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ORIGINAL STUDY

Surgical treatment of lateral ankle instability. Does allograft tendon have a better functional result?

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Surgical treatment of lateral ankle instability can be performed with or without allograft. We compared these two technical options referring to patients' functional, radiological and ultrasound data.
Forty patients were surgically treated for lateral painful instability of the ankle. Twenty patients underwent ligamentoplasty using the Broström-Gould technique and twenty underwent a ligamentoplasty by allograft tendon. Patients were matched in age and gender. The assessment was done at 2.5 years postoperatively by functional scores (Olerud & Molander, and Foot & Ankle Outcome), dynamic x-rays (focused on varus and anterior drawer stress tests) and ultrasound examination (focused on anterior talo-fibular and calcaneo-fibular ligaments).
No significant difference was found between the two techniques for all scores.
Functional scores were more than 75% and the complication rate was low (<10%). Regarding the surgical technique, the tendon allograft could not prove to be more beneficial.

Keywords : allograft tendon ; lateral ankle chronic instability ; ligamentoplasty ; Broström-Gould.

INTRODUCTION

Ankle sprains account for 4-7% of emergency admissions *(15)*. Studies have reported that 10 to 30% of the patients maintain sequelae despite adequate conservative treatment ; 5 to 20% of the sprains lead to lateral instability in the frontal plan. In the long term, these instabilities are responsible of talo-crural osteoarthritis *(2,13)*.

There are factors predisposing to ankle instability such as static hindfoot disorders, ligament hyperlaxity, ankle stabilizing muscles weakness, and proprioceptive deficiency.

Numerous surgical techniques have been proposed to treat lateral ankle instabilities. The aim of surgery is to restore a stable and functional ankle in

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a symptomatic patient, in order to limit the evolution towards a talo-crural osteoarthritis *(24)*.

Our prospective study aimed to compare the functional, radiological and ultrasound data of operated patients for lateral instability of the ankle by two techniques : Broström-Gould repair and ligamentoplasty by tendon allograft. We hypothesized that by its allogenic properties, ligamentoplasty by allograft tendon would have better functional, radiological and ultrasonography outcomes.

MATERIAL AND METHODS

Forty patients were surgically treated for lateral instability of the ankle: twenty patients underwent direct anatomical repair according to the Broström-Gould technique and twenty patients underwent ligamentoplasty by tendon allograft. The surgeries were performed by three senior surgeons (SA, LC, DP) from 2010 to 2016 with a minimal postoperative follow-up of 6 months.

We included all lateral surgical repairs and capsulo-ligamental reconstructions of the ankle.

25% of patients had associated procedures such as removal of osteochondral lesions (17.5%), plantar fascia release (2.5%), hallux valgus correction osteotomy (2.5%), and Achilles'tendon lengthening (2.5%). Patients who underwent valgus or varus calcaneum osteotomy were excluded.

The study was approved by the Ethical Committee of the Saint-Luc University Clinics in Brussels and the Saint-Pierre Ottignies Clinic (Registration No. B403201523492).

Our study included 40 patients who were divided into two groups according to the surgical technique: 20 patients in the Broström-Gould technique group (Group 1) and 20 patients in the tendon allograft reconstruction technique group (Group 2). The groups were matched according to age and gender (table 1). The choice of technique was based on the anatomical quality of the residual ligaments. Indeed, cases with good quality residual ligaments were managed by reinsertion associated to inferior extensor retinaculum reinforcement (Broström-Gould technique). Those with residual ligaments of poor quality not allowing suture underwent ligament reconstruction by tendon allograft *(19,9)*.

All patients had a history of at least three episodes of ankle sprain which had been treated conservatively at the emergency department. Clinical instability was assessed by dynamic varus and anterior drawer. The unstable ankle was compared to the healthy one. All patients initially underwent dynamic X-Ray and ultrasonography. In case of difficult interpretation (patient's insufficient collaboration or poor US performance), MRI or arthro-CT scan was performed.

