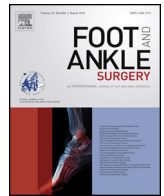




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Review

Non-anatomical or direct anatomical repair of chronic lateral instability of the ankle: A systematic review of the literature after at least 10 years of follow-up

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ABSTRACT

Introduction: A lateral ankle sprain is one of the most frequent reasons for consultation at the emergency trauma unit. Numerous surgical procedures have been described with long-term outcomes that differ. **Hypothesis:** The long-term results of anatomical repair of the anterior talofibular ligament (ATFL) and the calcaneofibular (CFL) ligament are better, with less secondary radiological osteoarthritis than non-anatomical repair.

Materials and methods: A review of the literature after a minimum follow-up of 10 years was performed to analyze the clinical and radiological results of direct anatomical repair (Broström, Duquenois) and non-anatomical repair (Watson Jones, Evans, Castaing). Thirteen articles were selected.

Results: Eight hundred and one ankles were evaluated after a mean follow-up of 15.3 years. The functional outcome was better after anatomical repair but with recurrent instability. Loss of range of motion and secondary osteoarthritis was more frequent after non-anatomical repair.

Conclusion: Anatomical repair of the lateral collateral ligament of the ankle resulted in a better functional outcome and less secondary osteoarthritis than non-anatomical repair.

Study design: Review of the literature; level of proof IV.

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1. Introduction

Ankle sprains are the main cause for consultation in emergency trauma units, with nearly 6000 cases per day in France [1]. This represents a major socioeconomic burden [2] whose management is a subject of debate [3,4]. In case of recurrent sprains, lateral ankle instability develops in 20%–30% of cases depending on the series [5,2,6,7] and results in pain, insecurity and recurrent sprains that are a real handicap. Chronic lateral instability is associated with a risk of secondary osteoarthritis of the ankle joint. The goals of surgical treatment are to stabilize the ankle, treat associated injuries and prevent long-term osteoarthritis [8,9] but no consensus is established in literature. More than 50 techniques have been described in the literature with good and very good intermediate-term functional results but with long-term clinical and radiological outcomes that vary [10–16]. There are direct anatomical repair (DAR) and non-anatomical repair (NAR) techniques. Long-term recurrence of instability has been reported with DAR and joint stiffness of the subtalar joint has been reported with NAR [17].

The goal of this review of the literature was to analyze the clinical and radiological results of direct anatomical repair and non-anatomical repair of chronic lateral instability of the ankle after at least 10 years of follow-up.

2. Materials and methods

This review was designed according to the recommendations in the literature [18] for systematic reviews of the literature and meta-analyses [19].

2.1. Search strategy

In February 2015, a bibliographic search was performed in the databases PubMed, Medline, CINAHL, Cochrane, and Embase. The MeSH keywords were “lateral ankle instability” and “surgical treatment”. Two of the authors (TN and RL) independently selected articles that responded to the question with no time limit for publication. The selection was made after reading the title and the abstract. The selected articles were read entirely and the bibliographic references of each article were analyzed to make sure that no major article on the subject had been excluded.

2.2. Selection criteria

Inclusion criteria were all articles that reported the clinical and radiological outcome of surgical management of lateral instability of the ankle in adults, whatever the surgical technique with at least 5 years of follow-up (initially). Later, a minimum follow-up of 10 years was chosen to increase the scientific value of the article. Included articles had to have a clinical evaluation with one or several functional clinical scores [20] (American Orthopaedic Foot and Ankle Society (AOFAS) [21], Kaikkonen ankle score [22], Roos and Karlsson score [20], Good score [23]), as well as radiological assessment to evaluate secondary osteoarthritis (according to Krips et al. [24]). The following pre-selection criteria were chosen (1) all patients were at least 18 years old, (2) lateral instability of the ankle was the primary indication for surgery, (3) this was the first operation on the ankle, (4) a clinical and radiological evaluation was performed at the final follow-up. Selected studies were (1) not limited in time for the date of publication, (2) written in French or in English, (3) had an abstract that was available online. In case of disagreement on the selection of an article, the two authors reached a consensus. Articles with a follow-up of less than 10 years, with involvement of several medial and lateral

