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ORIGINAL ARTICLE

Chronic lateral ankle instability surgical repairs: The long term prospective

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KEYWORDS
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Summary The present study sought to assess the clinical and radiological results and long-term joint impact of different techniques of lateral ankle ligament reconstruction.
Material and methods: A multicenter retrospective review was performed on 310 lateral ankle ligament reconstructions, with a mean 13-year-follow-up (minimum FU: 5 years). Male subjects (53%) and sports trauma (78%) predominated. Mean duration of instability was 92 months; mean age at surgery was 28 years. Twenty-eight percent of cases showed subtalar joint involvement. Four classes of surgical technique were distinguished: C1, direct capsular ligamentous complex reattachment; C2, augmented repair; C3, ligamentoplasty using part of the peroneus brevis tendon and C4, ligamentoplasty using the whole peroneus brevis tendon. Clinical and functional assessment used Karlsson and Good-Jones-Livingstone scores; radiologic assessment combined centered AP and lateral views, hindfoot weight-bearing Méary views and dynamic views (manual technique, Telos® or self-imposed varus).
Results: The majority of results (92%) were satisfactory. The mean Karlsson score of 90 [19—100] (i.e., 87% good and very good results) correlated with the subjective assessment, and did not evolve over time. Postoperative complications (20%), particularly when neurologic, were

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associated with poorer results. Control X-ray confirmed the very minor progression in degenerative changes, with improved stability; there was, however, no correlation between functional result and residual laxity on X-ray. Unstable and painful ankles showed poorer clinical results and more secondary osteoarthritis. Analysis by class of technique found poorer results in C4-type plasties and poorer control of laxity on X-ray in C1-type tension restoration.
Discussion: The present results confirm the interest of lateral ankle ligamentoplasty in the management of instability and protection against secondary osteoarthritis, and of precise lesion assessment (CT-scan/MRI) to adapt surgery to the ligamentary and associated lesions.
Level of evidence: Level IV. Retrospective therapeutic study.

Introduction

One feature of ankle ligament surgery is the range of techniques described and the generally favorable results associated with them. The requirements for reconstruction are to restore the capsulo-ligamentary structure while conserving tibiotarsal and subtalar joint mobility and ensuring lasting stabilization to avoid secondary osteoarthritis due to deterioration of the joint [1].

The present study sought:

- to assess long-term functional results in lateral collateral capsulo-ligamentary reconstruction in terms of stability and laxity, and to determine factors of failure and predictive pre-operative factors and long-term joint impact;
- to specify the examinations contributing to initial lesion assessment so as to define lesion-adapted treatment attitudes.

Material and methods

This multicenter retrospective study was performed in seven French orthopedic centers: two private hospitals in Grenoble (clinique des Alpes) and Toulouse (clinique de l'Union) and five teaching hospitals in Lille, Limoges, Lyon, Montpellier and Paris (Salpêtrière).

Inclusion criteria

All lateral collateral capsulo-ligamentary reconstructions performed between 1990 and 2003 were included, whether anatomic or not, and with or without associated surgery. Minimum follow-up was set at 5 years. Two series with very long (greater than 20 years) follow-up (H. Duquennoy's files from Lille, and C. Mansat's files from Toulouse) were included so as to assess very long-term results. Neuromuscular pathologies, unclosed growth-plate cartilage and associated fractures, apart from osteochondral lesions of the talar dome (OLTD), were excluded.

Epidemiology

The series comprised 310 lateral collateral capsulo-ligamentary reconstructions. Male subjects predominated (53%). Mean age at surgery was 28 years ($\pm$ 10). The instability syndrome, with iterative sprains (mean: 11 $\pm$ 10), had a mean 92 months' evolution. Left and right sides were equally involved; 23% of contralateral ankles were considered also unstable. The etiology of spraining mainly concerned sports accidents (78%), with 16% home accidents and 6% work accidents. Initial management was basically orthopedic (43% strapping, 36% plaster or resin cast immobilization of very variable duration); 19% of patients had had no treatment; 79% had had some rehabilitation prior to the decision to operate.

Clinically, all the ankles were subjectively judged unstable, 52% unstable and painful and 2% essentially painful. Laxity was confirmed by varus coaptation defect (76%), anterior drawer (69%) and lateral coaptation defect (47%); hindfoot morphotype was well aligned in most cases (78%) or else in moderate varus.

