in the assessment of lesions weakly metabolic on 18 FDG-PET-CT, such as myxoid liposarcoma (17).

4. Biopsy

Apart from imaging findings, the diagnosis of a soft tissue sarcoma (STS) relies on biopsy. The choice of biopsy modality and sampling site is determined during multidisciplinary oncology consultation.

The fundamental principle is that this biopsy should be performed at the reference center ultimately treating the patient. Indeed, the histopathology of these lesions is particularly complex and requires expertise that is rarely encountered outside a reference center. Additionally, the biopsy route must be discussed multidisciplinarily. There are several modalities for STS biopsy (18):

- Excision biopsy, acceptable for lesions smaller than 3 cm;
- Percutaneous core needle biopsy;
- Open biopsy.

Fine needle aspirations are not recommended due to the small sample size. However, they may find their indication in very specific clinical situations, such as confirming a recurrence.

Percutaneous core needle biopsy is performed under imaging guidance, either ultrasound or CT scanner. The biopsy route is discussed between the radiologist and the surgeon to subsequently perform excision of the route with the mass in one piece. Indeed, the biopsy route is considered contaminated by the tumor and must be marked, for example with carbon black (19).

The main principles are:

- Minimize contamination of healthy tissues and choose the most direct route possible.
- Ensure that the sampling is sufficiently representative of the areas of interest within the tumor, i.e., the most aggressive part of the tumor.
- Decide the biopsy route in collaboration with the radiologist in anticipation of potential resection .
- The request for histopathological analysis must be clear and concise, including at least the patient's age, tumor site, laterality, supra- or sub-fascial localization, and radiological hypotheses.

- It is good practice to also take samples for genetic and possibly bacteriological studies, with the latter being particularly important in the assessment of bone tumors. If a surgical biopsy is performed, it should be done through a longitudinal incision.
- The use of a tourniquet for a biopsy of a soft tissue sarcoma located in an extremity does not pose a problem per se. However, compressive bands should never be used to empty the venous network. Simply elevating the limb for about 1 minute is sufficient to drain the vascular network and thus avoid potential tumor dissemination.
- In aggressive tumors, the biopsy tract is considered contaminated and is resected with the tumor. This includes any drainage paths placed intraoperatively, which should be placed close to the axis or in the incision. Situations involving inadequate biopsy or drainage paths may necessitate sometimes extensive resections .

Regardless of the biopsy modality chosen, it is essential to target a tissue and/or metabolically active area of the lesion so that the sample best represents the entirety of the lesion and its aggressiveness. Imaging examinations, particularly MRI and PET-CT, will help identify these areas before performing the biopsy . Care is taken to avoid biopsying fluid-filled or necrotic areas, as histopathological analysis of these areas is often disappointing.

In this regard, the samples must reach the pathologist promptly either as fresh specimens or fixed directly in formalin so that they can, if necessary, perform cytogenetic examinations. Bouin's solution is universally excluded as it hinders molecular investigations. Obtaining a fresh sample can be highly valuable for more detailed molecular analyses and/or for tumor banking purposes.

It is also important to note that only the histopathology of the subsequently resected surgical specimen in its entirety allows for the definitive diagnosis.
The diagnosis based on the biopsy may be provisional and partial, but it guides treatment according to the nature of the lesion and its grade. The grade is determined based on the degree of tumor differentiation and necrosis, as well as the mitotic index according to the classification of the National Federation of Cancer Centers (FNCLCC).

IV. PRINCIPLES OF SURGERY

The basic principle of soft tissue sarcoma (STS) surgery is the complete resection of the lesion with clear margins. However, the concept of resection margin remains highly variable in the literature. This notion was introduced by Enneking over 40 years ago (20). He distinguished between different types of resections:

- Intralesional: the tumor is curetted.
- Marginal: the resection passes through the reactive capsule of the tumor.
- Wide: a layer of healthy tissue is sacrificed along with the tumor. The thickness of this layer varies in the literature from a few millimeters to several centimeters.
- Radical: the entire anatomical compartment is sacrificed with the tumor.

Intralesional resections are not acceptable for sarcomas. They require a wide surgical revision, including skin scars, drain tracts, and the entire surgical field.
A marginal resection may sometimes be considered in certain specific situations depending on the type of lesion and its grade.
Radical resections are rarely used in high-grade, invasive, and large sarcomas.
Wide resection includes a wide range of safety margin thickness around the tumor. This notion has evolved over time. It is now

commonly accepted that the thickness of the resection margin can vary with the type and grade of the lesion (21). The safety margin can also be significantly reduced to save an anatomical structure if adjuvant treatment can be considered or if an anatomical barrier such as a fascia is present.

To assess resection margins, the surgical specimen must be clearly oriented. It is useful to complement the pathological information with an explanatory diagram to facilitate the analysis.

There are many methods today to classify the resection margin (22) (23). The most commonly adopted classification is the international "R" classification of tumor residues (24). The resection will be classified as follows:

- R0: complete resection;
- R1: presence of microscopic tumor residues at the section edges;
- R2: macroscopically visible tumor.

The surgeon's goal is to achieve an R0 resection with a resection margin whose thickness will vary depending on the diagnosis. A positive resection margin is associated with a significantly higher risk of local recurrence (25). The higher the grade of the lesion, the larger the resection margin should be. Furthermore, the resection margin could be significantly reduced if adjuvant treatment such as radiation therapy can be considered (26).

Several pathological details such as the presence of tumor buds at the section edges, lymphatic permeations, or a surgical margin of less than 1 mm are prognostic factors for a poor prognosis in terms of the risk of local recurrence and metastases.

V. PREOPERATIVE ASSESSMENT AND RESECTION PLAN

MRI remains the basic imaging for surgical planning. A detailed analysis of the imaging with radiologists helps identify structures that may need to be preserved or sacrificed. This is particularly important for informing the patient about the consequences of the surgical procedure.

The choice of surgical approach should have been decided before performing the biopsy in order to resect the tract along with the tumor . Various anatomical planes through which to remove the lesion safely are carefully analyzed. At this stage, it is important for the surgeon to try to disregard the reconstruction issues that the resection will entail. Indeed, many inadequate resections occur due to fear of being unable to close the skin planes, losing limb function, or sacrificing vascular or nerve structures. Many of these problems can be addressed secondarily through judicious choice of reconstruction techniques.

It is also very important to identify the anatomical position of the lesion within the affected structure. This may not be obvious for small lesions.

The CT scan can also be very useful for assessing possible bone involvement (see above).

Similarly, the angioscan allows an assessment of the vascular structures to be sacrificed and potentially requiring reconstruction.

VI. PRINCIPLES OF RECONSTRUCTION

The functional impact of surgery for a soft tissue sarcoma (STM) can vary widely. Various strategies can be used to address the functional deficit resulting from resection surgery. The critical point for the surgeon is to achieve adequate skin closure and coverage of the operated area. We outline here, non-exhaustively, some useful techniques in limb salvage and reconstruction surgery, along with illustrations.

- Covering Flaps

There are numerous types of flaps available, and mastering these covering principles is an expertise in itself. Nevertheless, there are many simple pedicled flaps that are useful to know. Indeed, these allow for satisfactory reconstruction in most cases. Among the simple pedicled flaps that are useful to

master, examples include the latissimus dorsi flap or the medial and lateral gastrocnemius flaps.

In situations where resection and reconstruction prove to be more complex, it is important to plan the surgery correctly and enlist the assistance of a plastic surgeon.

Sometimes, it is necessary to perform free flaps. In this situation, it is necessary to respect operative fields and use strictly separated instruments to avoid potential contamination of the donor site. It is also useful to involve different surgical teams to work together and thus reduce the operative time.

In situations where it is necessary, it is also possible to perform neuroanastomosed free flaps, allowing both coverage and functional recovery.

- Functional Muscle and Tendon Transfers

In surgeries for STMs requiring significant muscle sacrifice, it is possible to transfer muscle and tendon units to preserve both the limb and its function. This is particularly useful in cases involving large muscle sacrifices around the quadriceps, where transferring certain musculotendinous structures from the posterior compartment of the thigh, such as the biceps femoris or the semitendinosus anchored to the patella, can provide knee stabilization. Another example is in cases involving sacrifices in the anterolateral compartment of the leg, where loss of the foot dorsiflexors can be compensated by transferring the posterior leg muscle through the interosseous membrane to the midfoot.

- Vascular Grafts

Vascular grafts are highly valuable in the therapeutic arsenal for complex reconstructions. These grafts can be synthetic or from a homograft bank. In this case, it is necessary to plan a joint procedure with a vascular surgeon. The preoperative planning of the intervention must be meticulously calculated to maintain minimal ischemia time in the reconstructed limb. This generally implies that the vascular axes affected by the tumor will be the last to be sectioned at the time of lesion removal. Reconstruction then begins with the vascular graft.

- Skeletal Reconstructions

The proximity of bone structures or an articulation should not deter from taking necessary resection margins. In situations where

VII. CONCLUSION

The comprehensive management of a soft tissue sarcoma (STM) is inherently multimodal. Surgery constitutes one of the treatments, which must be meticulously prepared based on diagnosis, extension assessment, and high-quality imaging of the lesion. Ideally, these lesions should be treated in specialized sarcoma centers by expert teams.

BIBLIOGRAPHY

1. Casali P.G., Abecassis N., Aro H.T., Bauer S., Biagini R., Bielack S., et al: Soft tissue and visceral sarcomas: ESMO-EURACAN Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol 2018 and iv268-iv269, 29: pp.

2. Stiller C.A., Trama A., Serraino D., Rossi S., Navarro C., Chirlaque M.D., et al: Descriptive epidemiology of sarcomas in Europe: report from the RARECARE project. Eur J Cancer 2013 and 684-685, 49: pp.

3. Fletcher CDM, Bridge JA, Hogendoorn PCW, Mertens F. WHO classification of tumours of soft tissue and bone . Disponible sur : https://publications.iarc.fr/Book-And-Report-Series/Who-Classification-Of-Tumours/WHO-Classification.

4. Cancer, Malkin D.: Li-Fraumeni syndrome. Genes and 475-484, 2: pp.

5. Penel N., Grosjean J., Robin Y.M., Vanseymortier L., Clisant S., and Adenis A.: Frequency of certain established risk factors in soft tissue sarcomas in adults: a prospective descriptive study of 658 cases. Sarcoma 2008.

6. Martin-Broto J., Hindi N., Cruz J., Martinez-Trufero J., Valverde C., De Sande L.M., et al: Relevance of reference centers in sarcoma care and quality item evaluation: results from the prospective registry of the Spanish Group for Research in Sarcoma 2019.

7. Johnson G.D., Smith G., Dramis A., and Grimer R.J.: Delays in referral of soft tissue sarcomas. Sarcoma 2008. 2020 and undefined:.

8. Luis ÁM, Aguilar D.P., and Martín J.A.L.: Multidisciplinary management of soft tissue sarcomas. Clin Transl Oncol 2010 and 543-553, 12: pp.

9. 2006, Grimer R.J.: Size matters for sarcomas! Ann R Coll Surg Engl and 519-524, 88: pp.

10. Balach T., Stacy G.S., and Haydon R.C.: The clinical evaluation of soft tissue tumors. Radiol Clin North Am 2011 and 1185-1196, 49: pp.

11. Lakkaraju A, Sinha R, Garikipati R, Edward S, Robinson P. Ultrasound for initial evaluation and triage of clinically suspicioussoft-tissue masses. Clin Radiol 2009 and 64(6):615–21.

12. 2009, Ritchie DA.Commentary on ultrasound forinitial evaluation and triage of clinically suspicious soft-tissue masses. Clin Radiol and 64(6):622–3.

13. Dangoor A, Seddon B, Gerrand C, Grimer R, Whelan J, Judson I. UK guidelinesfor the management ofsoft tissue sarcomas. Clin Sarcoma Res 2016 and 6:20.

14. The Royal College of Radiologists, Royal College of Physicians of London, Royal College of Physicians, Surgeons of Glasgow, Royal College of Physicians of Edinburgh.

15. Macpherson RE, Pratap S, Tyrrell H, Khonsari M, Wilson S, Gibbons M, et al. Retrospective audit of 957 consecutive 18 F-FDG PET-CT scans compared to CT and MRI in 493 patients with different histological subtypes of bone and soft tissue sarcoma. Clin S.

16. Klenk C, Gawande R, Uslu L, Khurana A, Qiu D, Quon A, et al. Ionising radiation-free whole-body mri versus(18)F-fluorodeoxyglucose PET/CT scans for children and young adults with cancer: a prospective, nonrandomised, single-centre study. Lancet Oncol 2.

17. Gorelik N, Reddy SMV, Turcotte RE, Goulding K, Jung S, Alcindor T, et al. Early detection of metastases using whole-body MRI for initial staging and routine follow-up of myxoid liposarcoma. Skeletal Radiol 2018 and 47(3):369–79.

18. Traina F, Errani C, Toscano A, Pungetti C, Fabbri D, Mazzotti A, et al. Current concepts in the biopsy of musculoskeletal tumors. J Bone Joint Surg Am 2015 and 97(1):e7.

19. liveira MP, Lima PM, de A, da Silva HJ, de Mello RJV. Neoplasm seeding in biopsy tract of the musculoskeletal system. A systematic review. Acta Ortop Bras 2014 and 22(2):106–10.

20. Enneking W.F., Spanier S.S., and Goodman M.A.: A system for the surgical staging of musculoskeletal sarcoma. 1980. Clin Orthop Relat Res 2003 and ., undefined: pp. 4-18.

21. Kawaguchi N., Ahmed A.R., Matsumoto S., Manabe J., and Matsushita Y.: The concept of curative margin in

surgery for bone and soft tissue sarcoma. Clin Orthop Relat Res 2004 and 165-172, undefined: pp.

22. Gundle K.R., Kafchinski L., Gupta S., Griffin A.M., Dickson B.C., Chung P.W., et al: Analysis of margin classification systems for assessing the risk of local recurrence after soft tissue sarcoma resection. J Clin Oncol 2018 and 704-709, 36: pp.

23. Hoang K., Gao Y., and Miller B.J.: The variability in surgical margin reporting in limb salvage surgery for sarcoma. Iowa Orthop J 2015 and 181-186, 35: pp.

24. Wittekind C., Compton C., Quirke P., Nagtegaal I., Merkel S., Hermanek P., et al: A uniform residual tumor (R) classification: integration of the R classification and the circumferential margin status. Cancer 2009 and 3483-3488, 115: pp.

25. Gerrand C.H., Wunder J.S., Kandel R.A., O'Sullivan B., Catton C.N., Bell R.S., et al: Classification of positive margins after resection of soft-tissue sarcoma of the limb predicts the risk of local recurrence. J Bone Joint Surg Br 2001 and 1149-1155, 83: pp.

26. Cates M.M., and Cates J.M.M.: Surgical resection margin classifications for high-grade pleomorphic soft tissue sarcomas of the extremity or trunk: definitions of adequate resection margins and recommendations for sampling margins from primary resection.

27. Edward A. Athanasian, Mark E. Puhaindran, Bone and Soft Tissue Tumors, Green's Operative Hand Surgery, 59, 2185-2233, 2022.

FOCUS

Tibiofibular syndesmosis lesions : It's important to know ? And should we treat?

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ABSTRACT

Tibiofibular syndesmosis lesions are common injuries associated with ankle sprains and fractures. These injuries are often overlooked or underestimated, leading to long-term complications such as rotational instability and ankle osteoarthritis.
The complex anatomy of ankle ligaments includes the lateral ligament group, deltoid ligament, and syndesmosis, each consisting of multiple components.
Syndesmosis lesions typically occur in conjunction with malleolar fractures, particularly in cases of pronation external rotation or supination external rotation. Clinical examination involves assessing the patient's history, examining for specific signs such as edema and pain over the anterior inferior tibiofibular ligament, and performing stress tests to provoke pain in the syndesmosis.
Ankle X-rays, including weight-bearing views, can provide valuable information, although their diagnostic accuracy is limited. CT scans are useful for measuring inter-tibiofibular gaps and assessing fibular translation and rotation. MRI is a valuable diagnostic tool but may not be universally available.
The treatment of these lesions remains controversial, with no established consensus.
This work tries to give an overview of the latest search on this topic.

KEY WORDS : Distal Tibiofibular joint, Syndesmosis, Injury, Diagnosis, treatment.

Conflict of interest : The authors declare no conflict of interest in connection with the writing of this article.
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INTRODUCTION

Tibiofibular syndesmosis lesions are frequent and occur in 1-18 % of ankle sprains **(1;2)**. It also is estimated that 10% of all ankle fractures are associated with syndesmosis disruption, and It continues to be **underestimated**, with 20 % being overlooked in emergencies **(1)**. These lesions are more frequent during sports activities, particularly during competitions rather than training sessions **(3-5)**.
Orthopedists and emergency doctors should be informed that failure to treat them prevents a short-term return to sport and, **in the long term**, leads to **rotational instability** and, consequently, osteoarthritis of the ankle. There is currently no consensus on the treatment of these lesions **(1)**.

ANATOMY

The anatomy of ankle ligaments is complex, with three surgically important groups, each composed of three components (figure 1) **(6)**:

- The **lateral ligament** group comprises the anterior talofibular ligament, the posterior talofibular ligament, and the calcaneofibular ligament.

- Medially, the deltoid ligament consists of both superficial and two deep parts (anterior and posterior).
-
- The syndesmosis also consists of three structures: the anterior inferior tibiofibular ligament (AITFL), the interosseous ligament, and the posterior inferior tibiofibular ligament (PITFL):

    - The anterior inferior tibiofibular ligament (AITFL) is trapezoidal, wider at the tibia than at the fibula, and comprises three bundles: proximal, principal, and accessory distal (Basset ligament) **(7)**.

    - The posterior inferior tibiofibular ligament (PITFL) is more solid, horizontal, and longer, with two bundles: superficial and deep inferior transverse tibiofibular ligament distally in contact with the talus **(1)**.

    - The tibiofibular interosseous ligament (TFIL), also known as the syndesmotic plate or intermediate lateral malleolar ligament, is short, strong, and pyramidal, filling the space between the tibia and fibula.

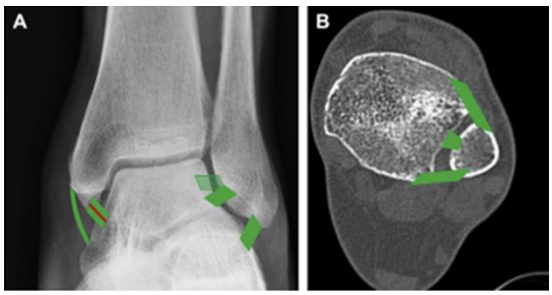

Figure 1 : Anatomy of ankle ligaments.

PATHOMECHANICS

Syndesmosis lesions frequently occur within a malleolar fracture and are rarely isolated lesions.
In malleolar fractures due to pronation external rotation (Weber C), syndesmosis lesions are always present, as the AITFL is affected in the second position after the medial malleolus and before the fibular fracture. Malleolar fractures due to supination/external rotation (Weber B) are accompanied by syndesmosis lesions in 50% of cases. The lateral structures are initially injured due to their tension in these situations.
Pure lesions of the syndesmosis, more specifically of the AITFL, are secondary to forced external rotation with dorsiflexion of the ankle and are not accompanied by lesions of the deltoid ligament.

CLINICAL EXAMINATION

Anamnesis is a crucial element in diagnosis. The trauma mechanism typically involves forced external rotation of the ankle in dorsiflexion, with the foot in supination or pronation. Unfortunately, patients often struggle to accurately describe the mechanism of their injury.
Syndesmosis lesions are suggested by **anterolateral edema** near the tibiotalar joint and pain on palpation over the AITFL (Sensitivity = 92%, Specificity = 79%) **(8)**.
During ankle examination, **syndesmosis stress tests** should be performed. They are considered positive when pain is triggered in the syndesmosis:

- The Frick test (Sensitivity = 30–71%, Specificity = 85%) involves forced dorsiflexion and external rotation of the ankle with the knee in 90° flexion **(1)**.

- The squeeze test (Sensitivity = 30%, Specificity = 88–93.5%) consists of high tibial and fibular compression, inducing a movement that separates the two distally, which may be possible and painful in the case of a syndesmosis ligament lesion **(1)**.

ANKLE X-RAYS

According to Tourné, a comparative weight-bearing ankle X-ray with AP and lateral views is part of the assessment process (figure 2) **(1)**:

• i**ncreased tibiofibular clear space (TFCS**), measured 10 mm proximally to the tibial plafond, is **pathological if >6 mm on AP view**.
• **reduced tibiofibular overlap (TFO)**, likewise measured 10 mm from the tibial plafond, is **pathological if < 6 mm on AP view.**
• **enlarged medial clear space (MCS**), **normally equal to or less than the superior clear space between the talar dome and tibial plafond**, indicates medial collateral ligament lesion.

Figure 2 : Ankle X-rays showing **TFCS** (1), **TFO**, (2), and **MCS** (3).

Tourné et al. state that radiologic measurements demonstrate poor reproducibility, with **TFCS** (Sensitivity=82%; Specificity=75%) and **TFO** (Sensitivity=36%; Specificity=78%) **(1)**.
Prakash, in his review, suggests that FTO has no diagnostic value **(9)**.
Schoennagel et al. reported that **TFCS** and, to a lesser extent, **MCS** show potential for indicating syndesmotic injury **(10)**. Furthermore, the results fail to correlate with MRI findings **(9)**.

CT SCAN

The comparative CT scans are essential in diagnosing syndesmosis lesions by measuring (figure 3) **(1)**:

• **the inter-tibiofibular gap**: with a threshold **of 4 mm**:
- the ***anterior*** gap (Se, 56.5%; Sp, 91.7%)
- the ***medial*** gap (Se, 74.4%; Sp, 78.4%) is reproducible , unlike the ***posterior*** gap.

• **anteroposterior translation** of the fibula and **rotation** concerning the tibia can also be assessed.
• TFCS and TFO can also be measured.

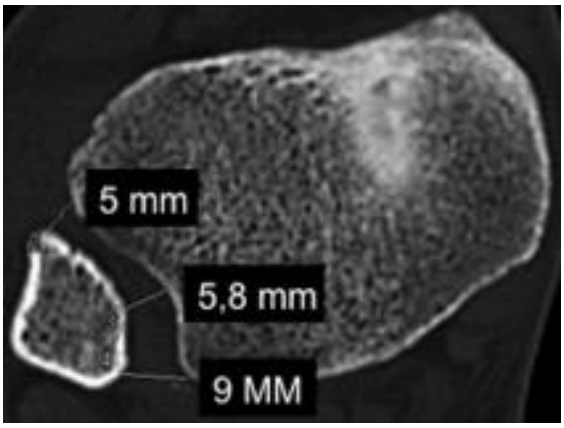

Figure 3 : CT scan measuring anterior, medial, and posterior gaps **(1)**

CLASSIFICATION

The initial classifications are based on clinical and X-ray findings, but they are inadequate for guiding therapy **(11)**. The Clanton classification is one of these classifications and is the most commonly used.

Classification of syndesmosis lesions	
Grade I	Less severe Clinical : Pain upon palpation of AITFL Additional tests: Normal X rays Injuries : Partial tear of AITFL
Grade II	Clinical : Positive external rotation and squeeze tests Additional tests: Normal X rays Injuries : Complete tear of AITFL +/- others lesions
Grade III	Severe injury Clinical : All clinical tests are positive Additional tests: Abnormal X rays Injuries : Complete tear of AITFL + PITFL + IOM + TL

Table N°1 : Clanton X-rays Classification **(12)**.