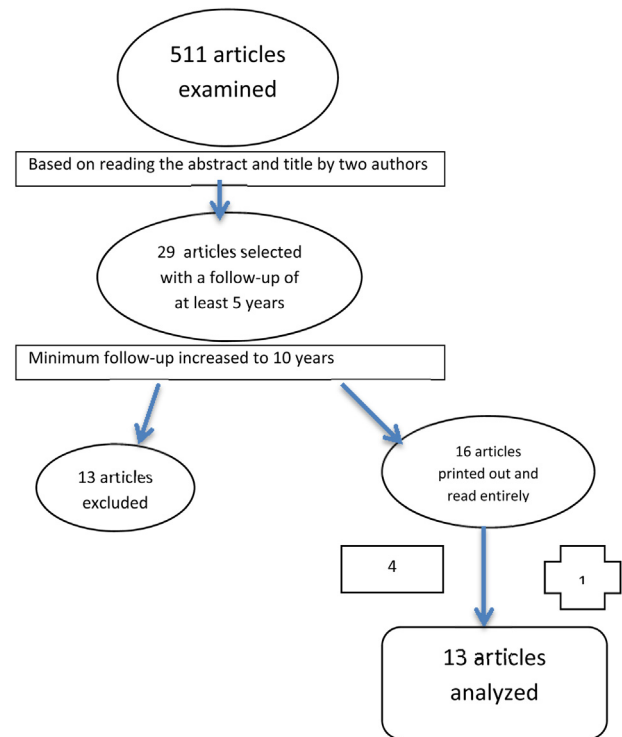


Fig. 1. Selection of articles by two authors.

ligaments, with associated bone injuries [25], or involving bone surgery (calcaneal osteotomy) were excluded.

2.3. Selection process

A total of 510 articles were examined. Twenty-nine articles reported results after at least 5 years of follow-up. An initial selection excluded articles that did not fulfill our criteria (epidemiological articles, articles on prevention, biomechanical studies, decision tree, technical notes, case reports, language criteria, articles on surgical anatomy and with unclear methodology). For the second selection we chose 16 articles with at least 10 years follow-up. Two articles were excluded because they did not present any clinical scores at the final follow-up [26,17], one because the surgical technique was not described [27], and one because there was no radiological assessment [28]. One article was included after it was identified in the discussion of several articles [29]. Finally 13 articles were selected that reported clinical and radiological results at 10 years of follow-up. Fig. 1 summarizes the selection process for articles.

3. Results

3.1. Level of evidence of the study

Clinical case series, level IV.

At total of only 13 articles were selected. Three evaluated surgical management by direct anatomical repair with or without a secondary graft (DAR) [30–32], 6 non anatomical repair (NAR) [33–38], 3 compared the two surgical techniques [39,24,40] and 1 article compared 4 techniques (DAR with and without grafts, NAR with or without peroneus brevis or hemi-Castaing procedures) [41]. Eight hundred and one cases were evaluated in these studies in patients whose mean age was 25.9 years (18–53) at surgery and after a mean follow-up of 15.3 years (10–26.3) at the final follow-up.

3.2. Anatomical repair

The clinical results were good or very good at the final follow-up. Nery et al. [32] reported an AOFAS score of 90/100 at the 10-year follow-up. The clinical outcome with Duquenois repair was satisfactory at 13 years of follow-up [30]: the mean AOFAS score was 89.7/100 however there was worsening or the development of secondary arthritis in 8/20 patients. Patients were satisfied following DAR with extensor retinaculum grafts, with Roos and Karlsson scores of 93% and residual laxity in 5% but without secondary osteoarthritis at 11 years of follow-up [31]. DAR results are summarized in Table 1.

3.3. Non-anatomical repair

In the study by Van der Rijt et al. [33], only one third of patients were asymptomatic following Watson–Jones reconstruction, and minimal radiological anterior osteophytes of the ankle were observed in 100% of the cases at 22 years of follow-up. The presence of osteophytes was directly linked to recurrent instability, especially sagittal, with a persistent and significant positive anterior drawer test. Karlsson et al. [34] also reported osteophytes in 32/37 patients who underwent Evans-type peroneus brevis tenodesis after a mean follow-up of 14 years (10–17). Nimon et al. [35], only reported 57% of good and very good results according to the Roos and Karlsson score, 10 years after Evans-type NAR. The mean AOFAS score was 87.2/100 and 25% of the patients presented with secondary osteoarthritis at the final follow-up. According to Morelli et al. [36], the clinical results were better following Watson–Jones ANR with an AOFAS score of 92.2/100 at 10.8 years of follow-up and osteoarthritis in 21% of the cases. These results were confirmed by Korkala et al. [37] and Becker et al. [38] who reported good and very good results in the Good score in 80% of the cases at 20 years of follow-up and 72% at 12 years. The results of NAR are summarized in Table 2.