Dynamic X-ray (50% manual, 50% Telos®) confirmed the increase in drawer and varus laxity, with a 2 mm difference in drawer with respect to the healthy side and an 8° difference in varus (Fig. 1); complementary examinations included arthroscan (14%), CT-scan (4%), MRI(10%), arthro-MRI (1.6%) and ultrasonography (1.3%). Clinical and paraclinical findings suggested subtalar joint involvement in 28% of cases.

Treatment

Four classes of surgical technique were distinguished (Table 1): C1, direct repair (Duquennoy); C2, augmented

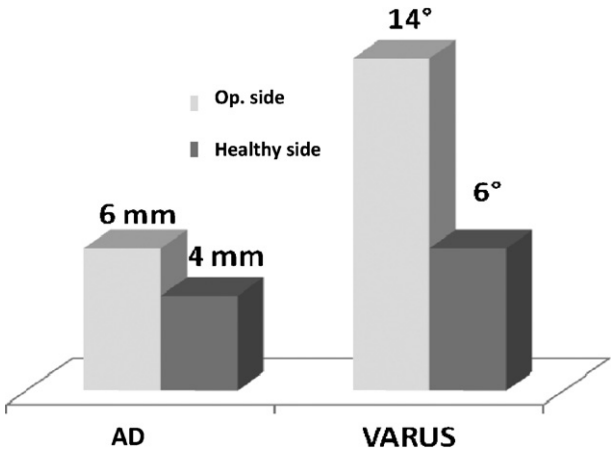

Figure 1 Radiologic results for anterior drawer and varus laxity in operated and healthy contralateral ankle.

Table 1 The four classes of surgical techniques used in the Sofcot series.

Class	Type of surgery	Examples of technique
C1	Direct capsular ligamentous reattachment	Duquennoy
C2	Augmented repair	Periosteum Inferior extensor retinaculum Peroneus tertius, etc.
C3	Plasty using part of a stabilizer tendon (peroneus brevis)	Hemi-Castaing
C4	Plasty using a whole stabilizer tendon: tenodesis reconstruction (peroneus brevis)	Castaing

repair (periosteum, inferior extensor retinaculum [IER], peroneus tertius); C3, ligamentoplasty using part of the peroneus brevis (hemi-Castaing); C4, ligamentoplasty using the whole peroneus brevis (Castaing). Associated surgery was performed in 24% of cases: resection for bone wrenching (6%), impingement (10%), peroneal tenosynovitis (1%) or cartilage lesions (4%), peroneal fissure suture (2%) or osteochondral graft (1%); there were no calcaneal osteotomies, mosaicplasties or chondrocyte grafts. Mean postoperative immobilization was for 6 (±2) weeks, with 3 (±2) weeks' non-weight-bearing. Postoperative proprioceptive rehabilitation was usually prescribed (97%).

Assessment methods

All assessment parameters were put together on a form drawn up on the basis of literature data. The pre-operative study covered age at surgery, gender, activity level (Tegner score), contralateral ankle status, initial sprain etiology, sprain-to-surgery interval, reason for surgery, signs of incipient arthritis or osteochondral lesion, and degree of radiological laxity on varus or anterior drawer views when available. Peri-operative data, given the retrospective design, focused on surgical technique, status of the various anatomic structures, and postoperative course.

Functional results were assessed in terms of Karlsson score [2] and global Good-Jones-Livingstone score [3]. The Karlsson score (Table 2) grades several parameters, totaled to give a score between 0 and 100: results were considered poor for scores under 50, medium for 50—79, good for 80—94 and excellent for 95—100. The Good-Jones-Livingstone score gave a global assessment (Table 3). Clinical examination focused on ankle mobility, and on possible laxity assessed by lateral coaptation defect amplitude measured in prone position, corresponding to the sum of talocrural and subtalar joint mobility (Fig. 2).

X-ray assessment of the operated and contralateral ankles comprised loaded AP (20° internal rotation) and lateral views, loaded circled hindfoot Méary view, and dynamic X-ray in forced varus and anterior drawer. Depending on the team, X-rays were either taken manually, using a Telos system or by self-imposed varus [4], and assessed: evolution of arthritis in 4 grades, following Van Dijk [5] (Table 4), residual laxity, and hindfoot morphotype.