MRI is an essential diagnostic technique that should be considered. Sikka's classification of MRI is very useful **(13)**. However, MRI remains an expensive imaging technique and may not be readily available everywhere.

Injury Grade	Definition
I	Isolated injures to the AITFL
II	Injury to the AITFL, interosseous ligament, and interossesous membrane
III	Injury to the AITFL, interosseous ligament, interossesous membrane, and PITFL
IV	Injury to the AITFL, interosseous ligament, interossesous membrane, PITFL, and deltoid ligament

Table N°2 : Sikka MRI classification **(13)**.

TREATMENT

Tourné and al describe non-operative treatment by resin boot cast with 15–45 days' non-weight-bearing **(1)**. After removing the cast, systematic rehabilitation is initiated, including mobilization to restore basic functions, as well as neuromuscular and proprioceptive rehabilitation **(14)**.

Surgical treatment via syndesmosis fixation was a controversial issue until Schepers' study, which concluded that there is no difference in outcomes between supra- or trans-syndesmotic placement of the syndesmotic screw **(15)**. The level should be chosen to obtain the most stable construct per individual fracture type. The screw should not be placed too high (>4 cm). The number of cortices did not influence the outcome, and the number of screws did not affect the outcome in multivariable analysis. There is no biomechanical advantage of a 4.5-mm screw over a 3.5-mm screw. Removal might be indicated after 12 weeks in cases of residual complaints of stiffness or syndesmotic malpositioning. According to a systematic review published in 2019 **(16)**, dynamic fixation by TightRope© System had **better functional outcomes** compared with syndesmotic screw fixation with lower rates of bad positioning and complications. Non-operative management of isolated stable syndesmotic sprains is feasible with good results with appropriate patient selection **(17)**. Operative stabilization of the tibiofibular syndesmosis is indicated when syndesmotic instability is confirmed either intra-operatively after definitive fixation of concomitant ankle fracture or in acute unstable isolated syndesmotic injuries Surgeons should have a low threshold for visualizing the inferior tibiofibular joint with an anterolateral incision to check reduction **(15)**.

CONCLUSION – TAKE HOME MESSAGE

Posterior malleolus fixation: "It's less than 25% of the articular surface" is perhaps the most widely used excuse for not fixing this important component of ankle fractures. **There is no evidence in the literature to support this assumption (6).** Fixation of the posterior malleolus (PM) ensures, via the posterior inferior

tibiofibular ligament (PITFL), that the fibula is restored to its anatomical length. Furthermore, the PITFL provides 70% of the strength of the syndesmosis according to laboratory studies.

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REFERENCES

1. Tourné Y, Molinier F, Andrieu M, Porta J, Barbier G. Diagnosis and treatment of tibiofibular syndesmosis lesions. Orthop Traumatol Surg Res. 2019;105(8s):S275-s86.

2. Rammelt S, Obruba P. An update on the evaluation and treatment of syndesmotic injuries. Eur J Trauma Emerg Surg. 2015;41(6):601-14.

3. Inge SY, Pull Ter Gunne AF, Aarts CAM, Bemelman M. A systematic review on dynamic versus static distal tibiofibular fixation. Injury. 2016;47(12):2627-34.

4. Ekstrand J, Timpka T, Hägglund M. Risk of injury in elite football played on artificial turf versus natural grass: a prospective two-cohort study. Br J Sports Med. 2006;40(12):975-80.

5. Wei F, Villwock MR, Meyer EG, Powell JW, Haut RC. A biomechanical investigation of ankle injury under excessive external foot rotation in the human cadaver. J Biomech Eng. 2010;132(9):091001.

6. Solan MC, Davies MS, Sakellariou A. Syndesmosis Stabilisation: Screws Versus Flexible Fixation. Foot Ankle Clin. 2017;22(1):35-63.

7. Williams BT, Ahrberg AB, Goldsmith MT, Campbell KJ, Shirley L, Wijdicks CA, et al. Ankle syndesmosis: a qualitative and quantitative anatomic analysis. Am J Sports Med. 2015;43(1):88-97.

8. Sman AD, Hiller CE, Refshauge KM. Diagnostic accuracy of clinical tests for diagnosis of ankle syndesmosis injury: a systematic review. Br J Sports Med. 2013;47(10):620-8.

9. Anand Prakash A. Syndesmotic stability: Is there a radiological normal?-A systematic review. Foot Ankle Surg. 2018;24(3):174-84.

10. Schoennagel BP, Karul M, Avanesov M, Bannas P, Gold G, Großterlinden LG, et al. Isolated syndesmotic injury in acute ankle trauma: comparison of plain film radiography with 3T MRI. Eur J Radiol. 2014;83(10):1856-61.

11. Rammelt S, Zwipp H, Grass R. Injuries to the distal tibiofibular syndesmosis: an evidence-based approach to acute and chronic lesions. Foot Ankle Clin. 2008;13(4):611-33, vii-viii.

12. Clanton TO, Campbell KJ, Wilson KJ, Michalski MP, Goldsmith MT, Wijdicks CA, et al. Qualitative and Quantitative Anatomic Investigation of the Lateral Ankle Ligaments for Surgical Reconstruction Procedures. J Bone Joint Surg Am. 2014;96(12):e98.

13. Sikka RS, Fetzer GB, Sugarman E, Wright RW, Fritts H, Boyd JL, et al. Correlating MRI findings with disability in syndesmotic sprains of NFL players. Foot Ankle Int. 2012;33(5):371-8.

14. Press CM, Gupta A, Hutchinson MR. Management of ankle syndesmosis injuries in the athlete. Curr Sports Med Rep. 2009;8(5):228-33.

15. Schepers T, van der Linden H, van Lieshout EM, Niesten DD, van der Elst M. Technical aspects of the syndesmotic screw and their effect on functional outcome following acute distal tibiofibular

syndesmosis injury. Injury. 2014;45(4):775-9.

16. Liu G, Chen L, Gong M, Xing F, Xiang Z. Clinical Evidence for Treatment of Distal Tibiofibular Syndesmosis Injury: A Systematic Review of Clinical Studies. J Foot Ankle Surg. 2019;58(6):1245-50.

17. Fort NM, Aiyer AA, Kaplan JR, Smyth NA, Kadakia AR. Management of acute injuries of the tibiofibular syndesmosis. European journal of orthopaedic surgery & traumatology. 2017;27:449-59.

FOCUS

Ruptures of the extensor apparatus on total knee prosthesis

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ABSTRACT

This paper presents a comprehensive review of ruptures of the extensor apparatus on total knee prosthesis. We explore the incidence, risk factors, and clinical presentation of this complication, along with the current diagnostic and therapeutic strategies. Our findings suggest that while the occurrence of extensor apparatus ruptures is relatively rare, it poses a significant challenge due to its impact on knee function and the complexity of treatment. Risk factors range from patient-related aspects such as rheumatoid arthritis, corticosteroid use, osteoporosis, and obesity, to surgical factors like the type of prosthesis and surgical technique. The paper further discusses the classification of these ruptures based on the fracture's appearance, the stability of the patellar implant, and the integrity of the extensor apparatus. We conclude with a discussion on the need for further research to optimize prevention and management strategies for this serious complication following TKA.

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I. INTRODUCTION

Total knee arthroplasty (TKA) has become a common surgical procedure to alleviate pain and improve function in patients with degenerative knee diseases. However, one of the potential complications following TKA is the rupture of the extensor apparatus, which includes the quadriceps tendon, patella, and patellar tendon. This complication can significantly impact the functional outcome and patient satisfaction, making it a critical area of study.

II. PATELLA FRACTURES

Patella fractures are relatively rare, with rates varying between 0.2 and 2.1% when the patella is resurfaced and 0.05% when it is not (Yoo J.D. & 1-9). Fractures can occur as a result of trauma or fatigue (Ortiguera C.J. & 532-540). Risk factors are multiple, ranging from the patient's condition (rheumatoid arthritis, corticosteroid use, osteoporosis, obesity) to the type of prosthesis (posterior-stabilized prosthesis (Tria A.J. & 131-138), patellar button with 1 or 3 plots) through the surgical technique (release of the lateral wing, too much or insufficient resection of the patella, native joint line height not respected, rotation of the femoral implant) or the recovery of too much flexion (Wetzner S.M. & 215-219).
Ortiguera and Berry classified these fractures into three types based on the appearance of the fracture, the stability of the patellar implant, and the integrity of the extensor apparatus. Type 1 fractures are the most common and do not compromise the continuity of the extensor apparatus. In type 2, the implant is stable but the extensor apparatus is ruptured. In type 3, the patellar implant is loosened (Fig. 1).

Figure N°1: Ortiguera and Berry classified periprosthetic patella fractures into three types (Masoni):

- **Type I**: The extensor mechanism is intact and the implant is well-fixed.
- **Type II**: The extensor mechanism is disrupted, but the implant is stable.
- **Type III**: The patellar implant is loosened.

This classification system is widely used and helps guide treatment decisions

We will delve into the study of fractures that interrupt the extensor apparatus, specifically Ortiguera and Berry's type 2 fractures.

The complexity of the issue arises from the presence of the patellar button, whether it is loosened or not, which adds a layer of complication to the execution of a standard osteosynthesis. Complications are not uncommon, with rates reaching up to 50% (Ortiguera C.J. & 532-540).

The risk of infection is substantial, along with disassemblies, skin perforations by pins, among others. The installation of pins to establish a brace is feasible, but the stability of the setup can be uncertain based on the remaining bone. If the patellar button is loosened and mobile, it is generally advisable to remove it as repeated sealing would only add to the complexity of the procedure. Often, it is more beneficial to opt for a simple cerclage, accompanied by a trochanter-malleolus cast for a minimum of 45 days. For fractures at the tip of the patella and increasingly for transverse fractures, we typically resort to an osteosuture, safeguarded by a synthetic ligament passed transosseously at the anterior tibial tuberosity (TTA) and in the quadriceps tendon, flush with the proximal edge of the patella. This setup necessitates a plaster immobilization for at least 45 days.

Considering the high frequency of complications, osteosynthesis, regardless of its form, should be limited to fractures with an interfragmentary gap exceeding 1 cm. For all other cases, orthopedic treatment is the recommended course of action.

III. RUPTURES OF THE QUADRICEPS TENDON

These are extremely rare, since in a study published in 2005, Dobbs et al. (Dobbs R.E. & 37-45)found a prevalence of 0.1% in a series of 23,800 prostheses implanted at the Mayo Clinic between 1976 and 2002. Of the 34 patients in the series, 23 had an incomplete rupture, of which seven were not operated on and 16 were operated on, and 11 had a complete rupture requiring surgical treatment for ten of them.

The surgical technique is the same as for ruptures on a native knee, knowing that the presence of the patellar button can complicate the creation of bone tunnels. As with patellar fractures, the postoperative course is complicated by complications. Of the ten patients operated on for a complete rupture, Dobbs et al. (Dobbs R.E. & 37-45) reported four iterative ruptures and four satisfactory results, not to mention 12% of infectious complications, one of which led to an amputation. Of the 16 operated on for a partial rupture, only one had an iterative rupture and 12 had a satisfactory result. Thus, of the 11 patients who had a complete rupture, seven had a poor outcome, or 63.5%. In a TKA, the vascularization of the quadriceps tendon is probably reduced due to the anterior arthrotomy that allowed to enter the knee to place the TKA and also due to some excessive releases of the lateral patellar wing (Ritter M.A. & 368-372). This lack of vascularization in elderly patients (average age of 70 years in Dodds' series), often with comorbidities, probably explains this high rate of failures.

This suggests using synthetic (Dobbs R.E. & 37-45) (Fernandez-Baillo N. & 331-333) or biological reinforcements such as the semitendinosus or gracilis (Ait Si Selmi T) (Dobbs R.E. & 37-45) to improve the resistance of the sutures Some authors

(Barrack R.L. & 98-104) (Springer B.D. & 35-38) have also proposed the use of allografts of calcaneal tendon (Achilles tendon) in some significant retractions of the quadriceps tendon.

IV. RUPTURES OF THE PATELLAR TENDON

A rupture of the patellar tendon can occur during the intervention, immediately postoperatively or remotely from the surgery. Excessive traction on the tibial insertion of the ligament, in a context of stiff knee or revision surgery, can cause its avulsion or weakening during the eversion of the patella to expose the knee. The incidence is rare and varies from 0.17 to 1.4% (Fan C.H. & 26:). There are several options to repair these lesions that are mostly located at the tibial level. As with lesions on a native knee, in recent lesions direct repair by suture or reinsertion fixed by staples or anchors can be considered, or better, a reinsertion reinforced by semitendinosus or gracilis, or by synthetic ligament. In chronic lesions, the same techniques can be considered, but often, in multiply operated knees, it is necessary to resort to rotation flaps, autografts or allografts.

Therapeutical management:

A. Reconstruction by autograft

The semitendinosus is one of the most used tendons (Rand J.A. & 233-238) (Cadambi A. & 974-979). Cadambi and Engh (Cadambi A. & 974-979)described a technique that involves, in addition to the anterior incision that was used to place the prosthesis, a posteromedial incision at the level of the pes anserinus to harvest the tendon using a stripper, leaving it pedicled at its tibial insertion. Then, the proximal part of the tendon is passed subcutaneously to the anterior incision where it is mounted vertically to the medial edge of the patella. A 5 mm diameter tunnel is drilled transversely from inside to outside, below the studs of the patellar button to pass the semitendinosus tendon which is then fixed by several points of large absorbable thread to the surrounding soft tissues and to the starting point of the tendon. This technique is the same as that used for a native knee knowing that one can be hindered by the studs of the patellar implant, that the tip of the patella can be fragile and that a single anterior approach can be used without having to make a posteromedial incision. In the postoperative course, the knee must be protected by a plaster for six weeks and by a more or less articulated splint for another six weeks. Unfortunately, the results of this technique are relatively poor as presented in the series of Cadambi and Engh (Cadambi A. & 974-979), where, out of seven operated, which constitutes the largest published series, the average flexion is 80° and five patients out of seven have an active extension deficit of 5 to 15°. These results are unfortunately corroborated by other sporadic cases in the literature (Rand J.A. & 233-238) (Gustillo R.B.). As a result, if this technique can be attempted in case of recent injury, it should be avoided for chronic lesions.

B. Reconstruction with synthetic material

Given the poor quality of the tissues that we have to reconstruct, it is quite logical to think that synthetic material could replace the deficient tissues. Aracil et al. (Aracil J. & 204-208)proposed the use of a woven polyester ligament, and Browne and Hanssen (Browne J.A. & 1137-1143) proposed the use of a wick. For our part, we have been using a synthetic ligament for several years.

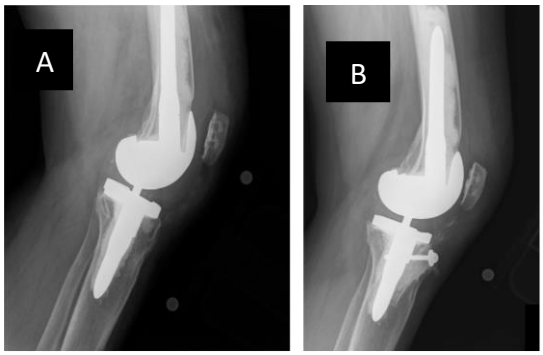

Figure N °2 : (Browne)
A-Before the surgery, a side view X-ray of the knee displayed an elevated patella, known as patella alta.
B-Following mesh reconstruction surgery, the subsequent side view X-ray of the knee exhibited restored patellar alignment. It's noteworthy to observe the utilization of a transfixion screw and washer, along with polymethylmethacrylate, to firmly anchor the mesh graft within the tibial trough.

The technique proposed by Aracil et al. (Aracil J. & 204-208)and that we also use but with another ligament, consists of passing the synthetic ligament through the quadriceps tendon, flush with the proximal edge of the patella, then passing it in front of the extensor apparatus, crossing the strands to make an eight and then fixing it at the level of the TTA, by drilling a bone tunnel of the size of the ligament which is then fixed by notched staples . These authors recommend immobilizing the knee postoperatively only with a protective splint for walking and starting passive mobilization of the knee quickly. This attitude is dangerous in our opinion, on the one hand because the ligament can act as a "butter cutter" in the quadriceps tendon and, on the other hand, because the quality of the bone is not always very good, so that the tibial fixation can also tear off. We recommend a minimum immobilization of 30 days followed by a protective splint for another month. In a series of five patients with an average follow-up of 56 months, these authors report an average flexion of 98°, an average extension deficit of 4.6° and an average graft elongation of 6.2 mm.

C. <u>Reconstruction with a medial gastrocnemius flap</u>

Using a medial gastrocnemius rotation flap was the method reported by Jaureguito et al. (Jaureguito J.W. & 866-873) and Busfield et al. (Busfield B.T. & pp.) . This method involves moving the medial part of the gastrocnemius muscle and flipping it over to cover the front of the tibia. The remaining extensor device can then be connected to the medial gastrocnemius. If there is a large loss of tendon tissue, the collection can reach the Achilles tendon. After the surgery, the knee has to be kept still in a cast from the hip to the ankle for six to eight weeks, followed by a hinged brace for a few more weeks. It is better to do active exercises and avoid working the quadriceps against resistance for at least three months. This is because the main issue with this surgery is not the rigidity but the inability to fully straighten the leg, which happens with all methods.

D. <u>Reconstruction by allograft</u>

Technique with the calcaneal tendon
The basic technique (Crossett L.S. & 1354-1361) consists of making a rectangular hole in the proximal part of the tibia in which the calcaneal bone block is inserted. This hole must be slightly medial and distal to the TTA. An osteosynthesis by screwing or metal wire cerclage will complete the fixation. The tendinous portion of the graft is pulled proximally and sutured to the remaining fibrous tissues. The graft must imperatively be stretched knee in extension to avoid any secondary relaxation of the transplant (56 Burnett R.S. & i). The subcutaneous cellular tissue and the skin are then closed over the graft. Postoperatively, the knee must be immobilized in extension in a trochanter-malleoli plaster for six to eight weeks.

E. <u>Complete Extensor Mechanism Graft Technique</u>

Technique for complete extensor mechanism graft involves making a midline

incision to expose the entire extensor mechanism. The quadriceps and patellar tendons are cut vertically, and the patella is divided into two tendon-patella-tendon flaps, one on each side. The remaining part of the patella is removed. The donated tissue is then fitted into the upper part of the shinbone and secured with screws. Next, the graft is pulled up under the quadriceps and attached using strong stitches. At the same time, the host quadriceps muscle is pulled downward to ensure maximum tension on the graft. Finally, the two flaps are stitched together over the graft. Following closure of the wound, the knee is placed in a plaster cast in a straight position for six to eight weeks (Emerson R.H. & 79-85.).

V. CONCLUSION

Extensor mechanism tears post-total knee replacement pose greater treatment challenges and yield less satisfactory results compared to natural knee cases. When dealing with patellar fractures exceeding 1 cm displacement along with active extension deficit, similar management to native knee fractures is necessary, favoring osteosutures supported by synthetic ligaments over pins to avoid associated drawbacks. In recent tendon tears, treatment mirrors that of natural knees; however, due to compromised soft tissue quality, reinforcing sutures or reinsertion with autologous tissue or synthetic ligaments is typically required, particularly for the patellar tendon. Chronic injuries offer a spectrum of treatment options, ranging from reinforced primary sutures to complete extensor mechanism allografts or medial gastrocnemius flaps. Regrettably, outcomes often fall short of expectations.

BIBLIOGRAPHY

1. Yoo J.D., and Kim N.K.: Periprosthetic fractures following total knee arthroplasty. Knee Surg Relat Res 2015 and 1-9, 27: pp.

2. Ortiguera C.J., and Berry D.J.: Patellar fracture after total knee arthroplasty. J Bone Joint Surg Am 2002 and 532-540, 84: pp.

3. Tria A.J., Harwood D.A., Alicea J.A., and Cody R.P.: Patellar fractures in posterior stabilized knee arthroplasties. Clin Orthop 1994 and 131-138, 299: pp.

4. Wetzner S.M., Bezreh J.S., Scott R.D., Bierbaum B.E., and Newberg A.H.: Bone scanning in the assessment of patellar viability following knee replacement. Clin Orthop 1985 and 215-219, 199: pp.

5. Dobbs R.E., Hanssen A.D., Lewallen D.G., and Pagnano M.W.: Quadriceps tendon rupture after total knee arthroplasty: prevalence, complications, and outcomes. J Bone Joint Surg Am 2005 and 37-45, 87: pp.

6. Ritter M.A., Herbst S.A., Keating E.M., Faris P.M., and Meding J.B.: Patellofemoral complications following total knee arthroplasty. Effect of a lateral release and sacrifice of the superior lateral geniculate artery. J Arthroplasty 1996 and 368-372, 11: pp.

7. Fernandez-Baillo N., Garay E.G., and Ordonez J.M.: Rupture of the quadriceps tendon after total knee arthroplasty. A case report. J Arthroplasty 1993 and 331-333, 8: pp.

8. Ait Si Selmi T, Neyret P, Rongieras F, Caton J. Ruptures de l'appareil extenseur du genou et fractures de rotule. EMC (Elsevier Masson SAS, Paris), Techniques chirurgicales – Orthopédie-Traumatologie, 44-730, 1999 : 16p.

9. Barrack R.L., Stanley T., and Allen Butler R.: Treating extensor mechanism disruption after total knee arthroplasty. Clin Orthop 2003 and 98-104, 416: pp.

10. Springer B.D., and Della Valle C.J.:

Extensor mechanism allograft reconstruction after total knee arthroplasty. J Arthroplasty 2008 and 35-38, 23: pp.

11. Fan C.H., Lo C.K., Yung S.H., and Chan K.M.: A rare mode of extensor mechanism failure in total knee arthroplasty. J Arthroplasty 2011 and 26:.

12. Rand J.A., Morrey B.F., and Bryan R.S.: Patellar tendon rupture after total knee arthroplasty. Clin Orthop 1989 and 233-238, 244: pp.

13. Cadambi A., and Engh G.A.: Use of a semitendinosus tendon autogenous graft for rupture of the patellar ligament after total knee arthroplasty: a report of seven cases. J Bone Joint Surg Am 1992 and 974-979, 74: pp.

14. Gustillo R.B., and Thompson R.: Quadriceps and patellar tendon ruptures following total knee arthroplasty. In Rand J.A., and Dorr L.D. (eds): Total arthroplasty of the knee: Proceedings of the Knee Society, 1985-1986. Rockville, MD: Aspen Publishers, 1.

15. Aracil J., Salom M., Aroca J.E., Torro V., and Lopez-Quiles D.: Extensor apparatus reconstruction with Leeds-Keio ligament in total knee arthroplasty. J Arthroplasty 1999 and 204-208, 14: pp.

16. Browne J.A., and Hanssen A.D.: Reconstruction of patellar tendon disruption after total knee arthroplasty: results of a new technique utilizing synthetic mesh. J Bone Joint Surg Am 2011 and 1137-1143, 93: pp.

17. Jaureguito J.W., Dubois C.M., Smith S.R., Gottlieb L.J., and Finn H.A.: Medial gastrocnemius transposition flap for the treatment of disruption of the extensor mechanism after total knee arthroplasty. J Bone Joint Surg Am 1997 and 866-873, 79: pp.