Broström-Gould is the modified technique of Broström which consists of direct anatomical repair of the anterior talo-fibular (ATFL) and calcaneo-fibular ligaments (CFL) by direct end-to-end suture or transosseous reinsertion *(2)*. The Gould technique is considered as the reinforcement of a Broström suture by the use of the distal retinaculum of the extensors (Figure 1). The cutaneous incision may be made anterior or posterior to the lateral malleolus. The posterior approach provides a better access to the CFL. The anterior edge of the fibular malleolus is marked and the joint is opened from proximal to distal towards the ATFL. Sutures are made through the distal part of the ligaments (two for the ATFL and one for the CFL), then either in the proximal part of the respective ligaments or in a

Table 1. — Test of homogeneity between two groups

	Broström-Gould	Allograft	p value
Male/Female	11/9	11/9	1.0
Age (years)	37.9 ± 14.2	37.8 ± 14.8	0.94
Height (cm)	172.2 ± 11.5	169.5 ± 8.7	0.17
Weight (kg)	78.3 ± 19.9	77.5 ± 21.8	0.98
% of smoker	30	25	0.55
Delay post-surgery (year)	2.6 ± 1.4	3 ± 2.2	0.45

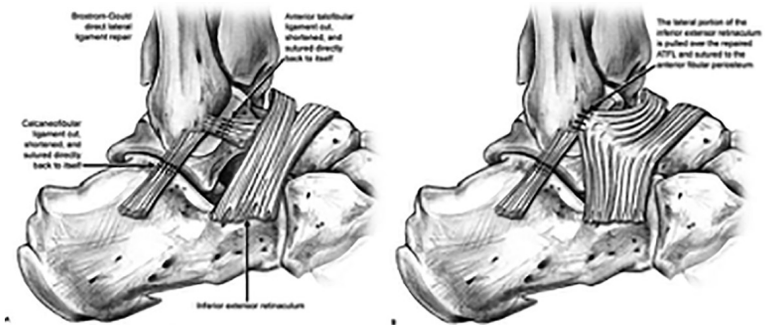

Figure 1. — Brostrom-Gould Technic *(27)*.

transmalleolar tunnels before being knotted outside the tunnel. Throughout the procedure, the foot is positioned in dorsiflexion and pronation *(2)*. Due to the risk for secondary distension of scar tissue, the distal retinaculum of the extensors is used as a capsulo-ligament reinforcement plasty.

The allograft technique consists of the use of "cryopreserved" allografts (foot flexor or extensor tendons of the tissue bank of the Cliniques Universitaires Saint-Luc) to anatomically reconstruct the ATFL and/or CFL *(2,14)* (Figure 2). The cutaneous incision is longitudinal along the external malleolus from proximal to distal where it's dorsally curved. The allograft is soaked in a Rifocine solution for 20 minutes. First, one hole is drilled on the lateral aspect of the talus and two tunnels in the external malleolus that are oriented from its' distal tip towards cranial and posterior direction. Second, the mid portion of the tendon is fixed by a 3.5mm anchor in the talar hole, providing 2 bundles that are threaded through the 2 malleolar tunnels from anterior to posterior where they are joined by a suture. That represents the ATFL plasty. The inferior bundle is then passed around the lateral malleolus from posterior to anterior, then under the reconstructed ATFL to finally be fixed by a 3.5mm anchor on the lateral aspect of the calcaneus in order to reconstruct the CFL. The two remaining bundles are then sutured to each other, thereby forming a frame structure. During this procedure, the ankle is positioned at 90° and in valgus.

Cast immobilization was applied to all patients for 6 weeks. The first three were non-weight bearing and the next 3 weeks with a weight bearing. Thirty sessions of physiotherapy were then prescribed