Statistical analysis was performed by the SIIM Biostatistics Laboratory in Grenoble, using Stata 10 software under OSX. Numbers and frequencies were used for qualitative variables and mean and standard deviations for continuous variables. Testing set first order or alpha risk at 0.05. For continuous variables, paired means were compared by Student t-test and multiple means by Anova. Pairwise correlations were assessed by Spearman coefficient. Multivariate analysis by logistic regression was used to search for prognostic factors for good functional results in terms of Karlsson score.

Figure 2 Clinical measurement of tibiotalar and subtalar laxity.

Results

All the included patients were followed up. Mean follow-up (FU) was 13 years (5—30 years), and mean age at FU 41 years (21—70 yrs).

Complications

The two main postoperative complications were neurologic lesions (9%) and infection (5%), and were significantly correlated with less good results. Other complications comprised hematoma (3%), reflex sympathetic dystrophy (3%) and deep venous thrombosis (1%).

Overall results

A large majority (92%) of patients were satisfied with their result; 7.7% were disappointed and 0.3% (=one case) unhappy. Mean Karlsson score was 90 (19—100): i.e., 87% good and very good functional results; stability and pain score were satisfactory, with respectively 83% equal to or greater than 20/25 and 96% equal to or greater than 15. The Karlsson score correlated with the subjective assessment and with the Good-Jones-Livingstone score. Clinical results appeared to be stable over time: Karlsson scores did

Table 2 Karlsson score.

Category	Degree	Score
Pain	None	20
	On effort	15
	Walking on rough ground	10
	Walking on smooth ground	5
	Constant (severe)	0
Edema	None	10
	After effort	5
	Constant	0
Instability (subjective)	None	25
	1—2 sprains/yr	20
	1—2 sprains/month	15
	Walking on rough ground	10
	Walking on smooth ground	5
	Constant (severe), use of brace	0
Stiffness	None	5
	Moderate (morning, after exercise)	2
	Great (constant, severe)	0
Stairs	No problem	10
	Difficult (instability)	5
	Impossible	0
Running	No problem	10
	Difficult (instability)	5
	Impossible	0
Work and activity	Unchanged	15
	Same job, less sport, leisure unchanged	10
	Lighter work, no sport, leisure unchanged	5
	Change of job, leisure reduced	0
Help, orthesis	None	5
	For sport	2
	For daily life	0
Total		100

not vary according to follow-up, the mean length of which was comparable in the different results classes.

Dynamic X-ray at follow-up (36% manual, 46% Telos® and 18% self-imposed varus) showed improvement in laxity of 0.16 mm (±2) for drawer and 0.10° (±5) for varus. Radiologic evolution showed only slight progression in degenerative arthritic lesions, a majority of which (77%) were graded G0 (Table 5).

Table 3 Good-Jones-Livingstone functional score.

Excellent	Complete resumption of activity, pain-free, no edema, perfect stability
Good	Occasional pain (violent exercise), good stability (no apprehension)
Moderate	No real instability, but apprehension (rough ground)
Poor	Residual instability, pain and repeated edema

Analytic results

Surgery technique classes C1, C2, C3 and C4 did not differ on the main parameters (age at surgery, gender, sprain etiology, indication for surgery, pre-operative laxity). The two ''very long-term'' series (Duquennoy tension restoration plasty and Castaing peroneus brevis plasty) had a mean follow-up of 20 years, as compared to 10 years for the other series, yet did not differ in terms of result. Analysis was based on the Karlsson score, in perfect correlation with the Good-Jones-Livingstone score (Fig. 3).

Table 4 Van Dijk radiologic classification [5].

Grade	Tibiotalar joint line
G0	Normal
G1	Osteophytes without impingement
G2	Impingement with or without osteophytes
G3	Complete impingement

Table 5 Post-operative evolution of radiologic lesions (Van Dijk classification).

G0		G1		G2		G3	
Pre-op	Postop	Pre-op	Postop	Pre-op	Postop	Pre-op	Postop
88%	77%	9%	18%	3%	4%	0%	1%

Karlsson scores were significantly poorer with Castaing peroneus brevis plasty, principally due to the ''pain'' and ''residual instability'' components; even so, mean score at 20 years' FU was 80/100, and there was no difference in joint mobility or osteoarthritis compared to the other techniques. Radiologic residual laxity showed greater varus with isolated direct repair, where there was also a positive correlation between varus laxity pre-operatively and at follow-up. Degree of osteoarthritis was independent of technique, but correlated with poorer functional scores; there was, however, little real osteoarthritis, grades 2 and 3 representing only 3% of the series as a whole. Patients with greater osteoarthritis showed significantly greater radiologic varus laxity at follow-up.