18. Busfield B.T., Huffman G.R., Nahai F., Hoffman W., and Ries M.D.: Extended medial gastrocnemius rotational flap for treatment of chronic knee extensor mechanism deficiency in patients with and without total knee arthroplasty. Clin Orthop 2004 and pp., 428:.

19. Crossett L.S., Sinha R.K., Sechriest V.F., and Rubash H.E.: Reconstruction of a ruptured patellar tendon with Achilles tendon allograft following total knee arthroplasty. J Bone Joint Surg Am 2002 and 1354-1361, 84: pp.

20. 56 Burnett R.S., Berger R.A., Paprosky W.G., Della Valle C.J., Jacobs J.J., and Rosenberg A.G.: Extensor mechanism allograft reconstruction after total knee arthroplasty: a comparison of two techniques. J Bone Joint Surg Am 2004 and i, 86: pp. 2694-2699 View.

21. Emerson R.H., Head W.C., Malinin T.I.: Extensor mechanism reconstruction with an allograft after total knee arthroplasty. Clin Orthop 1994 and 79-85., 303: pp.

22. Masoni, Virginia & Giustra, Fortunato & Bosco, Francesco & Lo Carmine, Lorenzo & Capella, Marcello & Cacciola, Giorgio & Risitano, Salvatore & Sabatini, Luigi & Massè, Alessandro. (2023). Periprosthetic patella fractures in total knee replacement and revi.

23. Browne, J. A., & Hanssen, A. D. (2011). Reconstruction of Patellar Tendon Disruption After Total Knee Arthroplasty. The Journal of Bone & Joint Surgery, 93(12), 1137–1143. doi:10.2106/jbjs.j.01036.

TECHNICAL NOTE

Surgical Strategies for Pectoralis Major Tendon Rupture: Bone Trough Repair Technique

A. Lachkar, A. Najib, H. Yacoubi

ABSTRACT

Pectoralis Major Tendon (PMT) ruptures pose a growing concern, especially with increased engagement in fitness activities. Surgical intervention becomes necessary for complete tears, offering better outcomes for patients with high functional demands. Among various surgical approaches, the Bone Trough Repair Technique, particularly when employing the Transosseous Suture method, emerges as a reliable strategy. This technique demonstrates robust biomechanical strength, favorable clinical outcomes, and cost-effectiveness, making it a preferred choice for managing PMT ruptures. Studies comparing different repair techniques consistently highlight the superiority of the Bone Trough Repair Technique, further establishing its efficacy and reliability in restoring function and promoting optimal postoperative recovery.

KEYWORDS : Pectoralis major muscle, Tendon, Rupture, Bone trough technique, Suture

Conflict of interest: The authors declare no conflict of interest in connection with the writing of this article

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INTRODUCTION

The pectoralis major muscle, the largest muscle in the anterior chest wall, plays a crucial role in internal shoulder rotation and adduction. The incidence of pectoralis major tendon (PMT) rupture has witnessed a significant rise, particularly in the last decade, often associated with increased involvement in fitness and weight training, occasionally accompanied by the use of anabolic steroids [1 – 3]. Patissier was the first to describe this entity in the literature, dating back to 1822 [4]. Predominantly, injuries manifest at the tendon insertion (65%), followed by the musculotendinous junction (27%) [5 – 6]. Treatment selection for PMT tears depends on injury severity and the anticipated muscle usage based on the patient's activity level [1]. Non-operative approaches involve rest, ice, analgesia, and immobilization in a sling followed by a comprehensive rehabilitation program [7]. However, operative intervention is generally preferred for complete tears, especially for younger, healthier patients with high functional demands [1, 5, 7]. Numerous surgical techniques have been documented. This technical note offers an overview of the Bone Trough Reconstruction method as a reliable and effective reconstructive approach.

BIOMECHANICS OF PMT RUPTURE

The biomechanics underlying PMT rupture delve into the intricate interplay of muscle structure and movement mechanics. The Pectoralis Major Muscle (PMM) boasts a complex musculotendinous architecture, featuring two heads: the clavicular head (CH), arising from the medial clavicle, and the sternal head (SH), originating from the second to sixth ribs, the costal margin of the sternum, and the external oblique

aponeurosis [8]. Dominating over 80% of the muscle volume, the SH is further segmented into seven overlapping sections [5] (figure 1).

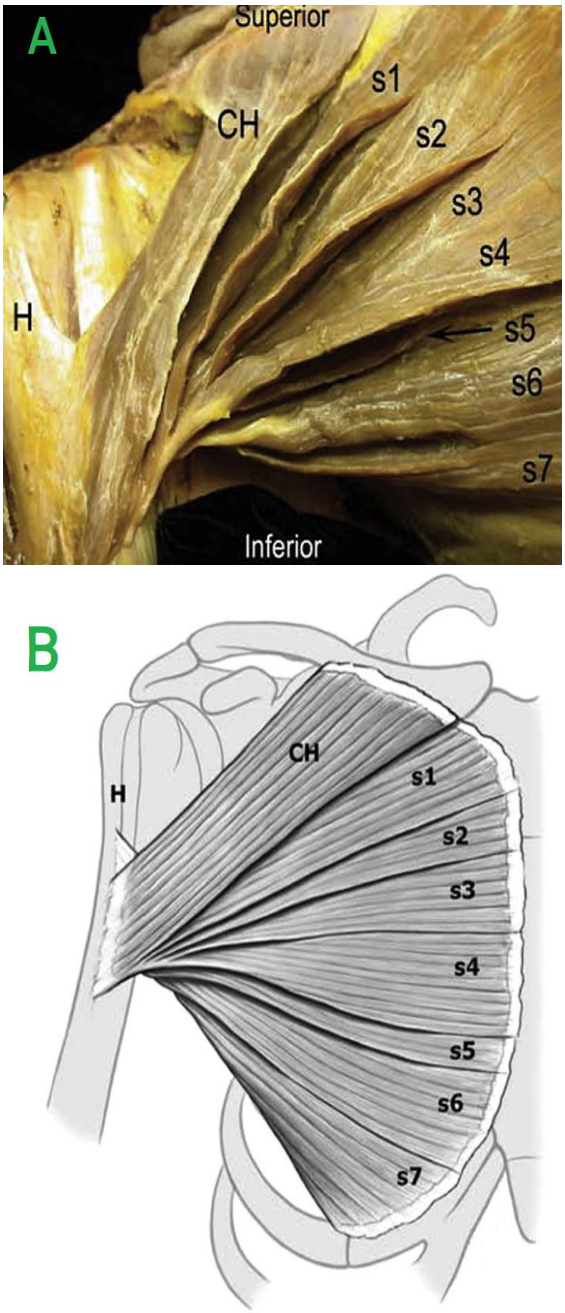

Fig 1: A: The anterior view of the chest wall reveals the delineated segments of the pectoralis major muscle. B: The anterior orientation of each muscle segment overlaps with the segment below it. *CH: clavicular head. S1-S7, Sternal Segments.*

Research conducted by Wolfe et al. [9] highlights that individual fiber lengths maintain a consistent excursion, averaging approximately 19% during forward flexion. During a 30-degree extension from neutral, the inferior fibers exhibit a remarkable 40% excursion, double that of their superior counterparts [10]. This discrepancy becomes particularly significant in the extended bench press position, where the musculotendinous unit experiences eccentric loading [11]. Consequently, a biomechanical rationale emerges for the prevalence of PM tendon ruptures. Typically, tendon failure ensues in a predictable pattern, commencing with the inferior segments of the sternal head, progressing to the superior segments of the sternal head, and culminating at the clavicular head [12].

CLASSIFICATIONS AND DIAGNOSTIC

Tendon tears within the PMM have previously undergone classification by Tietjen et al. [13] and Bak et al. [14], with a focus on injury severity and location (Table 1). However, the prevailing categorization often prioritizes the chronicity of these injuries, which significantly influences their management. Tietjen's conventional descriptive classification system categorizes PM injuries into three main categories, ranging from contusions to partial and complete tears [13]. In contrast, Bak's more contemporary classification method highlights the importance of tear chronicity, site, thickness, and width [14]. Furthermore, a novel classification system proposed by Elmaraghy [5] considers comprehensive anatomopathological aspects of tear width and thickness, particularly addressing the dual layers of the tendon muscle (figure 2). The chronicity and specific anatomical location of the injury play crucial roles in surgical planning, profoundly impacting the choice between anatomical repair or graft reconstruction [12]. Chronic tears, defined as those occurring at least 6 weeks post-initial injury, pose particular challenges [5].

Type	Description
I	Contusion or sprain
II	Partial tear
III	Complete tear
III-A	Muscle origin
III-B	Muscle belly
III-C	Musculotendinous junction
III-D	Tendon
III-E	Bony avulsion from insertional site
III-F	Tendon substance rupture

Table 1: The classification of pectoralis major injuries by Tietjen (purple lines) [13], modified by Bak (green lines) [14].

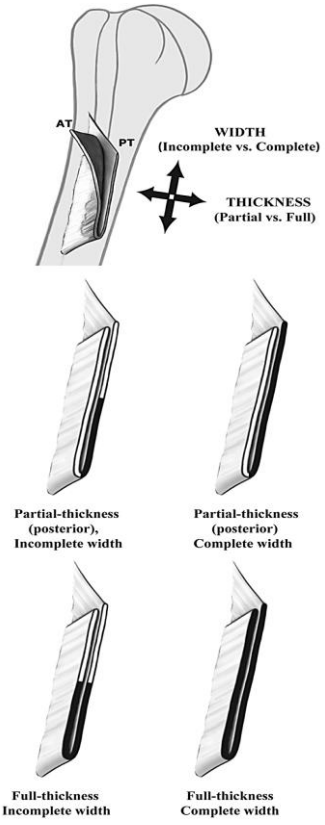

Fig 2: ElMaraghy classification [5]. Tear extent is evaluated by its width in a proximal-to-distal direction and its thickness in an anterior-to-posterior direction. AT : anterior tendon layer; PT : posterior tendon layer. Dark line : Tear patterns.

We underscore the challenge of accurately diagnosing a partial thickness rupture within the posterior layer of the PMT during physical examination, especially in acute cases. Preservation of the axillary fold continuity might falsely suggest intactness if the anterior tendon layer and its associated muscle segments (clavicular head and the majority of sternal segments) remain unaffected [15] (figure 3). Although Magnetic Resonance Imaging (MRI) is instrumental in detecting complete-width, full-thickness ruptures, its inability to differentiate between the bilaminar tendon layers diminishes its reliability in identifying partial thickness PM ruptures [16]. Numerous studies highlight that the definitive characterization of the rupture's true morphology (including location and extent) often occurs exclusively during surgical intervention [10, 12].

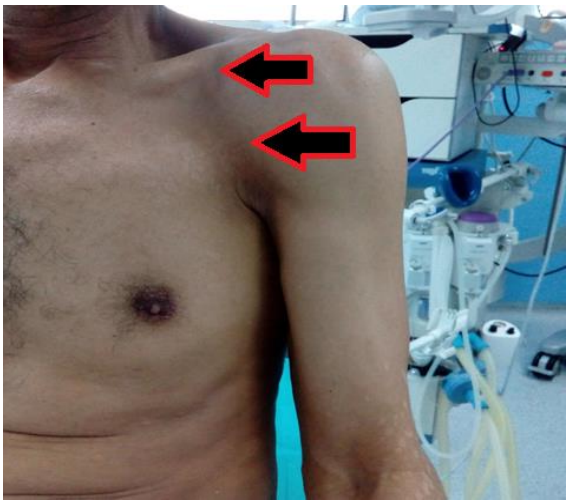

Fig 3: The depression of the axillary fold (arrows) associated with a pectoralis major muscle rupture.

SURGICAL TECHNIQUE

The patient is positioned supine under general anesthesia. An arm holder facilitates arm positioning. Intravenous antibiotics are administered during induction, and the skin is meticulously prepared with antiseptic paint. The surgical area is draped, with the arm exposed and the axilla shielded using povidone-iodine

impregnated occlusive drapes. An oblique incision is made along the deltopectoral groove. Axillary incisions are avoided due to the risk of deep infection. In cases where both the clavicular and sternal heads are ruptured, dissection proceeds medially to the deltoid, ensuring preservation of the cephalic vein (figure 4). In cases of simultaneous rupture of both the clavicular and sternal heads, dissection occurs medial to the deltoid while preserving the cephalic vein. If the clavicular head remains intact, the torn or ruptured sternal head is located beneath it, necessitating dissection medial to the clavicular head for identification. The retracted tendon is then identified and mobilized, with meticulous care taken to prevent injury to the medial and lateral pectoral neurovascular bundles [12].

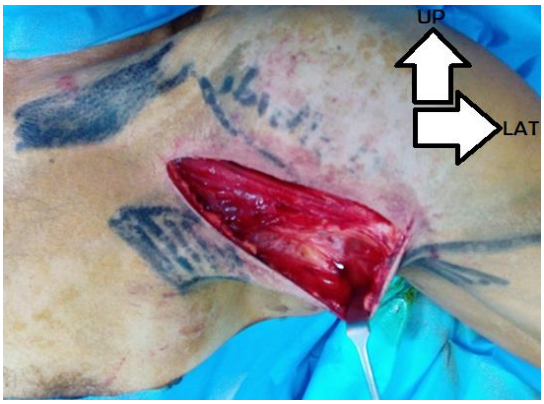

Fig 4: Intraoperative image depicting the incision and dissection of the superficial planes at the level of the axillary fold.

The Transosseous Suture with Bone Trough Technique involves creating a vertical trough above the insertion site of the PMM tendon, followed by drilling holes lateral to the trough. High-strength non-absorbable or absorbable sutures are utilized, placed through the tendon or muscle in a locking configuration using Krackow, Kessler, or Mason-Allen techniques [17, 18]. In cases of significant tendon damage or retraction, an allograft or autograft may be employed in conjunction with one of the aforementioned fixation techniques [12]. Sutures are then passed through the tendon, into the trough, out of the drill holes, and secured over the bone bridge (Figures 5 – 8).

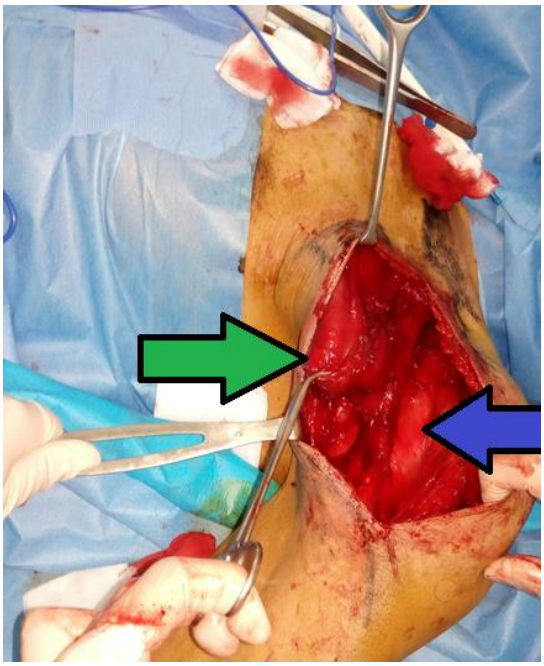

Fig 5: Intraoperative image illustrating the technique for repairing the PMT. The green arrow highlights the termination of the PMT, while the blue arrow indicates the bone trough.

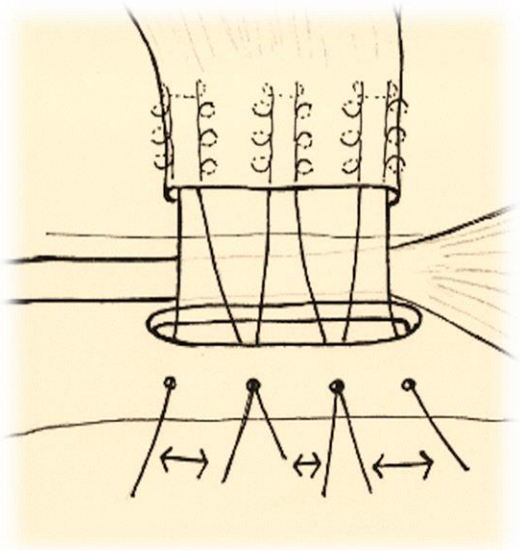

Fig 6: Schematic of bone trough repair: A 5-cm trough is carved into the insertion point of the pectoralis major muscle, situated lateral to the biceps tendon. Four drill holes are positioned 1 cm outward from the bone trough. Sutures are threaded through the tendon using a Krackow configuration, then passed through the

trough and out of separate drill holes. Following tendon realignment, sutures are securely tied [19].

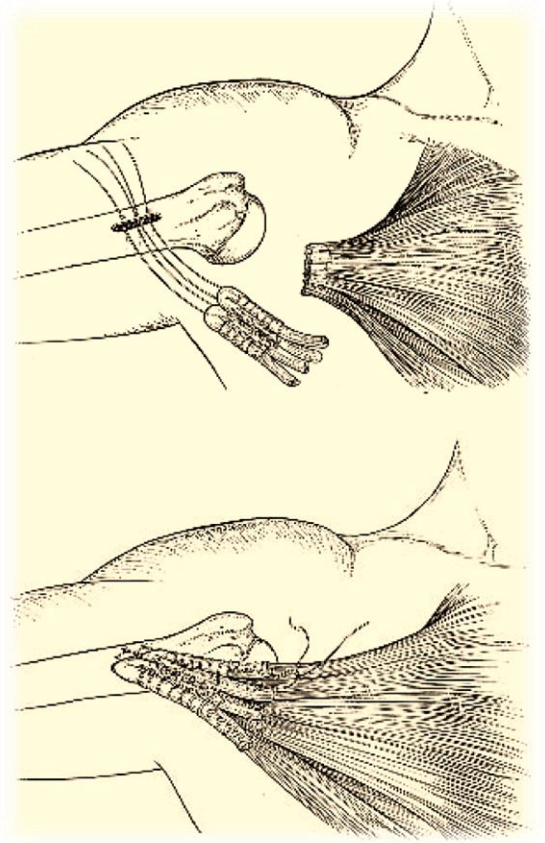

Fig 7: The schema outlines the utilization of allografts or autografts for significant tendon damage or retraction. A fixation method is applied, which includes crafting a graft using a 4-strand technique, threading suture ends through a trough in the humerus. Following this, the graft is anchored to the pectoralis muscle using the Krakow suture technique [19].

Prior to wound closure, the optimal range of motion (before the repair is tensioned) is assessed by gently moving the arm through its range, and this assessment is documented [5]. After surgery, the patient's arm is supported in a sling, while immediate engagement in active hand, wrist, and elbow exercises is encouraged. Initially, shoulder movement is restricted to passive motion within a predetermined safe range determined during surgery (typically external rotation to neutral and forward elevation to 60 degrees). Between 3 and 6 weeks post-surgery, the physiotherapist initiates active assisted motion, progressing to independent active motion thereafter [12]. Rehabilitation protocols are customized for each patient, considering factors such as the tear's chronicity, size, and location, as well as the quality of tendon and repair, and individual patient characteristics [17, 18].

Fig 8: Postoperative anteroposterior control X-ray displaying the impression of the bone trough and drill holes.

EFFICIENCY & RELIABILITY OF SURGICAL TECHNIQUE

Numerous studies have examined various repair techniques for PMT ruptures, aiming to determine their efficacy and reliability. Recent investigations have sought to establish the biomechanical superiority among these techniques. In 2011, Hart et al. [20] conducted a study comparing the Transosseous Suture (TOS) with trough technique to the use of suture anchors (SA), finding no significant biomechanical difference between the two methods. Building on this research, Rabuck et al. [19] compared the TOS with trough technique to SA and the cortical button repair method. Their findings indicated that the TOS with trough technique exhibited the highest strength among the repair methods assessed.

Moreover, in their meta-analysis, Gupton et al. [12] observed that the TOS technique consistently yielded the most favorable clinical outcomes. They reported a 96.8%

combined excellent/good outcome rate, along with the lowest rates of fair/poor outcomes (3.2%) and complications (3.2%). The TOS technique also boasted the highest predicted probability (97%) of achieving an excellent/good outcome compared to other commonly utilized techniques.

Furthermore, the cost-effectiveness of the TOS technique is notable, as it requires minimal resources, relying solely on simple absorbable and non-absorbable sutures without the need for additional specialized devices.

CONCLUSION

In summary, the Bone Trough Repair Technique, particularly when utilizing the Transosseous Suture approach, demonstrates notable efficacy and reliability in managing Pectoralis Major Tendon ruptures. Studies consistently highlight its biomechanical strength, favorable clinical outcomes, and cost-effectiveness. As such, it stands as a preferred surgical strategy for restoring function and promoting optimal postoperative recovery in patients with PMT injuries.

REFERENCES

[1] Durant EJ, De Cicco FL. Pectoralis Major Tear. 2023 Aug 7. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 31751065.

[2] Aarimaa V, Rantanen J, Heikkila J, Gelttula I, Orava S. Rupture of the pectoralis major muscle. Am J Sports Med 2004;32:1256-62. doi:10.1177/0363546503261137.

[3] Choufani C, Lebon L, Lefort H, Barbier O. Rupture du tendon du muscle grand pectoral [Pectoralis major rupture]. Rev Prat. 2021 Oct;71(8):870. French. PMID: 35147342.

[4] Patissier P. Traite des Maladies des Artisans. Paris; 1822.

[5] ElMaraghy AW, Devereaux MW. A systematic review and comprehensive classification of pectoralis major tears. J Shoulder Elbow Surg. 2012 Mar;21(3):412-22. doi: 10.1016/j.jse.2011.04.035. Epub 2011 Aug 10. PMID: 21831661.

[6] Merolla G, Paladini P, Artiaco S, Tos P, Lollino N, Porcellini G. Surgical repair of acute and chronic pectoralis major tendon rupture: clinical and ultrasound outcomes at a mean follow-up of 5 years. Eur J Orthop Surg Traumatol. 2015 Jan;25(1):91-8. doi: 10.1007/s00590-014-1451-y. Epub 2014 Apr 10. PMID: 24719085.

[7] Giordano JR, Klein B, Hershfeld B, Gruber J, Trasolini R, Cohn RM. A review of chronic pectoralis major tears: what options are available? Clin Shoulder Elb. 2023 Sep;26(3):330-339. doi: 10.5397/cise.2023.00129. Epub 2023 Aug 11. PMID: 37607861; PMCID: PMC10497927.

[8] Kowalczuk M, Elmaraghy A. Pectoralis Major Rupture: Evaluation and Management. J Am Acad Orthop Surg. 2022 Apr 1;30(7):e617-e627. doi: 10.5435/JAAOS-D-21-00541. PMID: 35025841.

[9] Wolfe SW, Wikiewicz TL, Cavanaugh JT. Rupture of the pectoralis major muscle. An anatomic and clinical analysis. Am J Sports Med 1992;20:587-3.

[10] Thompson K, Kwon Y, Flatow E, Jazrawi L, Strauss E, Alaia M. Everything pectoralis major: from repair to transfer. Phys Sportsmed. 2020 Feb;48(1):33-45. doi: 10.1080/00913847.2019.1637301. Epub 2019 Jul 23. PMID: 31246519.