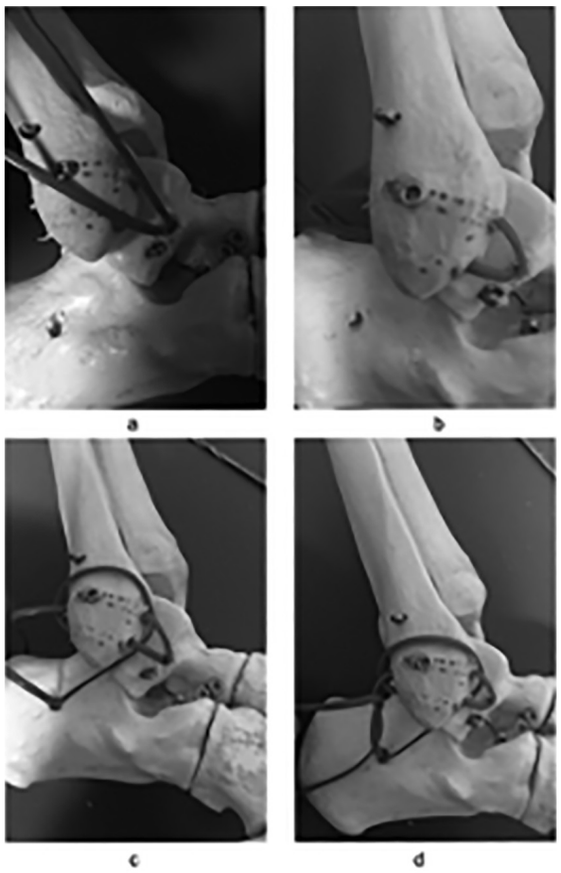

Figure 2. — Tendon Allograft, technique Hintermann modifed Ayong.

a. Mid portion of the tendon is fixed by a 3.5mm anchor in the talar hole, providing 2 bundles

b. The 2 bundles pass through the 2 malleolar tunnels which represents the ATFL plasty

c. The inferior bundle pass around the lateral malleolus, under the reconstructed ATFL to be fixed by a 3.5mm anchor on the calcaneus in order to reconstruct the CFL

d. The remaining bundles are sutured to each other, forming a frame structure.

while the ankle was protected by an orthosis (Aircast/Push Aequi) for at least one month. Physiotherapy consisted of the active mobilization, joint range of motion recovery, proprioception and strengthening of the stabilizing muscles of the ankle. The sports activities were prohibited for a minimum of 6 months. Patients were assessed at 1 week for the first change of cast, at 3 weeks for the weight bearing cast, at 6 weeks for cast removal, then at 3, 6 and 12 months.

Between 2010 and 2016, all patients having more than 6 months of postoperative follow-up replied to two questionnaires and underwent additional paraclinical tests in order to demonstrate possible residual instability. The functional scores were "Olerud & Molander" and "Foot & Ankle Outcome" (FAOS). The Olerud & Molander questionnaire consists of 7 items, an overall score of 100 points. These items are based on assessment of pain, laxity, oedema, climbing stairs, resumption of sports activities, technical aids and quality of life *(23)* (Table 2). Items are rated between 0, 5, 10, 15, 20 or 25. The FAOS consists of 4 items: pain (36 points), stiffness (8 points), symptoms (20 points) and quality of life (16 points) *(25)*.

Table 2. — Olerud & Molander questionnaire

Pain	None	25
	Minimum (depending on weather)	20
	During sport	15
	At walking on smooth terrain	5
	Constant & severe	0
Laxity	None	10
	Occasional	5
	Constant	0
Oedema	None	10
	Evening only	5
	Constantly	0
Stairs	Without problem	10
	Difficult	5
	Impossible	0
Aids/accessories	None	10
	Bandage or Splint	5
	Cane or Crutch	0
Activity daily/work	Activity unchanged	25
	Activity unchanged but reduced	20
	Work reduced or Part Time work	10
	Partially or totally Disabled	0
Total		**100**

The paraclinical tests consisted of dynamic X-ray and an ultrasonography of the two ankles by the same operator (TP). Radiological tests focused on the tibio-talar joint and included forced varus for the A-P views and the anterior drawer measurement for the lateral views. The forced varus manoeuvre tensions both CFL and ATFL. The measurement is based on the angle formed by the tangents to the tibial and talar articular surfaces. Lateral tibio-talus gaping is pathological if the value is greater than 10°, corresponding to ATFL rupture, 15° for ATFL and CFL rupture and 25° for complete lesion of the three lateral ankle ligaments (ATFL, CFL, PTFL). The anterior drawer manoeuvre tensions the ATFL and the anterior capsule and is quantified by the posterior tibio-talar joint gap. A distance greater than 8 mm is pathological *(26)*. Ultrasonography was centred on the ATFL and CFL. The measurements were performed in neutral position to evaluate the length of the corresponding ligament (Lneutral) and during a dynamic manoeuvre of hyper-extension of the ankle to measure the length of the ligament (Lstress). These tests were carried out for both ankles. The parameter evaluated was Lstress-Lneutral. The assessed ligament is considered to be broken or distended if the value is greater than 4 mm *(12,17)*.