Hindfoot measurement on circled Méary view found very few cases of hindfoot varus, and no correlation with poor clinical or radiological results.

Prognostic factors

The pre-operative factors of gender, age at surgery, side operated on, contralateral ankle status and occupation had no impact on results. Nor was a link found between functional result and residual laxity on dynamic X-ray: patients showing residual instability at follow-up did not show greater radiologic laxity. Findings were similar in regard to pain. Although there was no direct relation between results and the number of sprains, pre-operative signs of osteoarthritis and osteochondral lesion were significantly more frequent the longer the interval to surgery; in these cases, the clinical results were less good. Patients with instability associated with pain showed less good clinical results ($p < 0.02$) and more osteoarthritis ($p < 0.01$) than those with simple instability, despite comparable pre-operative laxity in both cases. An etiology of work accident concerned only 6% of the present series, which is a low figure considering the socioeconomic impact of this category of pathology. Although it is difficult to come to any firm conclusion statistically, due to the small number, work accidents were associated with less good functional results ($p = 0.02$).

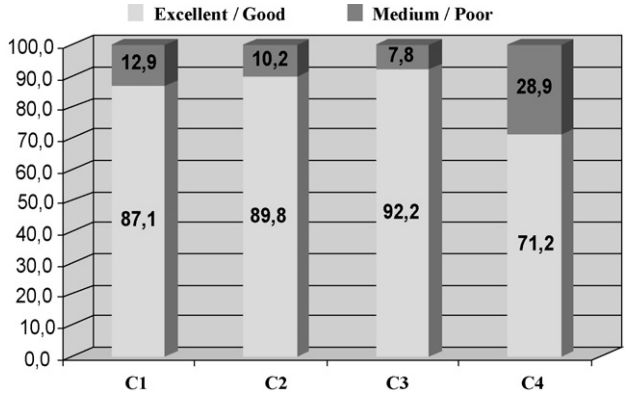

Figure 3 Clinical results per type of surgery (%).

Discussion

To the best of our knowledge, the present series is the largest to be reported with so long a follow-up. There is a large literature on ankle instability; but when more than 5-year-follow-up is specified, the usual search engines come up with significantly fewer references [4—32] We applied the same study criteria as in the present series to each article, when they were reported. The various techniques were classified as above (C1, C2, C3, C4), and results were analyzed per group and compared across groups and to the present series.

In group C1, basically comprising the Broström and Duquennoy techniques [6—9], there were between 81% and 96% of good and very good results, compared to 91% in the present series.

In group C2 (tension restoration associated to reinforcement) [10—15], results with the Bröstrom-Gould technique, using the third peroneal and the periosteum, were similar to those for the present series: 82% to 85% good and very good results. Plantar plasty, on the other hand, [13,14], gave widely variable results: 67% to 100% good and very good.

In group C3, using part of a stabilizing tendon [9,16,17], results with the Chrisman-Snook and hemi-Castaing techniques approximate those of the present series, with 90% to 93% good and very good results.

In group C4, the Castaing technique [18], there were 80% good and very good results, compared to 71% in the present series, with an almost identical number of patients. The Evans technique gives very variable results, ranging from 50 to 93% good and very good results, for a mean of 75% [19—22]. The Watson-Jones technique gives a mean 50% good and very good results [23—25]: this figure is brought down by van der Right et al.'s study [26], with its follow-up of more than 20 years. Results with techniques involving part or all of a tendon or augmented repair give results comparable to those of the present series. Isolated direct repair, on the other hand, gives different results. Reconstruction using the whole peroneus brevis tendon [18—27] tends to give poorer results than with a half-tendon [9,16,17]. Krips et al. [11,12,28,29], comparing so-called ''anatomic'' (Broström-Gould and periosteum) and ''non-anatomic'' techniques (hemi-Castaing, Watson-Jones, Evans), reported the former to give better results, significantly so in two cases ($p < 0.005$). Although with less than 5 year-follow-up, the Société orthopédique de l'Ouest series, comparing 131 hemi-Castaings and 76 Duquennoys, gave results comparable to the present for the former,

Table 6 Residual instability rate according to surgical technique: comparison with literature.