[11] Rodríguez-Ridao D, Antequera-Vique JA, Martín-Fuentes I, Muyor JM. Effect of Five Bench Inclinations on the Electromyographic Activity of the Pectoralis Major, Anterior Deltoid, and Triceps Brachii during the Bench Press Exercise. Int J Environ Res Public Health. 2020 Oct 8;17(19):7339. doi: 10.3390/ijerph17197339. PMID: 33049982; PMCID: PMC7579505.

[12] Gupton M, Johnson JE. Surgical Treatment of Pectoralis Major Muscle Ruptures: A Systematic Review and Meta-analysis. Orthop J Sports Med. 2019 Feb 7;7(2):2325967118824551. doi: 10.1177/2325967118824551. PMID: 30800687; PMCID: PMC6378447.

[13] Tietjen R. Closed injuries of the pectoralis major muscle. J Trauma. 1980 Mar;20(3):262-4. doi: 10.1097/00005373-198003000-00015. PMID: 7359604.

[14] Bak K, Cameron EA, Henderson IJ. Rupture of the pectoralis major: a meta-analysis of 112 cases. Knee Surg Sports Traumatol Arthrosc. 2000;8(2):113-9. doi: 10.1007/s001670050197. PMID: 10795675.

[15] Hinz M, Kleim BD, Mayr F, Imhoff AB, Siebenlist S. Akute muskulotendinöse Ruptur des M. pectoralis major : Fallbericht einer seltenen Verletzung und Literaturübersicht [Acute rupture of the pectoralis major muscle at the musculotendinous junction : Case report of a rare injury and literature review]. Unfallchirurg. 2021 Nov;124(11):951-956. German. doi: 10.1007/s00113-021-00997-6. Epub 2021 Apr 19. PMID: 33876275; PMCID: PMC8571155.

[16] Godoy IRB, Martinez-Salazar EL, Simeone FJ, Bredella MA, Palmer WE, Torriani M. MRI of pectoralis major tears: association between ancillary findings and tear severity. Skeletal Radiol. 2018 Aug;47(8):1127-1135. doi: 10.1007/s00256-018-2893-9. Epub 2018 Feb 9. PMID: 29426957.

[17] Lipman A, Strauss E. Treatment of Pectoralis Major Muscle Ruptures. Bull Hosp Jt Dis (2013). 2016 Mar;74(1):63-72. PMID: 26977551.

[18] Petilon J, Carr DR, Sekiya JK, Unger DV. Pectoralis major muscle injuries: evaluation and management. J Am Acad Orthop Surg. 2005 Jan-Feb;13(1):59-68. doi: 10.5435/00124635-200501000-00008. PMID: 15712983

[19] Rabuck SJ, Lynch JL, Guo X, Zhang LQ, Edwards SL, Nuber GW, Saltzman MD. Biomechanical comparison of 3 methods to repair pectoralis major ruptures. Am J Sports Med. 2012 Jul;40(7):1635-40. doi: 10.1177/0363546512449291. Epub 2012 Jun 7. PMID: 22679296.

[20] Hart ND, Lindsey DP, McAdams TR. Pectoralis major tendon rupture: a biomechanical analysis of repair techniques. J Orthop Res. 2011 Nov;29(11):1783-7. doi: 10.1002/jor.21438. Epub 2011 Apr 28. PMID: 21538507.

THESIS

Morphology and asymmetry of the tibial plateau : Differences linked to the size of the epiphysis and to the sex

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ABSTRACT

BACKGROUND : Asymmetric tibial base plate for total knee replacement would optimize the coverage of the tibial plateau and reduce the risk of overhang and conflict with the soft parts around the knee.
Our work is a morphological analysis of the upper end of the tibia and the asymmetries wich exists between the medial and lateral compartment.

METHODS : We carried out on the analysis of 150 MRIs of knee performed in our radiology department (90 men and 60 women (sex ratio: 3/2). Average age: 39.7 years old).

The measurements performed were: tML, tMAP, tLAP, RCM, RCL, MBB and LBB. Also, we opted for the calculation and the comparison according to the gender of the following ratios: tMAP / tML, tLAP / tML, RCM / tML and RCL / tML.

In order to characterize the asymmetry between the medial and lateral tibial condyles, we opted for the calculation of the following ratios: tLAP / tMAP; LBB / MBB and RCL / RCM.

RESULTS : Our results demonstrated greater measurements in men with a structural differences for tMAP, tLAP, RCM. However, thess differences was more related to the size of the epiphysis for RCL, MBB, LBB.
The asymmetry was more pronounced in women with tLAP / tMAP and did not vary with the size of the epiphysis. Size differences was less pronounced for RCL / RCM and LBB / MBB.

CONCLUSION : These various elements could justify the interest of using an asymmetric tibial base to optimize coverage during knee replacements.

KEY WORDS : Asymmetry, Morphology, MRI, Tibial plateau.

Conflicts of interests: All authors declare that they have no direct or indirect conflict of interest related to the work submitted for publication

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I. INTRODUCTION

The morphological analysis of the tibial plateau reveals asymmetry of the two condyles [1–5]. This asymmetry concerns both the antero-posterior and transverse measurements as well as the aspect of the anterior rim. This encouraged the development of asymmetric total knee replacement (TKA) tibial bases that would optimize the coverage of the tibial plateau and reduce the risk of overhang and conflict with the soft tissues around the knee [6–10]. In order to better characterize the asymmetry between the two sides of the tibial plateau and to conceptualize a prosthetic component that would better cover the tibial resection surface with minimal overhang and unnecessary internal

rotation, we looked at the measurements of this extremity and studied the differences in it. We also wanted to investigate whether this asymmetry varied with gender or whether the apparent gender differences were only related to the difference in epiphyseal size. The last point we wanted to support was to see if the degree of asymmetry between the two sides of the tibial plateau varied with epiphyseal size or not.

II. MATERIAL AND METHODS

Our study was carried out on the analysis of 150 knee MRIs performed at the radiology department of our institution. These were MRIs of normal knees (12%) or presenting meniscal lesions (63%), rupture of the ACL (26%) or PCL (4.6%), osteoarthritis (33.3%) or cartilage damage (32.6%). Our cohort consisted of 90 men and 60 women (sex ratio: 3/2). The average age was 39.7 years with extremes ranging from 18 to 72 years. We excluded all MRIs of knees with fractures and malunions, neoplastic lesions, congenital dysmorphisms, open growth cartilage, and valgus or varus deformities greater than 15 degrees.

MRI technique:
MRI was performed using a Siemens Magnetome Amira 1.5 Tesla device (Siemens Healthineers Global syngo.plaza Viewer). MRI scans were obtained using a sectional thickness of two millimeters.

Measurements:
In an axial plan, perpendicular to the diaphyseal axis, 10 mm below the articular cartilage.
- The medio-lateral width of the tibia (tML) is the longest medio-lateral distance in the reference axial section. (Figure 1)
- The medial antero-posterior length (tMAP) and the lateral antero-posterior length (tLAP) were defined as the longest anteroposterior distances plotted perpendicular to the tML line, respectively at the level of the medial and lateral tibial condyles (Figure 1).
- Anteromedial radius (RCM): this is the radius of curvature of the circle tangent to the antero-medial part of the internal tibial plateau (Figure 2).
- Antero-lateral radius (RCL): this is the radius of curvature of the circle tangent to the antero-lateral part of the external tibial plateau (Figure 2).
- Medial bounding box (MBB) is the area in square millimeters (mm^2) of the rectangle drawn along the lines of the medio-lateral width and of the medial antero-posterior length containing the tibial plateau medial (Figure 3).

- Lateral bounding box (LBB) is the area in square millimeters (mm^2) whose edges delimit the external tibial plateau (Figure 3).
In order to compare our variables and eliminate the variations related to the size of the epiphysis, we opted for the calculation and comparison of the following ratios: tMAP / tML, tLAP / tML, RCM / tML and RCL / tML.
Also, in order to characterize the asymmetry between the medial and lateral tibial condyles, we analyzed the following ratios: tLAP / tMAP; LBB / MBB and RCL / RCM.
Statistical analysis:
The statistical analysis was performed using Student's t-test and Pearson's correlation coefficient, using SPSS for Windows (version 18.0, SPSS).

III. RESULTS

1. The tMAP, tLAP and tML :

The average of each of these variables (in terms of absolute values) is always greater for men than for women, with a significant difference between the two sexes ($p < 0.001$) (Table 2).
For tMAP / tML ratio, the average was 0.68 ± 0.23 for men and 0.68 ± 0.10 for women. For tLAP / tML ratio, it was 0.60 ± 0.23 for men and 0.61 ± 0.07 for women, with a statically significant difference between the

two sexes ($p < 0.001$) for the two ratios. This means that there is a structural difference between the two sexes regarding tMAP and tLAP not related to the size of the epiphysis.

2. The anterior radii of curvature (RCM and RCL):

The RCM's average was greater than RCL. The averages were as follows:

- RCM: 25.40 ± 2.91 mm for women and 29.02 ± 2.67 mm for men ($p < 0.0001$).
- RCL: 19.50 ± 2.67 mm for women and 21.40 ± 2.92 mm for men ($p < 0.0001$).

For men, the average RCM / tML was 0.38 ± 0.04, with extremes at 0.29 and 0.55. For women, it was 0.37 ± 0.04, with extremes of 0.24 and 0.48. The difference was significant (structural difference).
For men, the mean RCL / tML was 0.28 ± 0.04, with extremes at 0.20 and 0.43. For women, it was 0.28 ± 0.03, with extremes of 0.21 and 0.37. The difference was not significant (difference related to the size of the epiphysis).

3. Boundary frames (MBB and LBB):

The surface area of MBB was greater than LBB for both sexes.
For men, the average MBB was 1290.27 ± 338 mm², with extremes at 483 and 2083.18 mm². For women, it was 1139 ± 294 mm², with extremes at 491 and 1775 mm². The difference between the 2 sexes was significant ($p = 0.05$).
For men, the average LBB was 1035.57 ± 316 mm², with extremes at 368 and 1866 mm². For women, it was 889.6 ± 241 mm², with extremes at 384 and 1499 mm². The difference between the 2 sexes was significant ($p = 0.03$).
For men, the average MBB / tML was 16.89 ± 3.99, with extremes at 8.49 and 25.72. For women, it was 16.27 ± 3.91, with extremes at 7.25 and 25.44. The difference between the 2 sexes was not significant ($p = 0.349$) (difference related to the size of the epiphysis).
For men, the mean LBB / tML was 13.53 ± 3.71, with extremes at 5.54 and 22.85. For women, it was 12.70 ± 3.20, with extremes at 5.67 and 20.90. The difference between the two sexes was not significant ($p = 0.159$) (difference related to the size of the epiphysis).

4. Asymmetry of the two tibial compartments:

4.1.The tLAP / tMAP ratio:

The average tLAP / tMAP ratio for men was 0.89 ± 0.05 and for women it was 0.87 ± 0.06. This means that the lateral compartment is smaller than the medial compartment with a statically significant difference in ratio between the two sexes ($p = 0.03$). The asymmetry between the 2 compartments is more pronounced in women.
The tLAP/tMAP ratio did not vary according to the tML ($r^2 = 0.0003$) and therefore, the asymmetry of the two compartments does not really vary according to the size of the epiphysis.

4.2.The RCL / RCM ratio :

For men, the average RCL / RCM ratio was 0.76 ± 0.13, with extremes at 0.50 and 1.42. For women, it was 0.74 ± 0.09, with extremes of 0.56 and 0.95. The difference was not significant between the two sexes ($p = 0.2$).
The increase in tML is accompanied by a negligible increase in the RCL / RCM ratio, with an $r^2 = 0.038$.

4.3.The LBB / MBB ratio :

This ratio varies between 0.48 and 1.06 with an average of 0.80 ± 0.13 for men. It varies between 0.40 and 1.28 with an average of 0.79 ± 0.13 for women. The difference between the two sexes is not significant ($p = 0.516$).
The LBB / MBB ratio increases slightly with increasing tML, with $r = 0.14$ (weak positive correlation).

IV. DISCUSSION

Our work is a morphological analysis and a study of the asymmetry of the tibial plateau on 150 knee MRIs. The use of MRI in our study emanates from its reliability in such analyzes [11]. Previous studies on the morphology of the upper end of the tibia have been carried out around the world (America, Europe and Asia) [1, 2, 4, 5, 12–15]. In Africa, we have only listed two studies: the first concerning South Africa [16] and the second concerning Egypt, Sudan, Somalia and Djibouti [13]. To our knowledge, our study is the first in Morocco and in the Maghreb.

Knowing the morphological characteristics of the proximal tibia would make the choice of the most suitable tibial base possible, ensuring the best coverage of the tibial cut without ending up with an overhang which would be at the origin of a conflict with surrounding capsuloligamentous structures or detrimental internal rotation [7–10]. Thus, the asymmetrical design (reduced lateral component) have shown less conflict with the popliteal tendon and a better fit at the tibial plateau [17].

Dai and al. showed that the coverage of the tibia by a non-anatomical component was approximately 85-87%, while it increases to 92% with the use of an anatomical models [7]. Also, symmetrical base requires an internal rotation of more than 5 ° for compensation in 39 to 60% of patients to improve bone coverage [7, 8, 18].

In our population, and as shown in the literature [1, 6, 7, 14, 19–21], the averages of tML, tMAP and tLAP as well as the anterior radii of curvature RCM and RCL and the bounding boxes MBB and LBB showed a statically significant difference in terms of absolute values

according to the gender, with larger dimensions in men. Also, the lateral compartment was smaller than the medial with statistically significant differences.

In order to see if these differences between the two sexes were structural or only related to the difference in the size of the epiphysis, we calculated the "variable / tML" ratios.

The ratios tMAP / tML, tLAP / tML and RCM / tML showed significant differences according to the gender. We concluded that for equal tML, the values of tMAP, tLAP, and RCM in men were greater than in women; and therefore, there is a structural morphological difference of the tibial plateau between men and women not depending on the size of the epiphysis (tML). Lim et al [19] in their study on the Korean population found the seam result concerning tMAP / tML but without a significant difference between the two sexes for tLAP / tML. Also during our review of the literature, other authors: Mahfouz (Asians, Caucasians, Americans of African origin) [5], li (Caucasians) [14], Lim (Koreans) [19], Misir (Turkish) [22], Zhang (north of china) [23] found that there were structural differences according to the sex and that at equal epiphysis size the measurements in women were smaller, using the tML / tAP ratio (aspect ratio) as defined by Hitt [24]; the tAP being defined by the maximum distance between the anterior and posterior edges of the intercondylar region. Hafez (Arabic) [13], Shah (India) [20] and Moghtadaei (Iran) [15], Li (China) [14] Agrawal (India) [25] did not objectify this difference using the “ aspect ratio ”. However, it seems to us that our approach (calculation of tMAP / tML and tLAP / tML ratios) is more sensitive and accurate for the detection of these structural differences between the two sexes than the calculation of the aspect ratio.

The RCL / tML, MBB / tML and LBB / tML ratios showed insignificant differences between the two sexes. We concluded that at epiphysis size; RCL, MBB and LBB have the same values in both sexes.

All morphological studies of the proximal tibia, as well as our present study, objectify an asymmetry between the two condyles with reduced measurements on the lateral side [9, 10, 24, 26], but few are those which characterize this asymmetry in sex and its variability according to the size of the

epiphysis. To do so, we have studied a number of ratios: tLAP / tMAP; LBB / MBB and RCL / RCM, their variations according to sex and according to the size of the epiphysis (tML).
We were able to objectify that the difference between these 2 compartments (tLAP / tMAP ratio) was more pronounced in women (p=0.03) as noticed by Hafez [13]. This asymmetry (tLAP / tMAP ratio) did not vary according to the size of the epiphysis (tML). The asymmetry between the two compartments also concerned the difference between RCM and RCL as well as MBB and LBB, although there was no significant difference in RCL / RCM and LBB ratios / MBB according to the gender. These ratios, along with tLAP / tMAP, did not vary with epiphysis size. We did not find any studies that looked at these ratios.
In our opinion, as for many authors, our results support the use of an asymmetric tibial base to maximize coverage of the resected tibial surface while avoiding conflict with peripheral structures and internal rotation of the base [7–9]. It even seems that, because of the structural differences linked to the sex in the tibia, the use of "gender" type implants could be advantageous; this would have smaller tMAP, tLAP and RCM measurements at equal tML and a smaller tLAP / tMAP ratio. This opinion is not shared by all the authors, some would preferentially opt for symmetrical implants [18].

CONCLUSION

Our present morphologic study showed that there is a structural difference of the anteroposterior measurements of the medial and lateral tibial plateau as well as the anterior radius of curvature of the medial plateau according to the gender. This difference is unrelated to the size of the epiphysis. Also, the asymmetry of the two plateaus tLAP / tMAP is more pronounced in women. These various elements could justify the interest of using an asymmetric "gender" tibial base to optimize coverage during knee replacements.

Declarations of interest: none

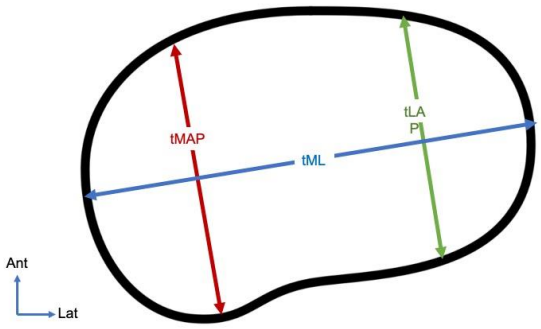

Figure 1

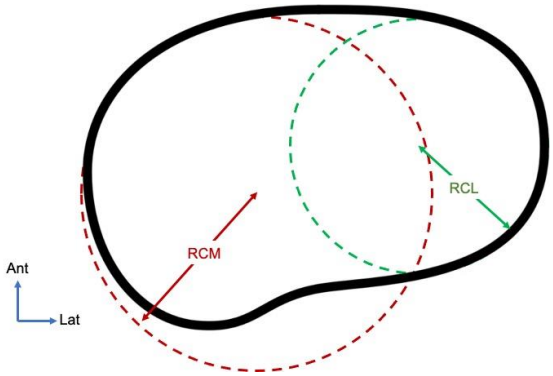

Figure 2

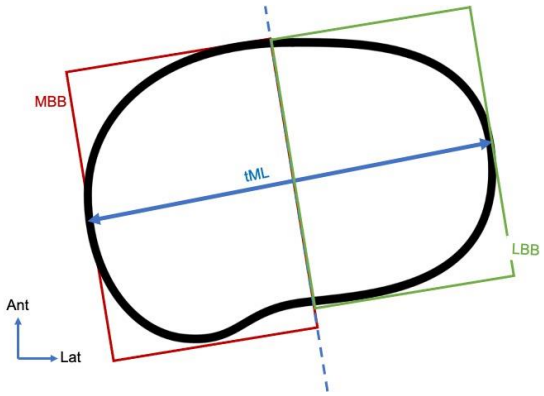

Figure 3

Variables	Male			Female			Both sexes	p
	Max	Min	Average	Max	Min	Average	Average	
tML	92.14	56.92	76.06± 6.64	84.31	57.46	69.97± 6.46	73.63± 7.20	<0.001
tMAP	62.56	35.38	52.27± 5.54	63.24	38.19	48.49± 5.80	50.74± 5.93	<0.001
tLAP	55.71	33.08	46.65± 4.97	53.95	29.59	42.23± 5.04	44.88± 5.43	<0.001

Table 1 : Antero-posterior and transverse measurements.

LEGENDS

FIGURES

Figure 1: Representative diagram of tMAP, tLAP and tML on an axial section [12].
Figure 2: RCM and RCL radii of curvature, as adopted from Dai et al. [6, 7]
Figure 3: MBB and LBB surfaces on an axial section.

TABLES

Table 1: Antero-posterior and transverse measurements.

BIBLIOGRAPHY

1. Alkan SB, Acar M, Altunkeser A, et al (2017) Analysis of Some Morphometric Parameters of Tibia. Asian J Biomed Pharm Sci 7:

2. Hovinga KR, Lerner AL (2009) Anatomic variations between Japanese and Caucasian populations in the healthy young adult knee joint. J Orthop Res Off Publ Orthop Res Soc 27:1191–1196. https://doi.org/10.1002/jor.20858

3. Bansal V, Mishra A, Verma T, et al (2018) Anthropometric assessment of tibial resection surface morphology in total knee arthroplasty for tibial component design in Indian population. J Arthrosc Jt Surg 5:24–28. https://doi.org/10.1016/j.jajs.2017.12.002

4. Fan L, Xu T, Li X, et al (2017) Morphologic features of the distal femur and tibia plateau in Southeastern Chinese population: A cross-sectional study. Medicine (Baltimore) 96:e8524. https://doi.org/10.1097/MD.0000000000008524

5. Mahfouz M, Abdel Fatah EE, Bowers LS, Scuderi G (2012) Three-dimensional morphology of the knee reveals ethnic differences. Clin Orthop 470:172–185. https://doi.org/10.1007/s11999-011-2089-2

6. Dai Y, Bischoff JE (2013) Comprehensive assessment of tibial plateau morphology in total knee arthroplasty: Influence of shape and size on anthropometric variability. J Orthop Res Off Publ Orthop Res Soc 31:1643–1652. https://doi.org/10.1002/jor.22410

7. Dai Y, Scuderi GR, Bischoff JE, et al (2014) Anatomic tibial component design can increase tibial coverage and rotational alignment accuracy: a comparison of six contemporary designs. Knee Surg Sports Traumatol Arthrosc Off J ESSKA 22:2911–2923. https://doi.org/10.1007/s00167-014-3282-0

8. Jin C, Song E-K, Prakash J, et al (2017) How Much Does the Anatomical Tibial Component Improve the Bony Coverage in Total Knee Arthroplasty? J Arthroplasty 32:1829–1833. https://doi.org/10.1016/j.arth.2016.12.041

9. Wevers HW, Simurda M, Griffin M, Tarrel J (1994) Improved fit by asymmetric tibial prosthesis for total knee arthroplasty. Med Eng Phys 16:297–300. https://doi.org/10.1016/1350-4533(94)90054-x

10. Kwak DS, Surendran S, Pengatteeri YH, et al (2007) Morphometry of the proximal tibia to design the tibial component of total knee arthroplasty for the Korean population. The Knee 14:295–300. https://doi.org/10.1016/j.knee.2007.05.004

11. Loures FB, Carrara RJ, Góes RF de A,

et al (2017) Anthropometric study of the knee in patients with osteoarthritis: intraoperative measurement versus magnetic resonance imaging. Radiol Bras 50:170–175. https://doi.org/10.1590/0100-3984.2016.0007

12. Kim TK, Phillips M, Bhandari M, et al (2017) What Differences in Morphologic Features of the Knee Exist Among Patients of Various Races? A Systematic Review. Clin Orthop 475:170–182. https://doi.org/10.1007/s11999-016-5097-4

13. Hafez MA, Sheikhedrees SM, Saweeres ESB (2016) Anthropometry of Arabian Arthritic Knees: Comparison to Other Ethnic Groups and Implant Dimensions. J Arthroplasty 31:1109–1116. https://doi.org/10.1016/j.arth.2015.11.017

14. Li P, Tsai T-Y, Li J-S, et al (2014) Morphological measurement of the knee: race and sex effects. Acta Orthop Belg 80:260–268

15. Moghtadaei M, Moghimi J, Farahini H, Jahansouz A (2015) Morphology of proximal tibia in Iranian population and its correlation with available prostheses. Med J Islam Repub Iran 29:225

16. Naidoo N, Lazarus L, Ajayi NO, Satyapal KS (2015) Anthropometry of the Black Adult Tibia: A South African Study. https://doi.org/10.4067/S0717-95022015000200030

17. Kazakin A, Nandi S, Bono J (2014) Diagnosis and treatment of intraoperative popliteus tendon impingement. J Knee Surg 27:485–488. https://doi.org/10.1055/s-0034-1367729

18. Incavo SJ, Ronchetti PJ, Howe JG, Tranowski JP (1994) Tibial plateau coverage in total knee arthroplasty. Clin Orthop 81–85

19. Lim H-C, Bae J-H, Yoon J-Y, et al (2013) Gender differences of the morphology of the distal femur and proximal tibia in a Korean population. The Knee 20:26–30. https://doi.org/10.1016/j.knee.2012.05.010

20. Shah DS, Ghyar R, Ravi B, et al (2014) Morphological Measurements of Knee Joints in Indian Population: Comparison to Current Knee Prostheses. Open J Rheumatol Autoimmune Dis 4:720–726. https://doi.org/10.4236/ojra.2014.42012

21. Gandhi S, Singla RK, Kullar JS, et al (2014) Morphometric Analysis of Upper End of Tibia. J Clin Diagn Res JCDR 8:AC10–AC13. https://doi.org/10.7860/JCDR/2014/8973.4736

22. Misir A, Yildiz KI, Kizkapan TB (2019) Wider femoral and mediolaterally narrower tibial components are required for total knee arthroplasty in Turkish patients. Knee Surg Sports Traumatol Arthrosc 27:2155–2166. https://doi.org/10.1007/s00167-019-05448-9

23. Zhang Y, Wang J, Xiao J, et al (2014) Measurement and comparison of tibial posterior slope angle in different methods based on three-dimensional reconstruction. The Knee 21:694–698. https://doi.org/10.1016/j.knee.2014.01.008

24. Hitt K, Shurman JR, Greene K, et al (2003) Anthropometric measurements of the human knee: correlation to the sizing of current knee arthroplasty systems. J Bone Joint Surg Am 85-A Suppl 4:115–122

25. Agrawal DRRK, Dalei DTR, Reddy DAG (2017) Computer tomography 3D reconstruction based study of knee anthropometry of Indian population: Comparison with other ethnic groups and current TKA implants. Int J Orthop Sci 3:242–249

26. Mensch JS, Amstutz HC (1975) Knee morphology as a guide to knee replacement. Clin Orthop 231–241

THESIS

Bone allograft : Preliminary results of the bone bank of the CHU Mohammed VI of Marrakech

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SUMMARY

Bone allografts have gained a privileged place in the therapeutic arsenal in orthopedic surgery, due to the bone bank that currently delivers cryo-preserved femoral heads. Our work aims to appreciate bone allografts as a mode of skeleton reconstruction and to evaluate its effectiveness based on different indications through the analysis of postoperative results, including functional and radiological results. This is a prospective descriptive study of fifteen cases of cryopreserved femoral head bone allografts from the bone bank over a 2-year period from April 2018 to February 2020. Our patients were divided into 3 groups based on the indications for allografting: PTH revision group (73%), tumor reconstruction group (20%) and pseudarthrosis group (7%).