The statistics were completed by SPSS's Sigmaplot 13 software. For the quantitative and parametric data, we used a t-paired test. For discrete or continuous quantitative data that did not comply with the Shapiro test, we used a Mann-Whitney rank test. The level of significance was set at 0.05. We performed a ranks correlation test of Spearman between the anthropometric parameters and the functional scores. We performed a proportional test on the pre-operative examinations and the instability experienced by the patients in each group using Chi-square.

We evaluated the effect of the surgical technique and the side using a two ways repeated measures of variance on bilaterally radiological and ultrasonography data.

Table 3. — Scores of functional results

	Broström-Gould	Allograft	P value
Olerud &Molander (/100)	87.5 [80-95]	90 [80-100]	0.64
Pain - FAOS 1 (/36)	30.5 [18-34.5]	32 [28-36]	0.46
Stiffness – FAOS 2 (/8)	6 [4-8]	8 [6-8]	0.068
Oedema – FAOS 3 (/20)	15 [10.5-18.25]	18 [13-19]	0.19
Quality of life – FAOS 4 (/16)	12 [3-16]	12 [9-16]	0.17

Table 4. — Spearman Correlation Results

	Olerud & Molander	FAOS 1 Pain	FAOS 2 Stiffness	FAOS 3 Edema	FAOS 4 Quality of life
Age	0.0199	0.09	0.39	0.16	-0.06
Height	0.0947	0.14	0.23	0.11	-0.004
Weight	-0.09	0.07	-0.22	-0.244	-0.23
Post-op delay	0.399	0.49	0.09	0.19	0.23
Type	0.0564	0.13	0.29	0.24	0.23

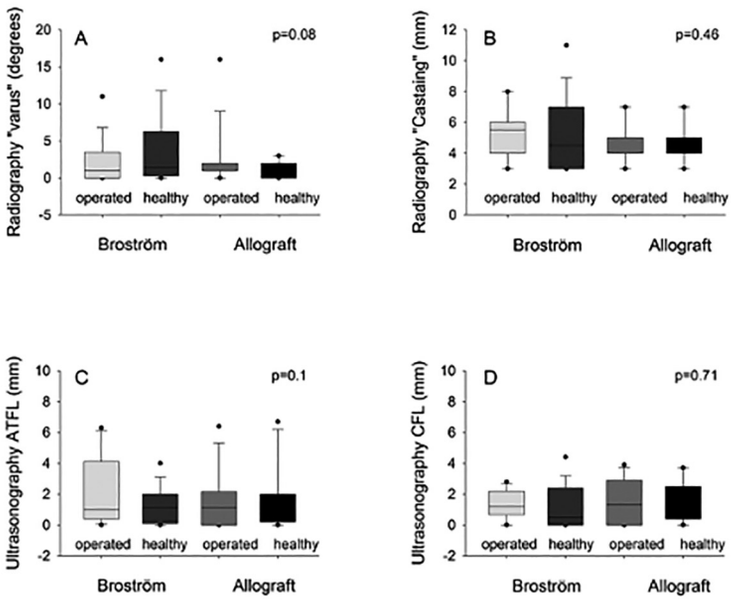

Figure 3. — Results (box plot) of dynamic Radiography and Ultrasonography for the pathological and healthy ankles in each group (p value of interaction).
A : Varus according to surgical technic ; B : Anterior drawer according to the surgical technic ;
C : ATFL (anterior talo-fibular ligament) ultrasonography according to the surgical technic ;
D : CFL (calcaneo-fibular ligament) ultrasonography according to the surgical technic.

RESULTS

The homogeneity between the 2 groups was verified for age, weight, height, postoperative delay and number of smoking patients with no significant difference (Table 1). The proportion of different pre-operative examinations done in each group was not significantly different (chi-square 0.18).