3.4. Studies comparing anatomical and non-anatomical repair

Clinical results were better with DAR (80% of good and very good results on the Roos and Karlsson score compared to 33% with ANR) with a greater tendency for stiffness and osteoarthritis following NAR in two studies by Krips et al. [39,24]. Mabit et al. [41], reported poorer results with NAR using the entire peroneus brevis tendon while control of laxity was poorer with DAR. Kitaoka et al. [40] did not report any difference in clinical laxity scores between DAR and NAR at 20 years of follow-up.

4. Discussion

This systematic review of the literature shows that the long-term outcome of the surgical treatment of chronic lateral instability of the ankle is good or very good with a trend toward recurrent instability when direct anatomical repair is used according to Mabit et al. [41] and secondary osteoarthritis with loss of range of motion in case of non-anatomical repair.

Lateral instability of the ankle develops in 20%–30% of the cases following a lateral ankle sprain [6,7,15,16]. Instability is multifactorial: objective laxity, a proprioceptive deficit, hyperlaxity, as well as calcaneal varus, and may result in long-term secondary osteoarthritis with a significant functional handicap. Although the outcome of conservative treatment is good for a simple sprain [2], surgical treatment is indicated in recurrent sprains in young athletes with chronic lateral instability. Numerous surgical techniques have been described in the literature. They are divided into direct anatomical repair (DAR) with or without associated grafts, non-anatomical repair (NAR) and anatomical reconstruction of the lateral collateral ligament (LCL). All these treatments have satisfactory short and intermediate-term functional results.

The principle of DAR, described by Broström in 1966 [42], is to restore tension in the torn LCL bundle by transosseous reinsertion

Table 1
Results of direct anatomical repair.

Articles	Type of surgery	Follow-up (years)	Number of patients	Functional results	Osteoarthritis according to Van dijk
Mabit et al. <i>OTSR</i> [41]	Duquenois	13	76	Good: 87.1% G and VG Residual instability: 16%	9% Grade I 2% Grade II 1% Grade III
	Duquenois + Renfort	13	49	Good: 89.8% G and VG Residual instability: 17.5%	
Muijs et al. <i>JBJS</i> [30]	Broström	13	21	AOFAS 89.7/100 Good: 81% VG and G	6/20 Grade I 1/20 Grade II
Krips et al. <i>JBJS</i> [39]	Broström	20	54	Good 43/54 VG and G Karlsson: 10/54 excellent	29/54 Grade I 3/54 Grade II
Krips et al. <i>Foot Ankle Int.</i> [24]	Broström	12.3	25	Good: 15/25 G and VG	1/25 Grade I
Kitaoka et al. <i>J. Orthop. Trauma</i> [40]	Broström	20	22	Good: 21/22 G and VG	1/36 Grade I
Tourné et al. <i>Foot Ankle Int.</i> [31]	Broström with graft (<i>extensor retinaculum</i>)	11	150	Good: 93% G and VG	No osteoarthritis
Néry et al. <i>AJSM</i> [32]	Broström–Gould	10	38	AOFAS 90/100	21% of cartilage under arthroscopy

Table 2
Results of non-anatomical reconstruction.

Articles	Type of surgery	Follow-up (years)	Number of patients	Functional results	Osteoarthritis according to Van dijk
Morelli et al. <i>Foot and Ankle Surgery</i> [36]	Watson–Jones	10.8	14	AOFAS 92.2/100 Good: 14/14 G and VG	14% Grade I 7% Grade II
Mabit et al. <i>OTSR</i> [41]	Castaing	13	49	Good: 71.2% G and VG Residual instability: 29%	
	Hemi Castaing	13	136	Good: 92.2% G and VG Residual instability: 4%	
Krips et al. <i>JBJS</i> [39]	Evans	22	45	Good: 15/45 G and VG Karlsson: 4/45 excellent	24/45 Grade I 7/45 Grade II 4/45 Grade III
Nimon et al. <i>JBJS</i> [35]	Evans	9.7	91	AOFAS 87.2/100 Good: 57% G and VG	16/63
Krips et al. <i>Foot Ankle Int.</i> [24]	Evans	12.3	29	Good: 8/29 G and VG	7 Grade I
Kitaoka et al. <i>J. Orthop. Trauma</i> [40]	?	20	31	Good: 27% G and VG	6/36 Grade I
Karlsson et al. <i>JBJS</i> [34]	Evans	14	42	Good: 50% G and VG 13 re-interventions	32/37 Grade I
Van der Rijt et al. <i>JBJS</i> [33]	Watson–Jones	22	9	Good: 33% G and VG	100% Grade I
Becker et al. <i>Clin. Orthop. Relat. Res.</i> [38]	Watson–Jones	12	25	Good: 72% G and VG	45% Grade I
Korkala et al. <i>Clin. Orthop. Relat. Res.</i> [37]	Evans	20	25	Good: 19/58 G and VG	6/25 Grade I