The average age of the PTH revision group was 69 years, that of the tumor reconstruction group was 28 years, while that of the pseudarthrosis group was 25 years. A clear female predominance was noted in our series. Preoperative and postoperative clinical evaluation of patients operated for PTH revision was performed using the Postel and Merle d'Aubigné score. Evaluation of bone loss of the cotyle was classified according to the SOFCOT 99 classification. The average postoperative follow-up was 10 months. Our clinical and radiological results were judged to be good to very good in the majority of cases with good integration of the bone allograft. Postoperative complications were marked by: one case of posterior hip dislocation, one case of postoperative infection surgically repaired.

Conflict of interest: The authors declare no conflict of interest in connection with the writing of this article.

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INTRODUCTION

Orthopedic surgery has experienced a significant expansion in our country. In fact, the first generations of total hip replacements are starting to come back for revisions that have proven to be laborious with the large bone defects they generate, as well as the traumatic sequelae of road accidents and the large amounts of bone loss difficult to fill in conservative surgeries of tumor pathology. Our work aims to:
Evaluate and assess the need for reconstructive surgery
Evaluate the functional results of patients with bone allografts

MATERIALS AND METHODS

2.1. Patients

This was a prospective study of 15 patients who were divided into 3 groups based on the indications for allograft : hip revision group (73%), tumor reconstruction group (20%), and pseudarthrosis group (7%), between April 2018 to February 2020. The average age of the hip revision group was 69 years, that of the tumor reconstruction group was 28 years, while that of the pseudarthrosis group was 25 years. A clear female predominance was noted in our

series. The initial etiology that required primary arthroplasty was in 8 cases (73%) a primary coxarthrosis, in 2 cases (18%) a hip dysplasia, in 1 case (9%) a rheumatoid arthritis.

2.2. Methods:

Graft preparation:

It starts with coordination with the bone bank to obtain cryo-preserved femoral heads, respecting the cold chain during their transportation from the bone bank to the operating room Upon arrival in the operating room, the allograft bone was warmed in the operating room in a physiological serum solution at 37°C supplemented with 1200 mg of Rifampicin (Rifadine®) (Figure 1)

To facilitate their incorporation into the bone defect, the femoral heads were cut into rounds after removing the cartilaginous part A homolateral iliac crest autograft was used in 13 patients. (figure 2)

THE SURGICAL PROCEDURE

The patients were fully informed about the bone allograft and its source from the bone bank. All 15 patients signed an informed consent before the surgical procedure. The revision was performed in a single stage for all patients. The acetabular revision technique was the same for all patients. The hip was approached through a posterior-lateral approach of Moore. The revision was performed in a single stage for 11 patients, with a duration of 4 to 5 hours. The acetabular implant was removed, along with interposition tissues. The acetabulum was then reamed until a bleeding bone was obtained. The loss of bone substance was filled with a bone allograft-autograft.

Implementation of the cortico-spongy graft filling the bone loss at the socket level. Implementation of the Kerboull ring which was done in all our patients who underwent PTH revision (figure 3). Stabilization of the Kerboull ring by cortical screws that are supported by the graft. Implementation of the socket of the double mobility revision prosthesis, followed by the femoral component which includes preparation of the femoral shaft with rasps. Preparation of the femur with a bone window or femoral osteotomy. Cement is placed in case of a cemented prosthesis and the final stem is placed. The prosthesis is then reduced after the head is placed on the stem and finally the stability of the prosthesis is checked at the end of the surgical procedure. These allografts came from cryopreserved femoral heads from the bone bank.

RESULTS

At a mean follow-up of 10.5 months, 15 cases of bone allografts of all indications, with extremes ranging from one month to 20 months 11 cases of PTH revision were performed in a single surgical time that lasted from 4 to 5 hours using a cemented double mobility revision prosthesis (Figure 4). 3 cases of tumor reconstruction for 2 aneurysmal cysts and 1 giant cell tumor case were initially treated with a curettage and filling with biological cement, and 6 months later with removal of the cement followed by reconstruction with cryopreserved allograft combined with an autograft from the patient's iliac crest (Figure 5).

One patient treated for aseptic pseudarthrosis of the leg on several occasions, a leg x-ray showed a fracture of the locked tibial plate, the patient benefited from removal of the plate and medullary nailing with placement of an autograft from the patient's iliac crest and a cryopreserved femoral head allograft. Consolidation was achieved in 5 months without complications (Figure 6). Careful study of successive x-rays and comparison with the early postoperative x-ray constitutes the main time for monitoring all total hip replacements that we have implanted in order to detect early complications and propose reintervention. For simplicity, the radiological study was carried out using three frontal pelvis x-rays: preoperative,

postoperative, and at the latest follow-up. No peri-prosthetic ossification was observed. The integration of the bone graft was judged good in all our patients at the latest follow-up.
The functional result in patients treated for hip revision surgery showed a significantly increased score of 3.4 points, from 9.8 to 13.2 points. The follow-up of our study is not long enough, so we can only give preliminary results regarding the survival rate of the implant after revision surgery. Regarding complications, there was 1 case of posterior hip dislocation treated with reduction under sedation in the operating room and 1 case of postoperative infection in a patient treated for hip revision surgery, which was controlled by removal of the material, abundant lavage, and an antibiotic therapy adapted to the antibiogram.

DISCUSSION

Revision Total Hip Arthroplasty (THA) :

Comparing the data from the literature on the subject is difficult due to the fact that both the lesions treated (severity of bone loss), the bone reconstruction techniques, and the implants used are different. If we focus more specifically on the studies using cryopreserved impacted allograft for filling the bone loss associated with a support ring (Table 1).

Regarding functional evaluation, the average overall functional score of Merle d'Aubigné according to Kerboull [1] was 17.4 at the last follow-up compared to 11.7 before surgery. According to Villatte [2], the PMA score was significantly increased after the intervention. This average PMA score at the last follow-up was (13.8). In Philippe's series [3], the PMA score significantly improved with an overall PMA score of 14.8, which is in line with our results in our series, where the PMA score improved from 9.8 to 13.2 with an average follow-up of 10.5 months.

As for complications, Erivan reported a 7% infection rate, 6% dislocation, and 8% aseptic loosening. According to Villatte [2], one patient was surgically revised for infection (1%), 6% for dislocation, and 2% for aseptic loosening. While Boyer [4] only reported 2% dislocation in a series of 152 patients. In our series, we only had one case of postoperative infection and one case of post dislocation, and no cases of either septic or aseptic loosening were reported.

TUMOR RECONSTRUCTION

Tumor pathology preferentially affects young women. According to Gharedaghi's study [5] on the evaluation of clinical results and complications of structural allograft reconstruction after bone tumor surgery, the average age of patients was 24 with a male predominance. According to Bullen's study [6] which reports the survival of massive allografts in segmental reconstructions of oncological bone defects, the average age of patients was 27 with a female predominance. In our series, the average age of our 3 patients was 28 years. In Gharedaghi's series [5], the predominant location was the distal end of the femur for 36 patients. The predominant histological type was osteosarcoma in 37% of cases. In our series, the location of the tumor was at the lower end of the femur in 67% with a predominance of aneurysmal cyst as the histological type. As for the evolution, Gharedaghi [5] noted 8 cases of infection, 6 cases of fracture, and 1 case of PSD in a series of 113. Farfali [7] reported 3 cases of infection, 3 cases of fracture, and 2 cases of PSD in a series of 26 patients. In our series, no complications have been reported.

THE PSEUDARTHROSIS

Bauer [8] treated 55 patients with an autologous graft for a septic pseudarthrosis of the femur or tibia, which was treated in two surgical procedures and healed and consolidated within 9 months.

In China [9], 14 patients were treated for PSD with a combination of autograft and plate fixation. Union was achieved in 5 months and 2 weeks; in our series, we treated one case of PSD with an allograft in a 25-year-old patient, and consolidation was obtained in 5 months, with an average delay of 10 months in our 3 patients

CONCLUSION

The bone bank project is more motivated by therapeutic necessity than by development and cutting-edge technologies. The major advantage of an allograft bone is a more biological reconstruction regardless of the indication. This observation implies a relentless fight against early and late postoperative complications.

Studies	Number of patients	Age (years)	Follow-up (years)	Acetabular defect	Type of graft
Pascarel and al.	211	63 (24—86)	6 (8—11)	Stade I 7 Stade II 44 Stade III 72 Stade IV 18	Structural/morceles Autograft/allograft
Massin and al.	81	61 (24—85)	8 (5—14)	Type I 7 Type II 18 Type III 52 Type IV 4 AAOS	Fragmented allograft Structural allograft
Kerboull and al.	60	68,5 (45—84)	10 (0—16)	Type III 48 Type IV 12	Fragmented allograft Structural allograft
Bonnome t and al.	56	60 (37—85)	8,2 (0,7—16,7)	Stade III 51 Stade IV 5 SOFCOT	Autograft/Allograft Structural/Piecemeal
Kawanab and al.	42	69,5 (42—86)	8,7 (4—12)	Type II 13 Type III 28 Type IV 1 (AAOS)	Fragmented allograft Bone substitute
R. Philippe and al.	95	69,5 (42—86)	8 (5—13,1)	Stade II 5 Stade III 84 Stade IV 6 AAOS	Fragmented Allograft
Villatte and al	88	71,7 ans (44,2-90)	10	I 4 II38 III44 IV 2 AAOS	Fragmented Allograft
Our serie	15	69	2	II 8 III 2 IV 1 I T1 10 III T1 1 SOFCOT 99	Allograft + Autograft

Table 1: Comparison of average age, follow-up, acetabular defect, and survival rates

Figure 1 : Cold chain

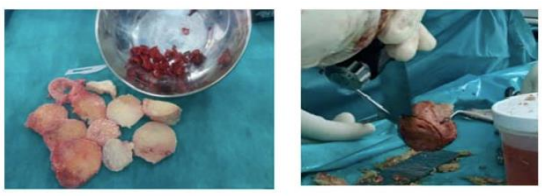

Figure 2 : Autografts + femoral heads in the form of disks.

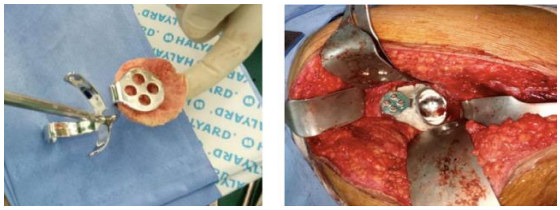

Figure 3 : Kerboull ring Figure 18: placement of the graft at the level of the acetabulum with placement of the Kerboull ring.

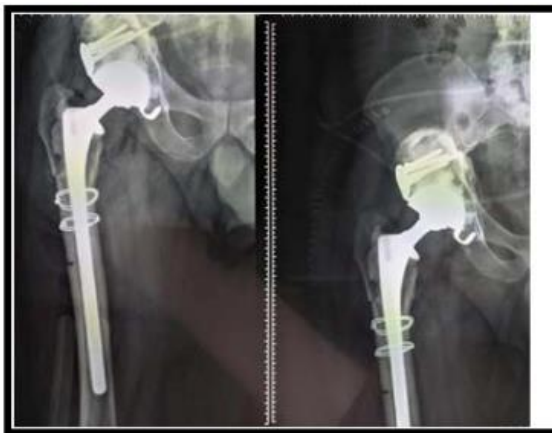

Figure 4 : Post-allograft control pelvis radiograph

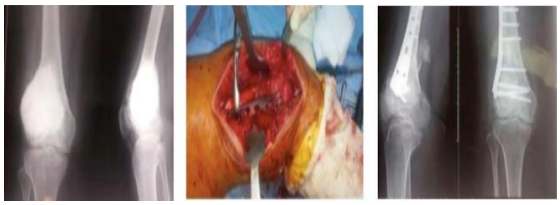

Figure 5 : a. Biological cement b. Placement of grafts and a locked plate of the lower extremity of the femur c. Postoperative control radiograph of tumor reconstructive surgery.

Figure 6 : a. Radiograph of the leg showing pseudarthrosis with a break in the osteosynthesis material b. Implementation of the centromedullary leg nail with bone allograft c. Postoperative control radiograph.

BIBLIOGRAPHY

1. Kerboull M, Hamadouche M, Kerboull L. The Kerboull Acetabular Reinforcement Device in Major Acetabular Reconstructions: Clinical Orthopaedics and Related Research. 2000;378:155–168.

2. Villatte G, Erivan R, Salles G, Pereira B, Galvin M, Descamps S, et al. Utilisation d'une allogreffe osseuse morcelée sécurisée avec un anneau de soutien dans les révisions acétabulaires de PTH aseptiques avec perte de substance osseuse : résultats de 95 cas à 7 ans de recul. Revue de Chirurgie Orthopédique et Traumatologique. 2017;103(4):384–389.

3. Philippe R, Gosselin O, Sedaghatian J, Dezaly C, Roche O, Sirveaux F, et al. Acetabular reconstruction using morselized allograft and a reinforcement ring for revision arthroplasty with Paprosky type II and III bone loss: Survival analysis of 95 hips after 5 to 13 years. Orthopaedics & Traumatology: Surgery & Research. 2012;98(2):129–137.

4. Boyer B, Philippot R, Schneider L, Farizon F. Utilisation exclusive de la double mobilité dans la reprise de PTH. Cent cinquante-deux hanches à 11ans de recul. Revue de Chirurgie Orthopédique et Traumatologique. 2016;102(7):S170.

5. Gharedaghi M, Peivandi MT, Mazloomi M, Shoorin HR, Hasani M, Seyf P, et al. Evaluation of Clinical Results and Complications of Structural Allograft Reconstruction after Bone Tumor Surgery. . NUMBER. 2016;4(3).

6. Bullens PHJ, Minderhoud NM, de Waal Malefijt MC, Veth RPH, Buma P, Schreuder HWB. Survival of massive allografts in segmental oncological bone defect reconstructions. International Orthopaedics (SICOT). 2009;33(3):757–760.

7. Farfalli GL, Aponte-Tinao L, Lopez-Millán L, Ayerza MA, Muscolo DL. Clinical and functional outcomes of tibial intercalary allografts after tumor resection. Orthopedics. 2012;35(3):e391-396.

8. Bauer T, Klouche S, Grimaud O, Lortat-Jacob A, Hardy P. Prise en charge des pseudarthroses septiques du fémur et du tibia dans un centre de référence des infections ostéoarticulaires. Résultats de 55 patients suivis de 2 à 11 ans. Revue de Chirurgie Orthopédique et Traumatologique. 2018;104(1):89–97.

9. Maimaitiyiming A, Amat A, Rehei A, Tusongjiang M, Li C. Treatment of the femoral shaft nonunion with double plate fixation and bone grafting: A case series of 14 patients. Injury. 2015;46(6):1102–1107.

THESIS

Bi-malleolar Equivalent Fracture Fixation : Adding deltoid ligament repair is it necessary ?

A. Ben Abdellah , S. Bensalah, A. Lachkar, H. Yacoubi, A. Najib

ABSTRACT

Bi-malleolar equivalent fracture is an ankle fracture, which consists of a fracture of the fibula associated with a rupture of the medial collateral ligament (MCL). To date, there is limited evidence of superior clinical outcomes with the addition of deltoid ligament repair compared to open reduction and medial fibular fixation alone. The aim of this study is to evaluate the clinical and functional results of the surgical treatment in a real world.

This was a retrospective study of 20 cases of bi-malleolar equivalent fracture treated only by open reduction and internal fixation of the fibula without deltoid ligament repair, in the department of Traumatology-Orthopedics of the Mohammed VI University Hospital (Oujda-Morocco), over a period of 10 years from 2013 to 2023. This bi-malleolar fractures were studied on the basis of a descriptive radiological analysis and using the the Weber and Danis and, Lauge-Hansen classification. Outcomes were evaluated according to AOFAS score, medial clear space (MCS) correction and, pain score (VAS).

20 cases treated between January 2013 and January 2023 were included. The median follow-up was 24 months. All patients underwent ORIF without deltoid ligament repair. Clinical, radiographic, and functional outcomes, as well as complications were considered.

Current literature does not provide clear indication for repair of the deltoid ligament at the time of ankle fracture repair. By comparing our functional results with those of other studies, we can conclude that deltoid ligament repair have may be some advantages for patients with high fibular fractures or in patients with concomitant syndesmotic fixation.

KEYWORDS : Bi-malleolar equivalent, fracture, deltoide ligament, syndesmotic fixation, medial clear space.

Conflict of interest: The authors declare no conflict of interest in connection with the writing of this article.
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1. INTRODUCTION

Malleolus fractures are common, ranking third in frequency after fractures of the distal radius and fractures of the upper extremity of the femur [1]. They occur more frequently in young active people, and come in different varieties with different prognoses. The equivalent bi-malleolar fracture is one of its variants: an ankle fracture which, while not necessarily having the specific characteristics of a classic bi-malleolar fracture, nevertheless causes similar damage to the bony and ligamentous structures around the ankle, resulting in loss of stability. It consists of a fracture of the fibula associated with a rupture of the medial collateral ligament. In a normal ankle, the deltoid ligament (DL) limits eversion and external rotation of the talus on the tibia. In bi-malleolar equivalent fractures, there is often significant medial instability even after fibular reduction. Retraction of the deltoid ligament with subsequent healing in a non-anatomical

position can theoretically lead to instability, persistent pain in the medial groove and loss of function with a risk of early osteoarthritis.

The three most characteristic mechanisms of injury of the DL occur from pronation-abduction, pronation-external rotation (PER), and supination-external rotation (SER) of the foot [2–3]. SER injury is the most common fracture type [4].

Several diagnostic modalities have been studied, but there is no consensus in the literature as to which is the most effective. Medial clear space (MCS) widening on gravity stress radiographs has been used as a predictive tool for DL rupture [5], while others advocate visualization with arthroscopy and MRI.

II. PATIENTS AND METHODS

This was a PROCESS-compliant retrospective and single-centre study of 20 cases diagnosed with bi-malleolar equivalent fracture treated by open reduction and internal fixation of the fibula by isolated external approach without deltoid ligament repair, at the department of traumatology and orthopedics of the Mohammed VI University Hospital (Oujda-Morocco) over a period of 10 years from 2013 to 2023. The radiological analysis was performed according to Lauge-Hansen and, Weber and Danis classification [6]. Surgery was performed by a junior residents or qualified final year resident.

The following clinical parameters were evaluated including American Orthopaedic Foot and Ankle Society Score (AOFAS) [7], visual analogue scale (VAS) and, Postoperative measurement of medial clear space (MCS) [8].

Follow up of patients was performed every two weeks of the rehabilitation period (two months) and then, every three months thereafter. All patients from our database provided their consents to use their medical records for research.

III. RESULTS

22 patients treated between January 2013 and January 2023 were included, the mean age was 36,5 years, with median follow-up of 12 months. All patients underwent a standard radiological evaluation, including frontal (non-stressed mortise view) and lateral X-ray of the ankle joint (Fig.1), with some patients benefiting from an externally rotated stress radiographs. Non of our patients underwent arthro-CT or musculoskeletal ultrasound of the ankle.

Fig.1 : Frontal (non-stressed mortise view) and lateral X-ray of the ankle joint

This fractures were classified as type B in 13 cases (65%) and, C in 7 cases (35%) according to Weber and Danis classification. According to lauge-Hansen classification, the supination-external rotation mechanism was the most frequent (70%).

In our study, the spiroid fracture of lateral malleolus is the most frequent (50%). Medial clear space (MCS) is analysed by measuring the space between the medial aspect of the talus and the lateral edge of the tibial malleolus on a mortise view, and was between 4-6 mm in 3 cases, 6-8 mm in 7 cases and, > 8mm in 10 cases, with mean MCS 7,78 mm. Syndesmosis analysis is performed by measuring the clear space between the medial border of the fibula and the lateral border of the posterior tibial tubercle on frontal radiograph (Fig.2). A total of 15 patients (75%) presented a bi-malleolar equivalent fracture with a tibiofibular diastasis exceeding 4 mm. we also noted, one case (5%) with posterior marginal fragment,2 cases (10%) with

postero-lateral fracture dislocation of the ankle. None of the cases analysed presented an osteochondral lesion of the talus.