For postoperative functional scores, we did not observe any significant difference between the

two surgical approaches (Table 3). Scores varied between 75 and 90%. We verified whether the functional scores were correlated to age, height, weight, gender and postoperative delay. There was a significant positive correlation between the Olerud & Molander Score, the FAOS-pain score and the postoperative delay but the correlation was low (Table 4).

The results of the radiology and ultrasonography scores showed no significant differences (interaction pvalue) between the two technics, nor between the healthy side and the operated side. (Figure 3)

The main postoperative complications were recurrent instabilities and neurological impairment. Three patients out of the whole cohort (7.5%) presented a recurrent instability on the operated ankle in forced varus manoeuvre (two in group 1 and one in group 2). A reoperation by allograft technique was planned for one of the patients of the Broström-Gould group who presented a recurrent instability. In the same group, one patient had neurological impairment in the distal area of the superficial fibular nerve. Infections and deep vein thrombosis had not been reported at final follow up.

The majority of patients were satisfied. Group 1 comprised 72% of satisfied patients, 11% were partially satisfied and 17% were not satisfied. In group 2, 84% of patients were satisfied, 10% were partially satisfied and 6% were not satisfied. The Chi-square test showed a significant difference (Chi-square 6.2, p = 0.044) between the two groups. Group 2 was generally more satisfied.

DISCUSSION

This study showed similar results regardless of surgical technique. Radiography and ultrasonography scores were not different from healthy ankles. Functional scores results were above 75% satisfaction. This proves the good results of lateral ankle ligamentoplasty. Our hypothesis has not been confirmed. The allograft tendon ligamentoplasty was not able to prove better functional results despite its' allogenic properties. However, Group 2 patients were qualitatively more satisfied. Comparing our results with those of the literature, JL Besse showed that the overall surgical technique for chronic ankle sprains generally showed good results on stability (80 to 95%) in the short and mid-term. If the instability is well controlled by the surgery, the residual pain is often minimal and reported as having no functional consequences *(2,3)*. Several authors showed the benefit in operating an unstable and painful ankle, regardless of age, but prior to complications. This surgery avoids complications such as osteochondritis or early talocural osteoarthritis *(20)*, for which the surgery is more hazardous.

Allograft are commonly used in orthopaedic management. Despite a rigorous screening of the donor population, it is difficult to formally evaluate the risk of transmission of a viral pathology following the use of a musculoskeletal allograft. This risk depends on the graft processing. For example, the risk is near zero when using lyophilized bone chips, whereas the risk of blood transfusion is comparable to the use of a frozen femoral head (1/500.000). Overall, the risk estimated by Buck et al is 1/1.600.000 for a properly screened donor *(4)*. Then, the risk of transmission of viral and bacterial pathology by an allograft is minimal and mainly related to the effectiveness of a well-conducted screening. The minimization of transmission risk is based on the use of grafts from safe banks which perform a complete screening such as patient's background and social habits. Blood tests focussing on antibodies and antigens are performed as standard *(16)*. In this study, we use "cryopreserved" allografts from the Tissue Bank of Cliniques Universitaires Saint-Luc.

Immunological rejection is a potential problem when using a graft. Most of the antigens are located within the tendon tissue. Most tenocytes do not survive cryopreservation without the use of cryoprotectants. Freezing therefore reduces graft antigenicity. The graft is revascularized following the invasion of mesenchymal cells without evidence of immunological rejection *(22)*.

A strong point in our study is that we matched the two groups and considered the combination of functional, radiographical and ultrasound scores. Few studies compared all these parameters. In 2016, Matheny showed comparable results on a larger cohort (n = 86), but without dynamic radiographic

Table 5. — Spearman correlation results: functional scores vs radiographic and ultrasonographic scores

	Olerud & Molander	FAOS 1 Pain	FAOS 2 Stiffness	FAOS 3 Edema	FAOS 4 Quality of life
Ultrasound FA	0.18	0.11	0.03	0.17	0.12
Ultrasound FM	-0.14	-0.20	-0.14	-0.13	-0.16
Rx Varus	0.13	0.05	-0.31	-0.20	0.03
Rx Castaing	-0.19	-0.26	-0.03	-0.27	-0.26

nor ultrasonography assessment. Moreover, the groups were unbalanced, more patients undergoing Broström-Gould treatment (71%) *(21)*.