[43]. This technique, which was made popular by Duquenois [44] and Ahlgren [45], respects the kinematics of the subtalar and tibiotalar joint. Positive results in the different series vary from 85 to 90% [46,47] as long as the two bundles of the lateral collateral ligament (anterior talofibular (ATFL) and calcaneofibular (CFL)) are reconstructed [13,8,48,49]. The main disadvantage is the use of damaged scar tissue with a risk of progressive distension and recurrent tears [11]. Thus, certain authors have described DAR with associated reconstructions using extensor retinaculum flaps (frondiform ligament) [50–52] or a fibular periosteal flap [53,54]. The goal is to provide healthy tissue with better resistance. In our review of the literature we found similar results with a good and very good outcome in 81–93% of the cases according to the Good score [31,30]. The anatomical design of this surgical technique appears to protect the ankle joint: 0% of osteoarthritis at 11 years [31] up to 53% at 20 years [39].

With NAR (anterolateral ligament reconstruction or tenodesis), the peroneus brevis is frequently used [35] with the disadvantage of sacrificing an important stabilizer of the ankle and reducing eversion strength. There are numerous versions of this ligament reconstruction procedure, which only differ in the pathway of the tendon (whose distal insertion is at the base of the 5th metatarsal) and the direction of the bone tunnels [55,9,56–58]. To reduce morbidity during harvesting certain authors describe the use of a half-tendon to reconstruct one or two bundles of the LCL [59]. The use of the calcaneal [60], plantaris [61,62] or the peroneus tertius [63] tendons has been described in the literature. Horibe et al. [64] described an anterolateral ligamentoplasty by cryopreserved allograft. Whatever the technique, the results are good or very good for instability in 80–95% of the cases [65,66,30,67,58] but with residual pain which varies depending on the series (5–67%) and frequent secondary

osteoarthritis due to biomechanical changes in the subtalar joint [55,41,13,68,14]. The functional outcome degenerates over time [17]. For Krips et al. [69], at 2–10 years of follow-up NAR does not restore the functional anatomy of the ankle compared to DAR, resulting in secondary osteoarthritis of the ankle mainly of the medial side. Better Good score (ref) results were reported for DAR at the final follow-up. These results were confirmed by Hennrikus et al. [70].

In our review of the literature, we observed clinical results that varied with only 27%–92.2% results of good and very good results on the Good score [40,41]. Secondary osteoarthritis of the ankle is frequent and can develop in up to 100% of cases at 22 years of follow-up [33].

To improve these results, two bundle (ATFL and CFL) anatomical reconstruction is the now a popular technique [71–74,12,75] for isometric results with minimally invasive surgery [76,77]. The most frequently used graft is the gracilis tendon [78–81] because it is easy to harvest, for the low rate of morbidity [82,83] and for its biomechanical properties. For Tashiro et al. [84], muscular strength was not decreased with a semitendinosis or gracilis tendon graft at the intermediate term follow-up. The goal is to use an autograft whose harvesting does not disturb ankle dynamics. Takao et al. [78] described reconstruction of the ATFL alone with a gracilis tendon with good results for stability and range of motion at two years of follow-up. According to Schmidt et al. [12], anatomical reconstruction preserves range of motion of the ankle and subtalar joints. The results of our review of the literature confirm the long-term preservation of range of motion and ankle and subtalar joint kinematics with anatomical repair. Restoring the anatomy prevents early secondary osteoarthritis. Like Guillo et al. [4] we do not recommend using non-anatomical repair as the first line therapy.

Conflict of interest

None.

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