Fig 2 : Sus-ligamentous fracture of the fibula with increased MCS and tibio-fibular diastasis

Surgical treatment was immediately performed in 7 cases and delayed in 13 cases, under loco-regional anesthesia in 19 cases (95%).stabilization of the injury was performed by isolated external approach of the fibula in supine position in all cases without deltoid ligament repair. In our series, syndesmosis was studied in all patients, based on radiological analysis of the tibiofibular clear space, measured pre- and intraoperatively after Hook test stress. Syndesmodesis screw (three-cortical) was used in 07 cases (35%) (Fig.3). Patients had this screw removed after 6 weeks. Extra-articular posterior marginal fragment not exceeding 1/3 of the articular surface of the tibial Pilon was therefore respected.

Fig 3 : Three cortical syndesmodesis scew.

Post-operatively, all patients were treated with analgesic, first generation cephalosporin (2g of cephalothin) during 48 hours and, thrombo-prophylaxis (enoxaparin) during 6 weeks. Rehabilitation was started from the first week as soon as the pain subsides and, Progressive partial weight-bearing is permitted from the 45th post-operative day, and is completed by the end of the second month.

After an average follow up of 24 months, we noticed as unique complications a complex regional pain syndrome (CRPS) that persisted even under adjusted treatment.

During the latest follow up, the means of AOFAS ankle scores and VAS were 84.4 ± 6.7 (good results) and, 4/10 respectively (Fig.4).

Fig 4 : Plantar and dorsal flexion of the ankle, showing the functional result after 12 months' follow-up.

Concerning the MCS evaluated in mortise view, postoperatively and during the latest follow up was 3,74 mm with better control in weber type B fractures (Fig.5).

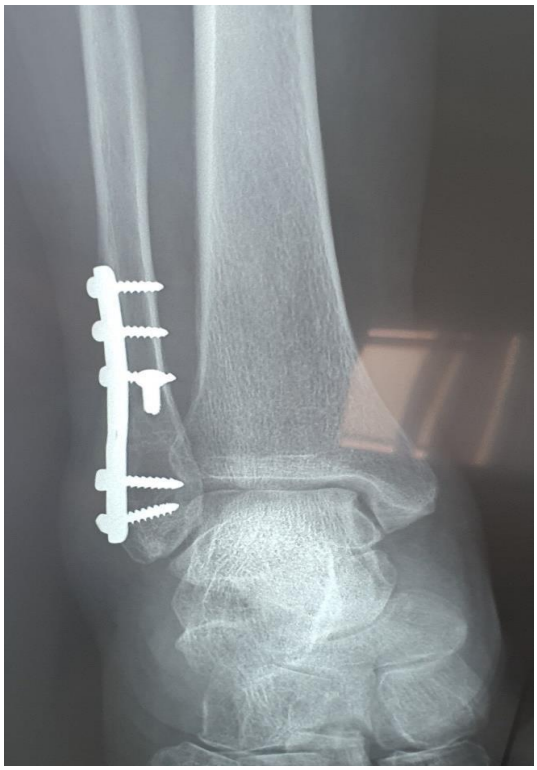

Fig 7 : Standard frontal X-ray at 11-month post-op follow-up showing reduction of the MCS to less than 4 mm

IV. DISCUSSION

The DL complex plays an important role in the stability of the ankle joint. This is the main restraint against anterior and lateral displacement of the talus [9]. Biomechanical studies have shown that intact DL centres the talus in the ankle mortise, independent of displaced lateral malleolus fracture [10,11-12]. The management of acute DL injury associated with ankle fracture fixation in still controversial, with no consensus regarding the indications for surgical repair or treatment strategies.

Many case series have considered DL repair in the management of ankle fracture with deltoid rupture [13–14]. They noted positive results and no incidence of complications. Hsu et al. treated 14 NFL players with lateral malleolus and DL injuries, concomitant with syndesmotic injury. Patients were treated with ORIF of the lateral malleolus and, repair of the superficial DL with suture anchors and, suture button fixation of the syndesmotic lesion. The authors obtained satisfactory results without complication after one-year fellow-up [13]. However, many cases series in the literature have chosen to treat DL lesions non-operatively [15–16]. They achieve good results with low complication rates, with complications largely unrelated to instability. They concluded that DL repair was not required.

Zeeger et al. recommended that DL exploration is indicated only when there is doubt about the congruence of the medial joint space on mortise-view radiographs [17]. However, this point may be contrasted with a study by Johnson and Hill, in which 8 of 26 patients without DL repair presented with DL laxity with abduction or external rotation. The authors concluded that leaving the DL tear unrepaired would not yield acceptable results [18].

Concerning the maintenance of ankle reduction and stability, Zhao et al [19] reported significantly a small MCS in the DL repair group at the final fellow-up ($p=0.03$). Woo et al reported a significant difference in the average final fellow-up in the MCS between the two groups ($p=0.001$), but found no difference in the immediate post-operative average MCS [20]. Gu et al found a significant reduction in MCS between pre-operative and post-operative radiographs in both groups at one-year fellow up, with better improvement in the DL repair group ($p=0,02$) [21].

The AOFAS ankle score was reported by Woo et al., Plazas et al. and, Zhao et al.Woo et al. reported that their scores were 92.8 ± 3.9 in the repaired group and 91.6 ± 4.7in the unrepaired group ($p= 0.805$). Plazas et al. reported scores were 95.2 (range: 55-100) for the repair group and 94,2 (range: 70-100) for the unrepaired group (p value not reported). Zhao et al. reported that their scores were 88.0 ± 5.8 in the repair group and 85.9 ± 8.7 in the non-repair group ($p=0.32$). there were no significant differences between the two groups for any of these studies.

Woo et al. found a statistically meaningful difference in patients undergoing syndesmotic fixation between the repair and non-repair groups. The reported AOFAS score averaged 93.1±3.9 in the repair group and, 89.8±3.7in the non repair-group (p=0.02) [22]. Maynou et al. used a the modified Cedell classification to evaluate the results of there study. Their inter-group differences were not significant [23].
In our series, the mean AOFAS of patients after a mean follow-up of 12 months was 84.4/100. The MCS (medial clear space) in mm at the end of follow-up measured after an average 12-month follow-up was 3.74 mm. It should be noted that our therapeutic approach regarding DL repair relied primarily on a non-surgical management, as the entire sample benefited from ORIF of the fibula using a 1/3-tube screw plate with cortical screw (3. 5mm) and syndesmosis fixation in 35% of cases after radiological analysis of the tibio-fibular clear space, measured pre- and post-operatively after Hook stress tests, and thus DL repair was deemed unnecessary given the absence of instability on the medial side at the end of surgery.

REFERENCES

[1] Biga N.Fractures malléolaires de l'adulte. Conférence d'enseignement. Cahiers d'enseignement de la SOFCOT n° 45.
Conférences d'Enseignement 1993 : 71-80

[2] Lauge-Hansen N. Fractures of the ankle. II. Combined experimental-surgical and experimental-roentgenologic investigations. Arch Surg 1950;60:957

[3] Sclafani SJ. Ligamentous injury of the lower tibiofibular syndesmosis: radiographic evidence. Radiology 1985;156:21.

[4] Gougoulias N, Khanna A, Sakellariou A, Maffulli N. Supination-external rotation ankle fractures: stability a key issue. Clin Orthop Relat Res 2010;468:243.

[5] Michelsen JD, Ahn UM, Helgemo SL. Motion of the ankle in a simulated supination-external rotation fracture model. J Bone Joint Surg Am 1996;78:1024.

[6] Lauge-Hansen N (1949) Ligamentous ankle fractures; diagnosis and treatment. Acta Chir Scand. 97(6):544–550

[7] Woo SH, Bae SY, Chung HJ. Short-term results of a ruptured deltoid ligament repair during an acute ankle fracture fixation. Foot Ankle Int 2018;39:35.

[8] DeAngelis NA, Eskander MS, French BG (2007) Does medial tenderness predict deep deltoid ligament incompetence in supination-external rotation type ankle fractures? J Orthop Trauma. 21(4):244–247. https://doi.org/10.1097/BOT.0b013e3180413835

[9]WatanabeK,KitaokaHB,BerglundLJ,ZhaoKD,KaufmanKR,AnKN.Theroleof ankle ligaments and articular geometry in stabilizing the ankle. Clin Biomech (Bristol, Avon) 2012;27:189.

[10] Michelsen JD, Ahn UM, Helgemo SL. Motion of the ankle in a simulated supination-external rotation fracture model. J Bone Joint Surg Am 1996;78:1024.

[11] Kusnezov NA, Eisenstein ED, Diab N, Thabet AM, Abdelgawad A. Medial malleolar fractures and associated deltoid ligament disruptions: current management controversies. Orthopedics 2017;40:e216.

[12] Harris J, Fallat L. Effects of isolated Weber B fibular fractures on the tibiotalar contact area. J Foot Ankle Surg 2004;43:3.

[13] Hsu AR, Lareau CR, Anderson RB. Repair of acute superficial deltoid complex avulsion during ankle fracture fixation in

National Football League players. Foot Ankle Int 2015;36:1272.

[14] Yu G-r, Zhang M-z, Aiyer A, Tang X, Xie M, Zeng L-r, et al. Repair of the acute deltoid ligament complex rupture associated with ankle fractures: a multicenter clinical study. J FootAnkle Surg 2015;54:198.

[15] De Souza L, Gustilo RB, Meyer TJ. Results of operative treatment of displaced external rotation-abduction fractures of the ankle. JBJS 1985;67:1066.

[16] Baird RA, Jackson ST. Fractures of the distal part of the fibula with associated disruption of the deltoid ligament. Treatment without repair of the deltoid ligament. J Bone Joint Surg Am 1987;69:1346.

[17] Zeegers AV, van der Werken C. Rupture of the deltoid ligament in ankle fractures: should it be repaired? Injury 1989;20:39.

[18] Johnson D, Hill J. Fracture-dislocation of the ankle with rupture of the deltoid ligament. Injury 1988;19:59.

[19] Zhao HM, Lu J, Zhang F et al (2017) Surgical treatment of ankle fracture with or without deltoid ligament repair: a comparative study. BMC Musculoskelet Disord. 18(1):543. https://doi.org/10.1186/s12891-017-1907-4

[20] Woo SH, Bae SY, Chung HJ (2018) Short-term results of a ruptured deltoid ligament repair during an acute ankle fracture fixation. Foot Ankle Int. 39(1):35–45. https://doi.org/10.1177/1071100717732383

[21] Gu G, Yu J, Huo Y, et al. (2017) Efficacy of deltoid ligament recon- struction on the curative effect, complication and long-term prog- nosis in ankle fracture-dislocation with deltoid ligament injury. Vol 10. www.ijcem.com/.

[22] Woo SH, Bae SY, Chung HJ. Short-term results of a ruptured deltoid ligament repair during an acute ankle fracture fixation. Foot Ankle Int 2018;39:35.

[23] Maynou C, Lesage P, Mestdagh H, Butruille Y. Indication for surgical treatment of deltoid ligament rupture in ankle fractures. J Bone Joint Surg Br 1999;81:357.

CLINICAL CASE

Interscapulo-thoracic Disarticulation : A Limb Salvage Surgery for High-Grade Synovial Sarcoma of the Arm

E. Bachkira, A. Messoudi, A. Rajaallah, C. Elkassimi, A. Rafaoui, M. Rahmi, M. Rafai

ABSTRACT

Synovial sarcoma (SS) is a malignant soft tissue tumor characterized by a high recurrence rate and distant metastases. This sarcoma typically arises near the knee and in the proximal region of the upper limb. The prognosis for SS is poor. Conservative surgical treatment is the preferred approach, but in advanced cases, amputation may sometimes be the only salvage solution]. Only a few cases of malignant tumors with vasculonervous infiltration of the scapular girdle have been documented in the literature. Interscapulo-thoracic disarticulation serves as a salvage treatment for sarcomas affecting the scapular girdle. This radical surgical amputation, which removes the entire upper limb, is indicated primarily in cases of neurovascular infiltration, failure of conservative treatment, and complications such as severe lymphedema and hemorrhage. Here, we present the case who underwent interscapulo-thoracic disarticulation for a locally advanced synovial sarcoma of the right arm.

Conflict of interest : The authors declare no conflict of interest in connection with the writing of this article.

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KEYWORDS

Forequarter Amputation; Interscapulothoracic; Sarcoma; Shoulder Girdle; Upper Limb

INTRODUCTION

Synovial sarcoma (SS) is a malignant soft tissue tumor characterized by a high recurrence rate and distant metastases. It accounts for 5 to 10% of all soft tissue tumor forms, predominantly affecting adolescents and young adults [1]. This sarcoma typically arises near the knee and in the proximal region of the upper limb [2]. SS is generally well-defined; however, in some instances, it may intermingle with surrounding muscles, tendons, and neurovascular structures. The prognosis for SS is poor, with 5-year and 10-year survival rates of 56% and 41.5%, respectively [1].
Conservative surgical treatment is the preferred approach, but in advanced cases, amputation may sometimes be the only salvage solution [3]. Only a few cases of malignant tumors with vasculonervous infiltration of the scapular girdle have been documented in the literature [1, 4, 5]. Interscapulo-thoracic disarticulation serves as a salvage treatment for sarcomas affecting the scapular girdle. It was first performed in 1808 for a ballistic trauma and later adopted in 1836 by Dixi Crosby to treat a malignant tumor of the upper limb [6]. This radical surgical amputation, which removes the entire upper limb, is indicated primarily in cases of neurovascular infiltration, failure of conservative treatment, and complications such as severe lymphedema and hemorrhage [7].
Here, we present the case of a 52-year-old patient who underwent interscapulo-thoracic disarticulation for a locally advanced synovial sarcoma of the right arm.

CASE PRESENTATION

We report the case of a 52-year-old female with a history of total thyroidectomy two years prior, presenting with a large, painful mass (VAS 8) in the right brachial segment, which had been growing for six months and was associated with a general deterioration of her health condition. Clinical examination revealed a right arm mass with a circumference of 63 cm, extending to the axillary fossa, firm in consistency, slightly movable across both planes, with signs of inflammation present. The neurovascular examination indicated a partial sensory and motor deficit of the radial nerve without downstream vascular impairment [Fig.1].

Fig 1 : Clinical presentation of the arm after chemotherapy

The patient underwent magnetic resonance imaging (MRI) of the arm, revealing an intramuscular tumor process at the expense of the right brachial triceps muscle, measuring 127x69x96mm, in contact with the humeral diaphysis without bone lysis, and reaching the humeral pedicle with loss of the separating fat strip [Fig.2].

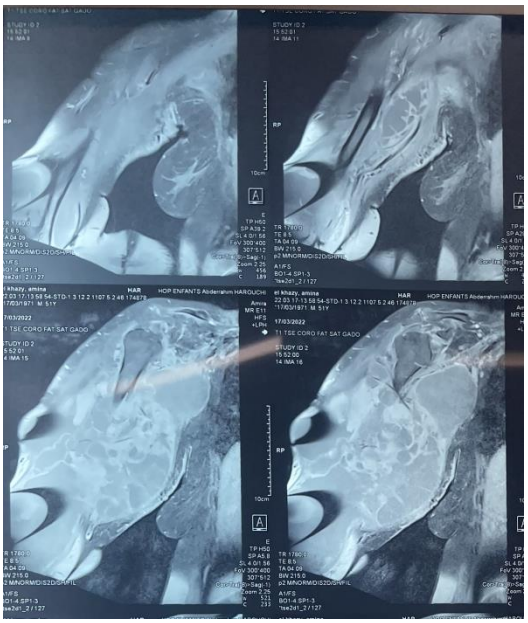
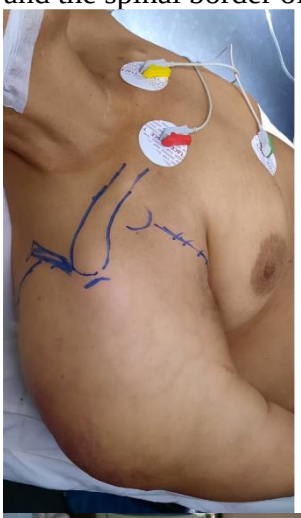


Fig 2 : MRI showing expansion of tumor process

A thoraco-abdomino-pelvic (TAP) CT scan did not reveal any progressive secondary-like lesion. A CT-guided biopsy was performed, revealing an undifferentiated malignant tumor proliferation with immunohistochemistry supportive of a Grade II monophasic synovial sarcoma. The patient received three cycles of initial chemotherapy, with a follow-up MRI showing a poorly defined lesion with heterogeneous signal in the anterior and posterior muscle compartments of the arm, delineating necrosis zones measuring 290x189x162mm, encompassing almost the entirety of the humeral bone without bone lysis, displacing the humeral pedicle medially, infiltrating the infraspinatus and subscapular muscles, reaching the deltoid muscle while preserving the separation strip, and also encompassing the scapula while respecting its cortex. The decision from the multidisciplinary team meeting (MDT) was for interscapulo-thoracic disarticulation. A discussion with the patient detailed the surgical procedure and its complications, leading to an informed consent signed by the patient prior to the operation.

Under general anesthesia, with the patient in a left lateral decubitus position (incomplete dorsal three-quarters) supported by two

points, pubic and sacral, the upper limb was included in the operative field. A semi-lateral approach was utilized, with most of the operation conducted anteriorly to preserve the clavicle, which was not infiltrated by the tumor, to avoid scoliotic posture and maintain an aesthetic appearance of the stump, thereby facilitating prosthesis fitting. The disarticulation involved two surgical stages, anterior and posterior. Bone landmarks included the clavicle, the coracoid process, and the spinal border of the scapula [Fig.3].



An elliptical incision was made, with an anterior cut following an oblique line from the coracoid process along the line of the vessels towards the deltopectoral groove, and continuing posteriorly parallel to the spinal edge of the scapula, crossing the inferior border of the latissimus dorsi while maintaining a distance of 5 cm from the mass's edge. Two flaps, anterior and posterior, were delineated with equivalent dimensions for closure. A skin and subcutaneous incision was made, with careful hemostasis of small vessels, exposure, and ligation of the cephalic vein. The pectoralis major tendon was cut far from its humeral insertion. The coracobrachialis muscle was severed close to the coracoid process. After collapsing the clavi-pectoro-axillary aponeurosis in front of the subclavius muscle, the vasculonervous bundle was exposed. The nerves; ulnar, median, radial, and musculocutaneous, were then infiltrated with lidocaine. The nerves were sectioned several minutes after infiltration. The axillary pedicle was ligated secondarily. Dissection then proceeded with internal rotation allowing for the cutting of the rotator cuff muscles. The anterior stage was completed by cutting the pectoralis minor tendon. The anterior surface of the scapula, covered by the subscapular and supraspinatus muscles, was revealed. External rotation facilitated the cutting of the subscapular muscle. The long head of the biceps tendon was cut at the supraglenoid tubercle. The teres major and latissimus dorsi were cut near their insertion on the humerus. A posterior incision was made. Pulling the limb in abduction drew the scapula, which was only attached to the thorax by the scapulothoracic muscles **[Fig.4]**.

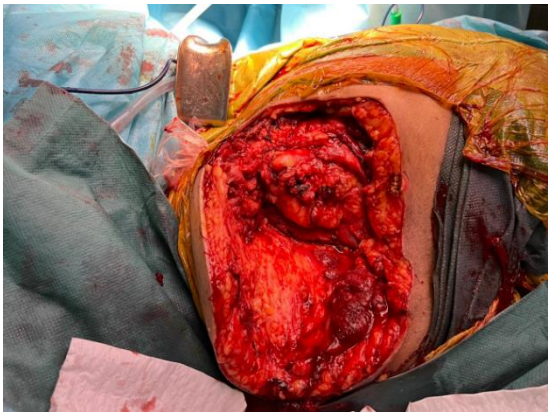


Fig 4 : Peroperative image after scapula resection

These muscles were freed and cut across the thorax. Careful hemostasis was performed. Finally, two drains were placed through the incision to prevent hematoma development, with a circumferential compressive bandage applied **[Fig.5]**. No

significant amputation complications, such as pneumothorax with subsequent respiratory failure, were observed. Psychological support was provided to the patient before discharge. Postural physiotherapy, mirror therapy, and desensitization were started in the first week to prevent phantom limb sensation and combat postural scoliosis. Pathological results from the surgical specimen confirmed the previous diagnosis of monophasic synovial sarcoma with clear resection margins. Six weeks post-amputation, the patient commenced an adjuvant chemotherapy protocol. Six months post-operation, MRI showed no residual tumor or recurrence. After 12 months, the patient reported no pain and displayed no complications such as postural scoliosis, with a good score according to the SF-36 health survey, rated at 87 points.

Fig.5 : Clinical appearance following closure

DISCUSSION

Upper limb disarticulation remains a radical oncological surgery, even though the outcome can be disfiguring, as observed in our patient. Interscapulo-thoracic amputation is effective for treating upper limb tumors when preservation is not possible.

Claudia Di para [9] considers this type of amputation the most mutilating for the upper limb and it is rarely proposed because it negatively impacts the quality of life. Prostheses are often inadequate in terms of aesthetics and function, and patients frequently refuse this type of aggressive surgical approach [9].

In our case, the patient had no other systemic therapeutic options as she had already undergone chemotherapy, and the surgery could not be conservative due to the non-resectable tumor with local infiltration reaching the scapula. These types of surgical interventions are characterized by an increased risk of complications, typically wound infection or flap necrosis, so a careful risk-benefit assessment is essential. Over the past decades, techniques for scapular belt amputation have been significantly modified since the first amputation (Tukiainen et al., 2020; Lesenský et al., 2017; Scaglioni et al., 2016), which took place in 1808 in a traumatic context [9]. Today, the well-established techniques include Berger's (linear incision at the middle third of the clavicle to first ensure vessel control), Kocher's (anterior approach), and Littlewood's (posterior approach). We chose to preserve the clavicle as it was not infiltrated by the tumor to maintain an aesthetic appearance and symmetry of both shoulders, compensating for the absence of scapulothoracic muscles to prevent a scoliotic posture.

Furthermore, Ulrich Elsner et al. [10] conducted a 12-year study on a series of 30 patients (11 women, 19 men) suffering from high-grade malignant tumors of the scapular girdle to develop guidelines for selecting patients eligible for this type of disarticulation, namely high-grade soft tissue and bone sarcomas, even in metastases. The indication is justified for unresectable sarcomas, with infiltration of the brachial plexus and axillary artery, recurrent soft tissue sarcomas after conservative limb surgery, radiation-induced sarcomas of the scapular girdle, poor response to induction chemotherapy, and in palliative care to address complications such as infection, septicemia, severe lymphedema, or hemorrhage. According to Daigeler et al. [11], patients

treated with upper limb disarticulation had better quality of life and pain relief. Finally, Parsons et al. (2012) [12] described their experience with 40 major amputations (including 30 forequarter amputations), concluding that in their patient group, recurrence rates were extremely high (79% of recurrences either locally or distantly), but in some cases, amputation led to prolonged survival in the absence of other treatment options. To our knowledge, this is the first described case of scapulo-humeral amputation with clavicle preservation.

CONCLUSION

Although upper limb disarticulation was initially described for treating traumatic injuries, it is more commonly indicated today in the management of malignant tumors in this region. For patients with malignant soft tissue tumors such as synovial sarcoma, particularly in cases of unresectable tumors, tumor recurrence with hemorrhagic manifestation, or failure of chemotherapy and radiotherapy treatments, interscapulo-thoracic disarticulation presents a safe and reliable therapeutic option to alleviate pain and enhance the quality of life for some patients.