A second highlight of this study is the use of ultrasonography *(11)*. It allowed us having a "dynamic photography" of the FAOS 1 and 2 scores. This technique evaluated the ligament inflammatory thickening related to pain reported by the functional scores. It was also useful for the assessment of ligament continuity and stretching that may be related to measured radiological values *(7,6)*.

A third highlight is the use of tissue bank allograft to avoid harvesting site morbidity of the autograft techniques such as Castaing. Nowadays, sterilization techniques in tissue banks have improved and are still progressing, significantly reducing the risk of viral transmission and osteolytic reactions *(29,5)*.

Some limitations must be underlined. The results are comparable in the two groups. Our study does not help us to choose the treatment to be carried out in first intention. However, in case of recurrence, Group 1 patients would benefit from a secondary surgical allograft as shown in the Baumhauer and O'Brien meta-analysis *(1)*.

A second weak point is the lack of correlation between functional scores and radiological and ultrasonography scores (Table 5). Indeed, our results suggested that radiographic and ultrasonography tests have a low sensitivity for patients already operated on for ankle instability. The reliability of dynamic tests is often limited by apprehension. We also know the weak objectivity of stress x-rays. The MRI assessment would be a judicious approach. Moreover, Lahde et al showed the lack of reliability of the anterior drawer test with 28% of false negatives in cases of ATFL rupture and 38% in combined ATFL and CFL rupture cases *(10,18)*.

A third weak point is the 2.5 years follow up. We did the statistical analysis in 8 patients for each group with a follow-up of more than 4 years (mean follow-up of 4.6 years ± 1.2) and we did not observe any difference in the results between the two groups. We assume that a longer follow-up with a larger cohort would be beneficial in assessing the value of one technique over another in terms of stability and protection against osteoarthritis *(8,28)*.

CONCLUSION

Direct anatomical repair and reconstruction by allograft tendon give identical results. Of the 40 patients, only one patient had to be re-operated by allograft tendon technique. A randomized study on a large cohort would confirm or invalidate our findings. It would also be interesting to compare the techniques of lateral ankle ligamentoplasty by allograft versus autograft.

REFERENCES

1. **Baumhauer JF, O'Brien T.** Surgical Considerations in the Treatment of Ankle Instability. *J Athl Train* 2002 ; 37 : 458-462.
2. **Besse JL.** Instabilités latérales chroniques de cheville. *Elsevier Masson* 2009 ; Pathologie du pied et de la cheville : 453-467.
3. **Besse JL.** Traitement des entorses graves et des instabilités chroniques de la cheville. *Cahiers d'enseignement de la Sofcot* 1997 ; 62 : 187-217.
4. **Buck BE, Malinin TI, Brown MD.** Bone transplantation and human immunodeficiency virus. An estimate of risk of acquired immunodeficiency syndrome (AIDS). *Clin Orthop* 1989 ; 240 : 129-136.
5. **Carey JL, Dunn WR, Dahm DL, Zeger SL, Spindler KP.** A systematic review of anterior cruciate ligament reconstruction with autograft compared with allograft. *J Bone Joint Surg Am* 2009 ; 91 : 2242-2250.