Technique class	Literature series			Sofcot series	
	Authors	Technique	Residual instability rate (%)	Technique	RI rate (%)
C1	Karlsson et Peterson, 1991 [2]	Broström	12	Duquennoy	16
	Bell et al., 2006 [7]	Broström	23		
	Muijs et al., 2008 [6]	Duquennoy	19		
C2	Jarde et al., 1999 [15]	Periosteum	8	Periosteum	17.5
	Krips et al., 2001 [12]	Broström-Gould	5	Inferior extensor retinaculum	
	De Vries et al., 2005 [13]	Plantar	32	Periosteum and inferior extensor retinaculum	
C3	Thermann et al., 1997 [9]	Chrisman-Snook	9	Hemi-Castaing	4
C4	Nimon et al. 2001 [22]	Evans	44	Castaing	29
	Krips et al., 2002 [22]	Watson-Jones Evans	15		
	Hamido et al., 2007 [24]	Watson-Jones	13		
	Jarde et al., 2002 [18]	Castaing	32		

whereas the latter were poorer due to greater residual instability, although statistically the difference was not significant [4].

The frequency of complications, mainly infectious (5%) and neurological (9%), in the present series was close to the findings of the literature: respectively, 4% and 11%.

Radiological comparison is hindered by the small number of series reporting X-ray analyses; where available [11—13,22,24,25], rates of radiological alteration are very variable (18—65%).

Overall clinical results are very favorable, with 70—90% of good and very good results. Focusing on a subjective criterion such as residual instability, however, reveals a variation from 15 to 26% according to the technique (Table 6), for a mean 20% taking all techniques together. The patient's subjective assessments are to be taken with caution: Nimon et al. [22], reporting 11 ankles managed by the Evans technique, found 57% good and very good results but 97% of patients satisfied.

The subtalar joint has been variously studied in the literature. Very few authors see it as a treatment selection criterion: in Thermann et al. [9] and Jarde et al.'s [18] series, the Castaing technique systematically gave subtalar instability. Some authors, on the other hand, make subtalar instability an exclusion criterion, although the recommended technique bridges the subtalar joint with an effect of tenodesis [12]. Tibiotalar osteoarthritis is mainly post-traumatic, and secondary to tibiotalar instability in 15% of cases [30,31]. According to Valderrabano et al. [32], the mean interval between trauma and onset of osteoarthritic lesions is 34 years; medial collateral lesions are more arthrogenic than lateral collateral lesions. Series vary widely, with low levels of proof and variable assessment scores, generally short follow-up and small numbers apart from a few multicenter series. With a 3% rate of osteoarthritis at follow-up, the present series confirms the protective impact of ligamentoplasty against onset of tibiotalar osteoarthritis over the long-term (mean 13 years' FU).

Conclusion

Analyzing the present series and comparing it with the literature revealed a few lessons and suggested some recommendations to enable athletes with unstable ankle both to recover and to conserve joint function.

The longer the chronic instability, the greater the risk of osteochondral lesion and osteoarthritis, which are factors of poorer clinical result. This argues for early treatment of ankle instability. Ligamentoplasty protects against onset of tibiotalar osteoarthritis in the long term. Patients with pain have less good results than those with simple instability, with a greater arthritic component at follow-up, despite comparable levels of residual laxity.

Work accidents are associated with poorer results, as are complications, especially when neurologic. There is no strict correlation between correction of laxity and functional result: certain ankles showing persistent laxity on X-ray may be functionally satisfactory, without clinical instability, and vice versa. Curing laxity in an ankle does not necessarily make it stable or pain-free: the role of the proprioceptive factor cannot be neglected. In severe

pre-operative laxity, isolated direct repair appears to be insufficient.

Subtalar joint involvement should always be considered and hindfoot varus should be screened for. Lesion assessment (ligamentary and/or associated lesions) in chronic instability is thus a fundamental phase, which nowadays can include CT and MRI examinations, to adapt the reconstruction technique both to ligamentary (notably subtalar) and associated lesions (talar osteochondral, impingement) and morphotype (calcaneal alignment osteotomy).

Conflict of interest statement

None.

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