REFERENCES

1. Yulian ED, Pandelaki J, Kodrat E, Wibisana IGNG. Forequarter amputation post transarterial chemoembolization and radiation in synovial sarcoma: A case report. International Journal of Surgery Case Reports. 2021 Apr;81:105824. doi: 10.1016/j.ijscr.2021.105824. Epub 2021 Mar 23. PMID: 33887868.

2. Goldblum JR, Folpe AL, Weiss SW. Soft Tissue Tumors. 2019; pp.1200–1218.

3. Lehnhardt M, Hirche C, Daigeler A, Goertz O, Ring A, Hirsch T, et al. Soft tissue sarcoma of the upper extremities: analysis of factors relevant for prognosis in 160 patients. Chirurg. 2012;83(2):143–152.

4. Clark MA, Thomas JM. Major amputation for soft-tissue sarcoma. British Journal of Surgery. 2003;90(1):102–107.

5. Puhaindran ME, Chou J, Forsberg JA, Athanasian EA. Major upper-limb amputations for malignant tumors. Journal of Hand Surgery. 2012;37(6):1235–1241.

6. Taylor M, Pichora D. Forequarter amputation following pre-operative embolization to treat two upper extremity malignancies in a previously irradiated tissue bed: a case report. Orthopedic & Muscular System. 2015;4(2):2-5.

7. Dimas JK, Kargel J, Bauer J, Chang P. Forequarter amputation for malignant tumours of the upper extremity: Case report, techniques and indications. Canadian Journal of Plastic Surgery. 2007;15(2):83–85.

8. Bukowski EL. Atlas of Amputations and Limb Deficiencies: Surgical, Prosthetic, and Rehabilitation Principles. Physical Therapy. 2006 Apr;86(4):595–596. doi: 10.1093/ptj/86.4.595.

9. Di Prata C, Zilio N, Del Fiore P, Sonkoue De Tamoki JG, Mocellin S, Rastrelli M. Forequarter amputation for local recurrence of sarcoma after previous amputation through the shoulder in a female patient – A case report. Current Problems in Cancer: Case Reports. 2021;Volume 4:100093. ISSN 2666-6219. https://doi.org/10.1016/j.cpccr.2021.100093.

10. Elsner U, Henrichs M, Gosheger G, Dieckmann R, Nottrott M, Hardes J, Streitbürger A. Forequarter amputation: a safe rescue procedure in a curative and palliative setting in high-grade malignoma of the shoulder girdle. World Journal of Surgical Oncology. 2016 Aug 15;14(1):216. doi: 10.1186/s12957-016-0973-7. PMID: 27526689; PMCID: PMC4986170.

11. Daigeler A, Lehnhardt M, Khadra A, Hauser J, Steinstraesser L, Langer S, et al. Proximal major limb amputations - a retrospective analysis of 45 oncological cases. World Journal of Surgical Oncology. 2009;7:1–10.

12. Parsons CM, Pimiento JM, Cheong D, Marzban SS, Gonzalez RJ, Johnson D, Letson GD, Zager JS. The role of radical amputations for extremity tumors: a single institution experience and review of the literature. Journal of Surgical Oncology. 2012;105(2):149–155. doi: 10.1002/jso.22067. Epub 2011 Aug 11. PMID: 21837679; PMCID: PMC4504014.

13. Al-Busaidi SS, Al-Hashmi SN, Jayachandran RK. Management of longstanding synovial sarcoma of the shoulder region – A case report. JPRAS Open. 2017;Volume 12:39-43. ISSN 2352-5878. https://doi.org/10.1016/j.jpra.2017.03.002.

14. Lins L, Carvalho FM. SF-36 total score as a single measure of health-related quality of life: Scoping review. SAGE Open Medicine. 2016 Oct 4;4:2050312116671725. doi: 10.1177/2050312116671725. PMID: 27757230; PMCID: PMC5052926.

CLINICAL CASE

Erecta dislocation of the shoulder - a rare entity (Case report and review of the literature)

Y. El Qadiri, O. Adnane, Z. Assammar, Mc. Berouag, Y. Sbihi, O. Eladaoui, Y. El Andaloussi, Ar. Haddoun, D. Bennouna, M. Fadili

ABSTRACT

Inferior shoulder dislocation, Erécta dislocation or mast dislocation of the shoulder is a rare and unusual form of shoulder dislocation, with an estimated incidence of 0.5% of all dislocations.
We present a case of inferior dislocation in a 65-year-old patient, occurring following an MVA with the upper limb in extreme abduction, external rotation and elbow flexed. Radiography confirmed the diagnosis.

Reduction was performed under general anaesthesia using gentle traction in the axis.
Davids and Talbott reported two mechanisms of Luxatio Erecta. The first is an indirect mechanism following forced abduction of an already abducted limb, so that the diaphysis is at a higher level than the acromion. The second mechanism is direct trauma following axial loading on an already abducted limb.

Two methods of reduction have been described in the literature. The first, which is the one used for our patient, consists of a traction-countertraction. The second is a small rotation of the humeral head, aimed at transforming the dislocation into its anterior variety, then reducing it by one of the methods described above.

Conflict of interest : The authors declare no conflict of interest in connection with the writing of this article.

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KEYWORDS

Erecta / Dislocation / Shoulder / Trauma

INTRODUCTION

inferior shoulder dislocation, or Erécta dislocation mast dislocation of the shoulder is a rare and unusual form of shoulder dislocation, estimated to account for 0.5% of all dislocations. It is the least common form of shoulder dislocation.

It is often associated with vascular and nerve complications, as well as bone and capsulo-ligament lesions.
We describe the mechanism and clinical expression of a case of erect dislocation of the shoulder.

OBSERVATION

Patient aged 65, had presented to the emergency department following an MVA, with left upper limb in extreme abduction, external rotation and elbow flexed to over 90˚ without downstream vasculonervous disorders.

Fig 1: Clinical attitude of Erecta dislocation. A frontal X-ray of the shoulder confirmed the diagnosis.

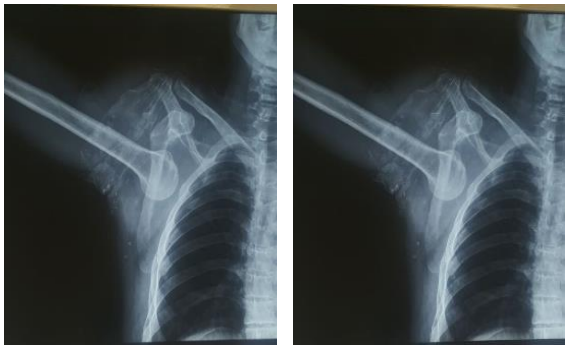

Fig 2: Radiograph of a Erecta dislocation.

Reduction was performed under general anaesthesia, using gentle traction in the limb axis with slight abduction, followed by restraint with an elbow-to-body brace for three weeks.

Fig 3: Post-reduction control radiograph.

Functional rehabilitation began immediately after removal of the orthosis. At the 2-year follow-up, the patient had not presented any instability episode, and the functional evolution had been judged excellent.

DISCUSSION

Historically, shoulder dislocation has been the most common dislocation treated in emergency departments. Nevertheless, inferior dislocation, known as luxatio Erecta, accounts for only 0.5% of all shoulder dislocations, compared with anterior and posterior dislocations which make up 95-97% and 2-4% respectively [1,2].

Davids and Talbott reported two mechanisms of Luxatio Erecta. One is an indirect mechanism resulting from forced abduction of an already abducted limb, so that the diaphysis is at a higher level than the acromion. In this case, the lower part of the capsule and the lower and middle glenohumeral ligaments are ruptured. The second mechanism is direct trauma following an axial load on an already abducted limb. In this second mechanism, in addition to the aforementioned lesions, it may also be associated with a fracture of the trochiter and a rupture of the rotator cuff [3].

Although this type of dislocation is rare, its prognosis is good. Reported recurrent dislocations are rare [4].

The clinical presentation of luxatio erecta is characteristic, with the arm abducted and the fixed forearm resting on the head. The humeral head is palpated on the chest wall. Radiography often reveals the humeral head located below the glenoid cavity, with the shaft parallel to the scapular spine [5].

In a study of 80 cases, Mallon et al. described rotator cuff lesions associated with luxatio erecta in 12% of patients [6].

Shai et al. reported in an orthoscopic study that luxatio erecta was associated with SLAP-

type labrum lesions, and recommended surgical treatment [7].

According to the study by Mallon et al. a luxation erecta is characterized by a high risk of neurovascular lesions. 60% of patients had axillary nerve damage, and 3.3% had vascular compression, making this type of dislocation the one with the highest incidence of vascular injury.

Trochanter fractures were found in 37% of patients [6]. The percentage of fractures in inferior dislocations is higher than in anterior and posterior dislocations.

Two methods of reduction have been described in the literature. The first, which is the one used for our patient, consists of traction-countertraction as described by Freundlich al [9]. The second, described by Nho et al, is a small rotation of the humeral head, aimed at transforming the dislocation into its anterior variety, then reducing it using one of the methods described above. These techniques can be performed with or without general anaesthesia.

In the literature, there are few MRI studies of luxatio erecta.

Krug et al. reported on the MRI of 4 patients with a history of luxatio erecta. 3 cases showed rotator cuff rupture and 2 biceps tendon rupture. All patients presented labral lesions. Rupture of the glenohumeral ligament was constant.

CONCLUSION

This is a rare condition, diagnosed clinically and confirmed by standard radiography. Vascular and neurological complications are frequent. Arthroscopic exploration is important for both diagnostic and therapeutic purposes.

BIBLIOGRAPHY

1. Szalay E, Rockwood CJ (1984) Injuries of the shoulder and arm. Emerg Med Clin North Am 2:279–294

2. McLaughlin H (1952) Posterior dislocation of the shoulder. J Bone Jt Surg 24:584–90

3. Davids JR, Talbott RD. Luxatio erecta humeri. A case report. Clin Orthop 1990;252:144—9.

4. Schai P, Hintermann B. Arthroscopic findings in luxatio erecta of the glenohumeral joint: case report and review of the literature. Clin J Sport Med 1998;8(2):138—41.

5. Kazu M, Akira O. Luxatio erecta (inferior dislocation of the shoulder): A report of two cases and areview of the literature. Injury Extra (2005) 36, 450—453

6. Mallon WJ, Bassett III FH, Goldner RD. Luxatio erecta: the inferior glenohumeral dislocation. J Orthop Trauma 1990; 4(1):19—24.

7. Schai P, Hintermann B. Arthroscopic findings in luxatio erecta of the glenohumeral joint: case report and review of the literature. Clin J Sport Med 1998;8(2):138—41.

8. Krug DK, Vinson EN, Helms CA. MRI findings associated with luxatio erecta humeri. Skeletal Radiol 2010; 39:27-33.

9. Freundlich BD (1983) Luxatio erecta. J Trauma 23:434–436. https:// doi. org/ 10. 1097/ 00005 373- 19830 5000- 00015

10. Nho SJ, Dodson CC, Bardzik KF, Brophy RH, Domb BG, MacGillivray JD (2006) The two-step maneuver for closed reduction of inferior glenohumeral dislocation (luxatio erecta to anterior dislocation to reduction). J Orthop Trauma 20:354–7. https:// doi.org/ 10. 1097/ 00005 131- 20060 5000- 00010

CLINICAL CASE

Principles of surgical treatment of primary malignant bone tumors of the humerus

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ABSTRACT

The proximal humerus represents the first location of primary tumors of the upper limb and the fourth for all primary malignant tumors [1]. The functional result of conservative treatment of shoulder tumors depends on the preservation of the glenoid, deltoid muscle and rotator cuff tendons as well as the vasculo-nervous elements.

"Open" surgical biopsy is preferable for primary bone tumors, especially when a cartilaginous tumor is suspected. It is carried out by a short approach, located on the route of the approach, which will be used for the surgical resection of the tumor so that the biopsy scar is excised in one piece with the tumor. The surgical treatment of primary malignant bone tumors is based on a wide resection, with excision of the bone segment affected by the tumor and any adjacent soft parts invaded, in a single piece without entering the tumor while maintaining a margin of healthy tissue in the periphery.

Most malignant bone tumors currently benefit from chemotherapy treatment following surgery, this is particularly the case for osteosarcomas and Ewing sarcomas.

Surgical treatment represents only part of this treatment. It has three essential objectives:

- Diagnosis, with biopsy,
- Excision of the tumor,
- Reconstruction.

As in other locations, several techniques can be used:

• A scapulohumeral arthrodesis using a vascularized autograft and/or an intercalary allograft or using a locked screwed plate and cement.

• Stabilization of the shoulder by the MARCOVE device: suspension of the humerus to the clavicle or to the second rib via a nail.

• Reconstruction using a cement or metal spacer.

• Massive prosthesis, reversed or not.

• Reconstruction with the clavicle turned over and fixed to the humerus.

Conflict of interest : The authors declare no conflict of interest in connection with the writing of this article.

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INTRODUCTION

The proximal humerus is a preferential location for osteosarcoma, Ewing sarcoma and chondrosarcoma [1-5]. Usually, these tumors arise in the metaphyseal region and extend outside the bone (extra-compartmental extension).

Currently it is possible to perform a conservative resection in more than 80% of cases. The indications for amputation are: huge tumors invading the vessels and nerves whose resection would result in a non-functional limb, infections on the tumor, a biopsy performed inappropriately (contamination of the vessels, contamination periarticular muscles, etc.), local recurrence... Amputation follows the same oncological requirements as conservative resections [2-3-7].

The study of locoregional tumor extension is done by MRI. This study is important in making it possible to determine the exact anatomical invasion and the relationships of the tumor with adjacent anatomical structures, particularly the vasculo-nervous elements. This study will clarify planning of surgery [4-6].
In this article we will describe 3 surgical techniques for high-grade malignant tumors of the proximal humerus.

MATERIALS AND METHODS

Materials :

Between January 2022 and December 2023, 3 patients were treated by conservative treatment of a primary malignant tumor of the proximal humerus.
All patients had a surgical biopsy before the procedure. The histological diagnosis was chondrosarcoma in 2 cases, osteosarcoma in one case.
The preoperative imaging assessment, including standard x-rays and MRI, was carried out to clarify osteoarticular invasion, soft tissues and vascular-nervous elements.
All tumors were extra-compartmental without metastasis at the time of diagnosis.
Only the patient with osteosarcoma of the humeral shaft received neoadjuvant chemotherapy. The resection removed the proximal humerus in 2 cases and resection of the diaphysis in 1 case. The average height of the resection was 11 cm (range: 7-14)
A centromedullary nail sleeved with cement and locked after wide carcinological resection of the osteosarcoma in the humeral shaft was performed in 1 case. The radial nerve was trapped in the tumor and could not be preserved and therefore resected with the tumor mass (fig. 1a,b and c).
A massive humeral prosthesis with a cemented stem was made in 1 case of chondrosarcoma. In this case, the tendons of the remaining cuff as well as that of the deltoid muscle were sutured in an overcoat to all of the remaining muscles around the prosthesis (fig. 2a and b).
A scapulohumeral arthrodesis, using a long-screwed plate locked and fixed to the acromion of the scapula and the clavicle with cement reinforced with 2 pins was carried out in 1 case of chondrosarcoma (fig. 3a and B).

Methods :

Tumor extension was evaluated taking into account the grade of the tumor, its intra- or extra-compartmental character and the presence or absence of metastases.
The bone resection was extensive: it is the recommended resection in cases of high-grade primary bone sarcoma. The limits of resection pass, everywhere, away from the tumor, in healthy tissue, but remaining in the anatomical compartment where the tumor developed. For soft parts, a muscular layer of one cm must cover the tumor [1-8].
The extension assessment included for all our patients a scintigraphy and a thoraco-abdomino-pelvic scan.
Radiological follow-up included standard radiographs. A Pet scan was necessary for the patient who presented with osteosarcoma due to the appearance of a small mass in his armpit, raising suspicion of a local recurrence.

Surgical Technique :

- Principles and purpose :

One-piece resection of the tumor and reconstruction of the osteoarticular defect constitute the principles of this surgery.
The essential goal of resection is local control of cancer disease and preservation of hand and elbow function. The ideal reconstruction should result in a pain-free, stable and mobile shoulder if possible [3].

- Installation :

Under general anesthesia, the patient is placed in a supine position and the affected upper limb is placed on a lateral hand table.

- Neurovascular exposure :

This is the first important step facilitating tumor resection in complete safety and sparing all the anatomical structures to be preserved. This step is also important in the final decision on the possibility of tumor resection.

- Tumor resection :

The bone resection was wide with resection limits passing, everywhere, away from the tumor, in healthy tissue, but remaining in the anatomical compartment.

- Reconstruction :

As in other locations, several techniques can be used.
For our 3 patients we opted for:
A massive reverse prosthesis in one case;
Reconstruction using a locked nail and cement spacer in one case;
A scapulohumeral arthrodesis using a locked screwed plate and cement in one case

Results :

In the early postoperative period, we mainly looked for a sensory and/or motor deficit.
Active mobilization of the elbow, wrist and hand is encouraged from the first postoperative day. Shoulder rehabilitation began 4 weeks later; Passive exercises were recommended at first.
In postoperative follow-up, we monitored our patients regularly for local or distant tumor recurrence.

Complications :

The patient who presented the osteosarcoma with damage to the radial nerve, presented a small mobile mass in the armpit after one year of follow-up and after neoadjuvant chemotherapy. The 3 cm by 2.5 cm mass was resected and sent to the anatomo-pathological examination revealing a recurrence or tumor residue. For radial paralysis, a tendon transfer to resuscitate the extension of the wrist and hand was carried out using the Merle d'Aubigné technique modified by Tubiana, giving a good result for the extension of the wrist and fingers after 5 months of follow-up.

DISCUSSION

The diagnosis is usually strongly suspected based on clinical data and imaging (mainly standard radiographs). However, before starting any treatment for a primary malignant bone tumor, it is essential to obtain histological certainty. For this, a biopsy is indicated [1-5].
This biopsy can be carried out percutaneously (it only provides a small quantity of tissue to the pathologist) or open (which is preferable, especially for tumors of the cartilaginous lineage, due to the greater quantity of tissue provided to the pathologist) [4].

Assessment of extension of the tumor :
It will be done at the time of diagnosis, then often after the first two courses of chemotherapy (in order to assess the response or progression of the tumor under chemotherapy) and before surgical resection [2].

Locoregional extension assessment :
It is based on :
— the clinical examination which assesses the tumor volume, the extension into the soft tissues, the proximity of the vessels.
— standard frontal and lateral radiographs, including the entire bone segment concerned with the adjacent joints, are essential to assess: the quality of the bone structure, measurements of the bone segments concerned in order to choose the material and the grafts used for reconstruction.
— on an MRI: the entire bone segment concerned with the adjacent joints in order to detect a possible skip-metastasis [7].
— if there is any doubt about vascular invasion, an angio-MRI will be requested [9].

General expansion assessment :
It is based on [6]:

— Bone scintigraphy with Technetium. PET scan is currently being evaluated in these indications.
— Chest X-ray and CT with injection.
— A bone marrow biopsy for Ewing sarcoma.
— Other examinations (brain, abdominopelvic CT will be requested depending on clinical warning signs).

Surgical Treatment

General principles of surgical resection

The timing of surgical treatment in the treatment of bone sarcomas depends on the efficiency of chemotherapy on the tumor. For non-chemosensitive tumors (chondrosarcoma), treatment is only surgical. It is therefore carried out as soon as possible after the biopsy result. If the tumor is "chemosensitive" (osteosarcoma, Ewing sarcoma, etc.) the surgical phase is preceded by neoadjuvant chemotherapy which often makes it possible to reduce the volume of the tumor, often simplifying the surgical procedure. Following the operation, we take into account the tumor's response to chemotherapy, assessed on the histological examination of the excision specimen.
The surgical treatment of bone sarcomas always includes a first stage of resection and, a second stage of reconstruction. These two stages are most often accomplished during the same procedure. Planning these interventions requires an imaging assessment to provide a good three-dimensional representation of the tumor and its anatomical relationships, particularly with vascular-nervous pedicles [9].
The logical therapeutic procedure is extra-tumor resection, without seeing the tumor, removing the bony segment where the tumor is located as well as its possible extension into the soft tissues and the path of the biopsy. The distance between the tumor boundary and the resection plane corresponds to the safety margin. The importance of this margin makes it possible to classify resections according to their limits in relation to the tumor tissue; four possibilities can be distinguished [10]:
"Contaminated" resection: it reflects an involuntary opening of the tumor during resection.
Marginal resection: the resection limits pass into contact with the tumor capsule without entering the tumor. It is therefore more of an excision than a true resection.
Wide resection: this is the recommended resection in cases of high-grade primary bone sarcoma. The limits of resection pass, everywhere, away from the tumor, in healthy tissue, but remaining in the anatomical compartment where the tumor developed [8].
Radical resection, proposed by Ennecking: it involves the removal of the entire anatomical compartment containing the tumor [4-10]. The possibilities for reconstruction are then limited, and it has not been proven that this type of resection improves local control or patient survival.

Whenever possible, biological reconstructions should be favored, that is to say those which reconstitute the bone stock and which, once consolidated, are durable, unlike prostheses, which wear out and must be regularly replaced [10].

The principles of reconstruction at the limb level

General :
At the limb level, the reconstruction can involve a bone segment without a joint being affected, or a bone segment and the adjacent joint. The reconstruction combines bone contribution and osteosynthesis.
When a joint is affected by resection, reconstruction can remove the joint (by performing an arthrodesis) or recreate it.
These arthrodeses are carried out in a "functional" position corresponding to the best compromise for everyday activities [9].
When reconstruction of the joint is possible, most often "massive" prostheses are used [1, 10].

Figure 3a : Radiograph before and after chondrosarcoma surgery

Figure 3b : Intraoperative appearance after tumor resection and shoulder arthrodesis

Types of reconstructions :

- Reconstruction of the proximal humerus with preservation of the deltoid :

After resection of the proximal humerus which removes the rotator cuff muscles, reconstruction with a standard prosthesis provides a mediocre result due to the loss of active mobility. It is possible to use a reconstruction using a reverse prosthesis surrounded by an allograft (composite reconstruction). This type of implant allows active abduction without the rotator cuff muscle to be maintained, only with the deltoid. The allograft improves the anchoring of the prosthesis in the humerus [1-8].

Figure 2a : Inverted prosthesis on X-ray control

Figure 2b : Clinical appearance at 1 month of follow up

- Diaphyseal reconstruction

Resections of a segment of the shaft are fewer common procedures than epiphysometaphyseal resections. The resection technique obeys the rules stated previously. Reconstruction uses a centromedullary nail or a screwed plate combined with a mixture of allograft (which provides immediate strength but degrades over the years) and autograft (which will consolidate and gradually thicken). This autograft can be a vascularized fibula (which has the advantage of rapidly consolidating without going through a resorption-reconstruction phase) [8].

Figure 1a : Radiograph before and after surgery for osteosarcoma of the humeral shaft

Figure 1b : Intraoperative appearance: centromedullary nail + cement

Figure 1c : Radial nerve taken by the tumor

- Amputations

Their indications are in fact due to the impossibility of performing a conservative surgical resection. Indeed, numerous studies have demonstrated that conservative resection, when possible, does not reduce the survival of patients with bone sarcoma. Currently it is possible to perform a conservative resection in more than 80% of cases [10]. The indications for amputations are: huge tumors invading the vessels and nerves whose resection would result in a non-functional limb, tumor infections, a biopsy performed in an inappropriate manner (contamination of the vessels, contamination periarticular muscles, etc.), local recurrence, etc. [10].