6. **Cheng Y, Cai Y, Wang Y.** Value of ultrasonography for detecting chronic injury of the lateral ligaments of the ankle joint compared with ultrasonography findings. *Br J Radiol* 2014 ; 87 : 20130406.
7. **Chien AJ, Jacobson JA, Jamadar DA et al.** Imaging Appearances of Lateral Ankle Ligament Reconstruction. *RadioGraphics* 2004 ; 24 : 999-1008.
8. **Clairbois L, Long Pretz P, Leemrijse T.** Reconstruction du ligament latéral de la cheville par allogreffe tendineuse. *Réunion du GESTO-GRECO* 2005.
9. **Cornu O, Druez V, Delloye C.** Intérêt d'une banque de tissus en chirurgie orthopédie. *Maîtrise Orthopédique* 2006 ; 154.
10. **Croy T, Saliba S, Saliba E, Anderson MW, Hertel J.** Differences in lateral ankle laxity measured via stress ultrasonography in individuals with chronic ankle instability, ankle sprain copers and healthy individuals. *J Orthop Sports Phys Ther* 2012 ; 42 : 593-600.
11. **Croy T, Saliba SA, Saliba E, Anderson MW, Hertel J.** Differences in lateral ankle laxity measured via stress ultrasonography in individuals with chronic ankle instability, ankle sprain copers and healthy individuals. *J Orthop Sports Phys Ther* 2012 ; 42 : 593-600.
12. **Gould N, Seligson D, Gassman J**. Early and late repair of lateral ligament of the ankle. *Foot Ankle Int* 1980 ; 1 : 84-89.
13. **Guillo S, Bauer T, Lee JW, Takao M et al.** Consensus in chronic ankle instability: aetiology, assessment, surgical indications and place for arthroscopy. *Orthop Traumatol Surg Res* 2013 ; 99 : 411-419.
14. **Hintermann B, Renggli P. A**natomic reconstruction of the lateral ligaments of the ankle using a plantaris tendon graft in the treatment of chronic ankle joint instability. *Orthopade* 1999 ; 28 : 778-784.
15. **Holmer P, Sondergaard L, Konradsen L, Nielsen PT, Jorgensen LN.** Epidemiology of sprains in the lateral ankle foot. *Foot Ankle Int* 1994 ; 15 : 72-74.
16. Inactivation et sécurisation des tissus et cellules vis-à-vis des bactéries. virus et des prions. partie III : virologie. *Conseil Supérieur de la Santé* 2012 ; 8785.
17. **Jeys L, Korrosis S, Stewart T, Harris NJ.** Bone anchors or interference screws? A biomechanical evaluation for autograft ankle stabilization. *Am J Sports Med* 2004 ; 32 : 1651-1659.
18. **Lahde S, Putkonen M, Puranen J, Raatikainen T.** Examination of the sprained ankle: anterior drawer test or arthrography? *Eur J Radiol* 1988 ; 8 : 255-257.
19. **Leemrijse T, Maldague P, Devos Bevernage B.** Chirurgie du pied : innovations et banque de tissu. *Maîtrise Orthopédique* 2006 ; 154.
20. **Mabit C, Tourné Y, Besse JL et al.** Chronic lateral ankle instability surgical repairs : The long term prospective. *Orthop Traumatol Surg Res* 2010 ; 96 : 417-423.
21. **Matheny LM, Johnson NS, Liechti DJ, Clanton TO.** Activity Level and Function After Lateral Ankle Ligament Repair Versus Reconstruction. *Am Journal Sports Med* 2016 ; 44 : 1301-1308.
22. **Minami A, Ishii S, Ogino T, Oikawa T, Kobayashi H.** Effect of the immunological antigenicity of the allogeneic tendons on tendon grafting. *Hand* 1982 ; 14 : 111-119.
23. **Olerud C, Molander H.** A scoring Scale for Symptom Evaluation After Ankle Fracture. *Arch Orthop Trauma Surg* 1984 ; 103 : 190-194.
24. **Rieck B, Reiser M, Bernett P.** Post-traumatic arthrosis of the upper ankle joint in chronic insufficiency of the fibular ligament. *Orthopade* 1986 ; 15 : 466-471.
25. **Roos EM, Brandsson S, Karlsson J.** Validation of the Foot and Ankle Outcome Score for Ankle Ligament Reconstruction. *Foot & Ankle Int* 2001 ; 22 : 788-794.
26. **Serra-Tosio G.** Repères et mesures en imagerie ostéo-articulaire. *Imagerie médicale : pratique* 2011 ; 155-158.
27. **Shakked RJ, Karnovsky S, Drakos MC.** Operative treatment of lateral ligament instability. *Curr Rev Musculoskelet Med* 2017 ; 10 :113-121.
28. **Tourné Y, Mabit C, Moroney PJ, Chaussard C, Saragaglia D.** Long-term follow-up of lateral reconstruction with extensor retinaculum flap for chronic ankle instability. *Foot Ankle Int* 2012 ; 33 : 1079-1086.
29. **Yinghui H, Shiyi C, Yongjia J et al.** Anatomical reconstruction of the lateral ligaments of the ankle with semitendinosus allograft. *Int Orthop* 2012 ; 36 : 2027-2031.