Amputation follows the same oncological imperatives as conservative resections. Imaging examinations must also clarify the bony boundaries and the soft parts of the tumor. The integrity of the muscle flaps that will be used for coverage must be checked.

Results Of These Treatments

Oncological results

In terms of bone tumors, it has been shown by several authors that conservative surgical treatment does not expose to more local recurrence, and, more particularly, that survival was the same as after amputation, when the assessment of loco-regional extension confirmed that a conservative resection was possible [3-10]. The local recurrence rate ranges from 7% to 45% depending on the type of tumor and its location.

Functional results

In the majority of publications, these results are evaluated using the Musculo Skeletal Tumor Society score (MTS score) [3-5], which evaluates from 0 to 5 pain, function, acceptance, use of the limb. The MTS score is expressed as a percentage of normal (set at thirty points).

Complications

The complication rates of resection-reconstruction in tumor surgery are four times higher than that of amputations and ten to twenty times higher than those observed in prosthetic surgery for osteoarthritis [2-7]. The complication rate after limb-sparing surgery varies from 9.2% to 92.3% [3-4].

CONCLUSION

The proximal humerus is a common site for primary malignant bone tumors. Limb conservative surgery is currently the rule. Technically, resection is difficult due to the proximity of the brachial plexus and the axillary vessels.
Surgical treatment remains the mainstay of treatment of bone tumors; However, it is part of a multidisciplinary strategy bringing together anatomopathologists, surgeons, oncologists and radiologists.
Biopsy is an integral part of treatment. The treatment of primary malignant bone tumors can only be considered in specialized centers.
There are many techniques of reconstruction actually. The choice of the type of reconstruction depends primarily on the tumor extension and the needs of the patient.

BIBLIOGRAPHY

1. DAHLIN DC : Bone tumors: general aspects and data on 6221 cases. In: Thomas Springfield, 1978.

2. ENNEKING WF : A system of staging musculoskeletal neo- plasms. Clin Orthop, 1986, 204, 9-24.

3. ENNEKING W, DUNHAM W, GEBHARDT M, MALAWAR M, PRITCHARD D : A system for the classification of skeletal resections. Chir Organi Mov, 1990, 75 (Suppl 1), 217- 240.

4. MALAWER MM : Tumors of the shoulder girdle. Technique of resection and description of a surgical classification. Orthop Clin North Am, 1991, 22, 7-35.

5. M. Kassab, V. Dumaine, A. Babinet, M. Ouaknine, B. Tomeno, P. Anract : Les reconstructions après résection tumorale de l'extrémité supérieure de l'humérus. Revue de chirurgie orthopédique 2005, 91, 15-23

6. Wittig J.C., Kellar-Graney K.L., Malawer M.M., Bickels J., Meller I. Limb-sparing surgery for high-grade sarcomas of the proximal humerus. Techn Shoulder Elbow Surg 2001; 2:54-69,

7. De Wilde L.F., Plasschaert F.S., Audenaert E.A., Verdonk R.C. Functional re- covery after a reverse prosthesis for reconstruction of the proximal humerus in tumor surgery. Clin Orthopaedics and Relat Res 2005; 430:156-62.

8. Donati D. et al. — The results of the surgical treatment of bone tumors using massive homoplastic grafts. Chir. Organi. Mov., 2003, 88(2), p. 115-22.

9. Biau D.J. et al. — Ipsilateral femoral autograft reconstruction after resection of a pelvic tumor.
J. Bone Joint Surg. Am., 2009, 91, 1, p. 142-51.

10. Philippe ANRACT : Surgical management of primary bone cancer. Bull. Acad. Natle Méd., 2009, 193, no 1, 107-126, séance du 20 janvier 2009

CLINICAL CASE

A rare case of closed medial total subtalar joint dislocation

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ABSTRACT

Pure medial subtalar dislocation without any fractures is a rare clinical entity commonly caused by high-energy mechanisms, and are more likely to be open and associated with fractures of the other foot bones. early diagnosis and reduction under general anesthesia should be attempted as soon as possible to prevent further complications. We report a 28-year-old male patient sustained a closed medial subtalar dislocation without any associated fractures after falling from a high height. The patient was successfully treated by closed reduction with a good functional outcome. The purpose of this clinical case report is to highlight this uncommon injury to avoid delayed diagnosis and treatment.

KEYWORDS : Subtalar joint dislocation, ankle, closed injury

INTRODUCTION

Subtalar dislocations can occur following a sports accident or in accidents such as falls or vehicle accidents. it defined according to Broca [1] as a dislocation in which the talus maintains its relation with the leg bones, while the calcaneus and the navicular move under it. It is a rare lesion, representing 1% of all dislocations observed in Traumatology.

Conflict of interest : The authors declare no conflict of interest in connection with the writing of this article.
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CASE PRESENTATION

28-year-old patient was admitted to the ER after falling from a high height while doing his job as a home builder. The patient was complained of severe pain in the right ankle. the ankle was found in medial plantar flexion, with diffuse ankle swelling. He had no lacerations of the skin. He had normal sensation on the lateral side of the foot. The patient was hemodynamically stable without any associated injuries. Due to the soft tissue swelling there were no palpable arteries, however he had less than 3 s capillary refill. Conventional (or plain) radiographs taken in the emergency department revealed a medial subtalar dislocation of the foot without apparent fracture.

Fig 1: Radiological part of unadulterated inner subtalar separation in front and profile occurrence

Fig 2: Control radio after decrease demonstrating great joint compatibility

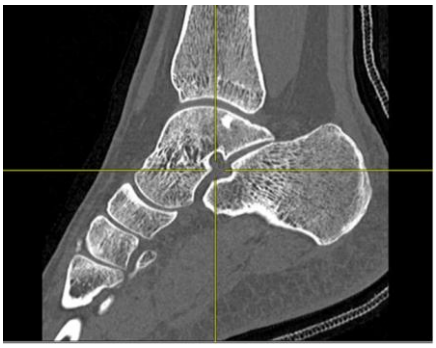

Fig 3: CT scan after reduction showing the absence of associated fracture or free intra articular fragment

DISCUSSION

Subtalar dislocation is a very rare lesion, and was first described by Dufarest and Judey in 1811 [2]. it defined as the simultaneous dislocation of both the talonavicular and the talocalcaneal joints without a major fracture of the talus [3]. The acute subtalar dislocation represents < 1-2% of all large joint dislocations and approximately 15% of all talar injuries[4]. The incidence of injury has been estimated to be 3-10 times more likely to occur in men than women [5].

The subtalar dislocation is classified according to the modification that Malgaigne and Buerger [6] made of Broca's classification (1853) [1], in medial, lateral, posterior or anterior dislocations depending on the direction in which the distal part of the foot moves with respect to the talus. The medial subtalar dislocation, the most common with a frequency close to 80% [7], is produced by an external rotation of the talus with the foot in inversion and flexion, with the sequential rupture of the dorsal talonavicular ligament, anterior and posterior interosseous ligaments [8].

A radiographic study should be made for diagnosis with an anteroposterior and lateral projection of the hindfoot to assess the diagnosis and rule out the possible association of bone fractures in the foot or ankle because, if the occur, they will condition the definitive treatment [7,9,10,11].

A closed reduction under sedation should be attempted as soon as possible [12] to avoid additional complications such as avascular necrosis of the talus, neurovascular or soft tissue lesions such as skin necrosis [9,11]. To reduce the dislocation, the knee and ankle are flexed towards plantar, in order to relax the triceps surae [9,13], longitudinal traction is performed and force is applied in the opposite direction to the dislocation in order to reduce the head of the talus on the navicular joint facet [10]. Occasionally, direct soft pressure on the head of the talus can make reduction easier [11]. After reduction, the correct neurovascular state of the limb is checked by palpation of the dorsalis pedis and posterior tibial pulses and distal oxygenation by pulse oximetry. If signs of ischemia are detected, additional imaging tests such as Eco Doppler or angio-CT will be performed [7].

Once the dislocation has been reduced, the joint is immobilized with a non-weight bearing posterior short-leg cast or below-the knee splint, since it prevents a high pressure in the compartments of the lower limb and allows a better control of the condition of the skin and soft tissues [10]. Joint congruence will be checked by conventional X-ray with at least two projections [14]. Post-reduction computed tomography scan is recommended to identify associated lesions.

CONCLUSION

Internal subtalar dislocation is a rare lesion, it has a good prognosis when a careful and early reduction is carried and the duration of the immobilization is respected, Post-reduction CT scan is recommended to identify occult fractures which sometimes require additional treatment.

REFERENCES

1. Broca P (1853) Mèmoire sur les luxationssous-astragaliennes. Mém Soc Chir 3: 241.

2. Judey P (1811) Observation dune luxation metatarsienne. Bull Fac Med Paris 11: 81-86.

3. Buckingham WW, Jr, LeFlore I. Subtalar dislocation of the foot. J Trauma. 1973; 13:753–65. [PubMed] [Google Scholar]

4. Syed AA, Agarwal M, Dosani A, Giannoudis PV, Matthews SJ. Medial subtalar dislocation: Importance of clinical diagnosis in distinguishing from other dislocations. Eur J Emerg Med. 2003; 10:232–5. [PubMed] [Google Scholar]

5. Perugia D, Basile A, Massoni C, Gumina S, Rossi F, Ferretti A. Conservative treatment of subtalar dislocations. Int Orthop. 2002; 26:56–60. [PMC free article] [PubMed] [Google Scholar]

6. Malgaigne JB (1856) Die Knochenbrüche un VerrenKungen. Suttgart Germany Rieger, pp. 11-820.

7. Rivera F, Bertone C, Crainz E, Maniscalco P, Filisio M (2003) Peritalar dislocation: three case reports and literature review. J Orthop Traumatol 4(1): 39-44.

8. Marotte JH, Samuel P, Moati JC, Lord G, Bombart M (1979) Subtalar dislocations with medial or lateral displacement. Rev Chir Orthop Reparatrice Appar Mot 65(7): 377-385.

9. Camarda L, Abruzzese A, La Gattuta A, Lentini R, D'Arienzo M (2016) Results of closed subtalar dislocations. Musculoskelet Surg 100(1): 63-69.

10. Prada-Cañizares A, Auñón-Martín I, Vilá Y Rico J, Pretell-Mazzini J (2016) Subtalar dislocation: management and prognosis for an uncommon orthopaedic condition. Int Orthop 40(5): 999-1007.

11. Rammelt S, Goronzy J (2015) Subtalar dislocations. Foot Ankle Clin 20(2): 253-264.

12. Bibbo C, Lin SS, Abidi N, Berberian W, Grossman M, et al. (2001) Missed and associated injuries after subtalar dislocation: the role of CT. Foot Ankle Int 22(4): 324-328.

13. Banerjee S, Abousayed MM, Vanderbrook DJ, Bagchi K (2017) Lateral Subtalar Dislocation with Tarsometatarsal Dislocation: A Case Report of a Rare Injury. Case Rep Orthop 2017: 8090721.

14. Garofalo R, Moretti B, Ortolano V, Cariola P, Solarino G, et al. (2004) Peritalar dislocations: a retrospective study of 18 cases. J Foot Ankle Surg Off Publ Am Coll Foot Ankle Surg 43(3): 166-172.

CLINICAL CASE

An Isolated Fracture of The Humeral capitellum : A rare Fracture not to be Ignored

A. Rabah, R. Badaoui, O. Troussi, M. Bousaidane, Y. Benyas, J. Boukhris, D. Bencheba, B. Chafry

ABSTRACT

Fractures of the capitellum are very rare [1]. therefore the diagnosis is based on clinical and radiology especially incidence of profile.Their initial care must be early and effective because of the risks generated on the elbow: rigidity, instability, osteoarthritis [2]. Our patient, a sports accident victim was operated urgently by internal first, open reduction and stabilization by buried Herbert screw.

KEYWORDS : Fracture, capitellum, herbert screw.

INTRODUCTION

Isolated capitellum fracture is a very rare articular fracture of the lower end of the humerus and represents less than 1% of all elbow fractures [3]. We report the observation of a 17-year-old boy with an isolated fracture of the capitellum.

Conflict of interest: The authors declare no conflict of interest in connection with the writing of this article.

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OBSERVATION

He is a 17 year old; with no pathological history, victim of a fall from height during a football match with landing on the left hand, wrist in flexion and elbow in extension, causing pain with total functional impotence of the left upper limb. The examination showed a vicious attitude of the traumatized upper limb with swelling of the elbow; pain on palpation and mobilization without skin lesion or associated vascular-nervous deficit. The frontal and lateral radiograph of the left elbow showed a fracture of the lower end of the humerus and the CT scan revealed an isolated fracture of the capitellum figures (1 and 2).

Fig 1 : Frontal and lateral x-ray of the elbow showing the fracture of the capitellum.

Fig 2 : CT scan of the elbow showing the isolated fracture of the capitellum.

The patient was admitted to the operating room and underwent surgical reduction and

fixation of the capitellum fracture with two Herbert screws (figures 3 and 4).

Fig 3: Intraoperative image showing reduction of the fracture and its fixation with 2 Herbert screws.

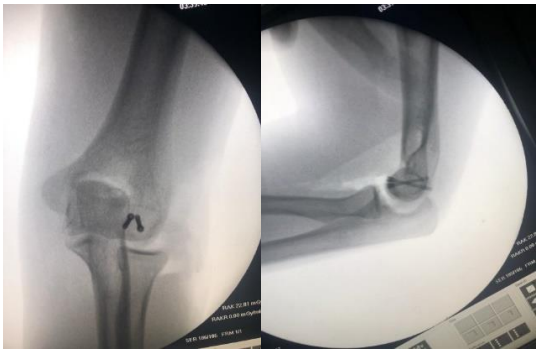

Fig 4: Front radiograph and profile of the control elbow showing fixation of the fracture with 2 Herbert screws.

The elbow was immobilized for 2 weeks followed by functional elbow rehabilitation. Three months after the trauma we noted a very good functional result with a stable and painless elbow and very satisfactory mobility with a normal return to sports activities.

DISCUSSION

Isolated capitellum fracture is very rare. The causes described in the literature and also for our patient are falls on the upper limb with the elbow extended. . As in our case, the frontal radiograph may be normal [4, 5]. the diagnosis is therefore made by the profile views [6] which show a fragment in the shape of a "crescent moon" detached from the humeral condyle. A CT scan with 3D reconstruction can be performed for fragment size study and operational planning [1, 5, 7-9]. The treatment consists of a surgical approach with anatomical reduction and stabilization with 2 Herberts screws, thus allowing better compression. A “test” of mobility was carried out intraoperatively, therefore assessing congruence. A wide variety of internal stabilization techniques have been described such as Kirschner wire [10], biodegradable pins, staples, bone clips and compression screws. Pins do not provide strong compression and stabilization of the fracture site. Most of these methods require a long period of postoperative immobilization which interferes with early functional recovery. Herbert screws have the advantage of being buried so as not to irritate the calf tissues [11]. There is no need to remove the screw hence the rehabilitation program starts earlier and functional recovery is faster.

CONCLUSION

Isolated humeral capitellum fracture is a very rare entity for which open reduction and fixation are the treatment of choice. Stabilization by Herbert screw, which is a modern method, gives satisfactory results because it allows strong inter-fragmentary compression, early mobilization, and therefore functional recovery of the elbow. Removal of the osteosynthesis material is rarely necessary.

REFERENCES

[1] Somanna MS, Amarnath SD, Sudhakar SM, Umanand MP. A rare case of isolated fracture of capitellum-a case report. Orthopaedics J. 2008;5(3):e5.

[2] Mehdian H, McKee MD. Fractures of capitellum and trochlea. Orthopedic Clinics. 2000 Jan 1;31(1):115-27

[3] Worrell RV. Isolated, displaced fracture of the capitellum. New York state journal of medicine. 1971 Oct;71(19):2314-5.

[4] Kaushal R, Bhanot A, Gupta PN, Bahadur R. Isolated shear fracture of humeral capitellum. Injury Extra. 2005 Jun 1;36(6):210-1.

[5] Oberstein A, Kreitner KF, Löwe A, Michiels I. Isolated fracture of the capitellum humeri following direct elbow trauma. Aktuelle Radiologie. 1994 Sep;4(5):271-3.

[6] Kwan MK, Khoo EH, Chua YP, Mansor A. Isolated displaced fracture of humeral capitellum: a report of two rare cases. Injury Extra. 2007 Dec 1;38(12):461-5.

[7] Nakatani T, Sawamura S, Imaizumi Y, Sakurai A, Fujioka H, Tomioka M, Kurosaka M, Yoshiya S. Isolated fracture of the capitellum: a case report. Journal of shoulder and elbow surgery. 2005 May 1;14(3):340-3.

[8] Jai HP, Joo HK, Joong HL, Seung DC, Jung HY. Isolated fracture of the capitellum in humerus-a case report. J Korean Soc Surg Hand. 2006;11:NUMBER-3.

[9] Sen RK, Tripathy SK, Goyal T, Aggarwal S. Coronal shear fracture of the humeral capitellum. Journal of Orthopaedic Surgery. 2013 Apr;21(1):82.

[10] Poynton AR, Kelly IP, O'Rourke SK. Fractures of the capitellum—a comparison of two fixation methods. Injury. 1998 Jun 1;29(5):341-3.

[11] Nakatani T, Sawamura S, Imaizumi Y, Sakurai A, Fujioka H, Tomioka M, Kurosaka M, Yoshiya S. Isolated fracture of the capitellum: a case report. Journal of shoulder and elbow surgery. 2005 May 1;14(3):340-343.

CLINICAL CASE

Unusual digital localization of Angiolipoma (A case report and review of the literature)

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ABSTRACT

Angiolipoma is a benign adypocytic soft tissue tumor composed of mature adipose tissue and small vascular proliferations.
We report the case of a 20-year-old female patient with a rare angiolipoma localized on the 3rd finger, whose diagnosis was confirmed on excisional biopsy.
The tumor typically occurs in adolescents and young adults, and rarely in patients over 50.
Angiolipoma often manifests as a painful, subcutaneous nodule. Due to the rarity of angiolipomas, and their similarity to lipomas, positive diagnosis is virtually impossible without a final histological study. The density of blood vessels relative to fat composition defines the spectrum of angiolipomas.

Conflict of interest : The authors declare no conflict of interest in connection with the writing of this article.

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KEYWORDS

Angiolipoma / Phalanx / Benign Tumor.

INTRODUCTION

Angiolipoma is a benign adypocytic soft tissue tumor composed of mature adipose tissue and small vascular proliferations, first reported by Howard et al [1]. This entity accounts for 5-17% of all lipomas.
Although a definitive diagnosis cannot be made with histopathological examination, ultrasound and/or MRI can be helpful. Surgical excision is the first-line treatment.

OBSERVATION

A 20-year-old woman with no specific pathological history presented with a mass of the 3rd finger that had been evolving for 1 year. Clinical examination revealed a soft bluish mass with little pain on palpation, 4 cm long, developed between the metacarpophalangeal joint and the proximal interphalangeal joint.

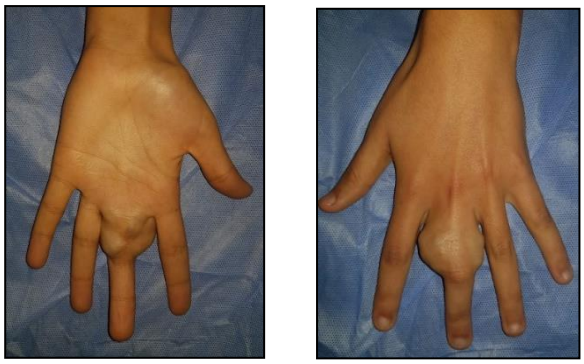

Fig1 : Clinical images of the dorsopalmar aspect of the left hand showing the volume and location of the tumor.

MRI revealed a mass with a lobulated contour dependent on subcutaneous tissue,

hypersignal in T1 and hyposignal in T2 enhancing predominantly lipomatous contrast medium.

Fig 2 : MRI showing tumor invasion of soft tissue without bone involvement

Treatment was surgical by excisional biopsy, which confirmed the histological diagnosis of angiolipoma, but the evolution was marked by a recurrence after 3 years.

Fig 3 : Intraoperative appearance of the tumor.

DISCUSSION

Angiolipoma is a benign tumor of the connective tissue. Howard et al. reported 288 angiolipomas in 248 patients, with a predominance of males and a mean age of 17 years [1].

The tumor typically occurs in adolescents and young adults, and rarely in patients over 50. Our patient falls within the age range of the majority of reported patients.
Angiolipomas often present as painful, subcutaneous nodules, and our patient presented with moderate pain, although asymptomatic angiolipomas do occur [4].

2/3 of angiolipomas occur on the forearm, and rarely on the chest wall [8]. Localization to the fingers is exceptional.

Lesions may be single or multiple. Multiple angiolipomas may run in families or be associated with diabetes or antiretroviral therapy [5,6].

The macroscopic appearance of the tumor is globular, yellowish and bleeding, reminiscent of an ordinary lipoma [7].

Given the rarity of angiolipomas, and their similarity to lipomas, positive diagnosis is virtually impossible without a final histological study. The density of blood vessels relative to adipose composition defines the spectrum of angiolipomas. The cellularity of this tumor may also be similar to Kaposi's sarcoma [7].

CONCLUSION

Angiolipoma is a painful benign soft-tissue tumour. However, they rarely localize to the finger. Because of the rarity of this entity, which presents as an acral tumor, doctors need to be aware of this possibility.

BIBLIOGRAPHY

1. Howard WR, Helwig EB: Angiolipoma. Arch Dermatol 1960;82:924-931. [PMID: 13716236].

2. Calonje E, Brenn T, Lazar A, McKee PH. Connective tissue tumors. In: Pathology of the Skin with Clinical Correlations, Vol. 2, 4th edn.Philadelphia: Elsevier Saunders, 2012: 1592.

3. Ohnishi Y, Watanabe M, Fujii T, et al. Infiltrating angiolipoma of the lower lip: A case report and literature review. Oncol Lett. 2015;9(2):833-836. [PMID: 25621058].

4. Boyd AS, Binhlam JQ. An asymptomatic nodule on the arm of a 46-year-old man. Am J Dermatopathol. 2015;37(1):52-3, 87. [PMID: 25548992].

5. Naversen DN, Trask DM, Watson FH, Burket JM. Painful tumors of the skin: "LEND AN EGG". J Am Acad Dermatol. 1993;28(2 Pt 2):298- 300. [PMID: 8436643].

6. Levitt J, Lutfi Ali SA, Sapadin A. Multiple subcutaneous
angiolipomas associated with new-onset diabetes mellitus. Int J Dermatol. 2002;41(11):783-785. [PMID: 12453005].

7. Goldblum JR, Folpe AL, Weiss SW. Benign Lipomatous Tumors Enzinger and Weiss's Soft Tissue Tumors. 7th edn. Philadelphia: Elsevier, 2020: 476–519.

8. Lin JJ, Lin F. Two entities in angiolipoma. A study of 459 cases of lipoma with review of literature on infiltrating angiolipoma. Cancer 1974;34:720–7.

9. Porter K, Boring M,Jehu TM, et al. Digital angiolipoma: uncommon location and presentation of a common tumour. BMJ Case Rep 2021 241777

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