Anatomical reconstruction and Evans tenodesis of the lateral ligaments of the ankle

CLINICAL AND RADIOLOGICAL FINDINGS AFTER FOLLOW-UP FOR 15 TO 30 YEARS

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In this retrospective study, we assessed the outcome in 99 patients who underwent reconstruction of the lateral ligaments of the ankle for chronic anterolateral instability with a minimum follow-up of 15 years.

Two techniques were compared: 54 patients had an anatomical reconstruction (AR group) and 45 had an Evans tenodesis (ET group). They were followed up for 19.9 ± 3.6 years and 21.8 ± 4.6 years, respectively. During follow-up, seven patients in the AR group and 17 in the ET group required a further operation ($p = 0.004$). At follow-up, significantly more patients ($n = 15$) in the ET group had limited dorsiflexion than in the AR group ($n = 6$, $p = 0.007$) and 18 in the ET group had a positive anterior drawer test compared with seven in the AR group ($p = 0.002$). In the ET group 27 had tenderness on palpation of the ankle compared with 15 in the AR group ($p = 0.001$). Stress radiographs showed ligamentous laxity significantly more often in the ET group ($n = 30$) than in the AR group ($n = 13$, $p < 0.001$). The mean values for talar tilt and anterior talar translation were significantly higher in the ET group than in the AR group ($p < 0.001$, $p = 0.007$, respectively). There were degenerative changes on standard radiographs in 32 patients in the AR group and 35 in the ET group ($p = 0.05$). Four patients in the ET group had developed severe osteoarthritis compared with none in the AR group ($p = 0.025$). Assessment of functional stability revealed a mean Karlsson score of 83.7 ± 10.4 points in the AR group and 67.0 ± 15.8 points in the ET group ($p < 0.001$). According to the Good rating system, 43 patients in the AR group had good or excellent results compared with 15 in the ET group ($p < 0.001$).

Compared with anatomical reconstruction, the Evans tenodesis does not prevent laxity in a large number of patients. Long-standing ligamentous laxity leads to degenerative change in the ankle, resulting in chronic pain, limited dorsiflexion and further operations. The functional result deteriorates more rapidly after the Evans tenodesis than after anatomical reconstruction.

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Chronic anterolateral instability of the ankle can be treated effectively by repair of the lateral ligaments. Tenodesis or reconstruction using an autogenous tendon graft, however, has been used in most studies.¹⁻²⁰ This usually involves a tenodesis between the distal fibula and the calcaneus, the talus or the base of the fifth metatarsal. The Evans procedure is a widely used non-anatomical reconstruction.²¹ It was originally described in 1953. Several subsequent modifications have been utilised.⁴ While the short-term results are satisfactory in most patients, it has been suggested that the results of tenodesis deteriorate with time.^{18,22} Karlsson et al.²² reported that approximately 50% of patients had a poor result ten to 17 years after an Evans procedure, whereas Sugimoto et al.²³ reported satisfactory results in 90% of patients ten to 18 years after a Watson-Jones tenodesis. Anatomical reconstruction has a more consistent outcome, with satisfactory results in 80% to 90% of cases.²⁴⁻²⁶ To our knowledge, the long-term results of anatomical reconstruction with a follow-up of more than ten years have not been reported. A multicentre comparison between anatomical reconstruction and tenodesis has recently been presented by Krips et al.²⁷ This showed better results for the former procedure with regard to function of the ankle, stability, laxity and degenerative changes two to ten years after operation. We sought to compare the long-term outcome of these two techniques at more than 15 years.

Patients and Methods

Between 1970 and 1985 we treated 112 patients with chronic anterolateral instability of the ankle using either anatomical reconstruction or the Evans tenodesis. Four

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different surgeons were involved. All patients had had symptoms for at least six months and had received physiotherapy before surgery. The decision as to which procedure was performed was made by the surgeon who undertook it. The criteria for inclusion in the study included age at operation between 16 and 40 years, a normal contralateral ankle, no previous history of fracture of the ankle, no previous surgery other than an anatomical reconstruction or a tenodesis and no history of joint hypermobility, generalised neuromuscular disorder or subtalar instability.

Of the 112 patients 59 had an anatomical reconstruction and 53 a tenodesis. Thirteen were lost to follow-up leaving 99 in the study. Of these, 54 had an anatomical reconstruction (AR) and 45 a tenodesis (ET). There were no significant differences in the baseline characteristics between the patients included in the study and those lost to follow-up.

All patients in the AR group had an anatomical reconstruction, as described by Karlsson et al.²⁵ In the ET group, all had a routine Evans tenodesis.⁴ Postoperatively, all were immobilised in a plaster-of-Paris cast for six weeks before starting physiotherapy.

The mean age of the patients in the AR group was 25 ± 4.2 years and in the ET group 24 ± 4.2 years. The male:female ratio was 32:22 in the AR group and 30:15 in the ET group. The left:right ratio was 28:26 in the AR group and 18:27 in the ET group. The mean follow-up was 19.9 ± 3.6 years in the AR group and 21.8 ± 4.6 years in the ET group.

At review details of postoperative complications, revision procedures and further injuries were noted. The functional outcome was assessed using the Karlsson score and the rating system described by Good et al.^{6,28} Absence of symptoms was considered to be an excellent result. Dorsi- and plantar flexion were measured to the nearest 5° using a goniometer. A reduction of more than 5° in comparison with the contralateral ankle was considered to represent a limited range. Swelling and tenderness were recorded, and ligamentous laxity was tested using the anterior drawer test with the ankle in 15° of plantar flexion. This test was considered to be positive if there was a difference of more than 5 mm compared with the contralateral ankle. Radiological examination included anteroposterior, lateral and stress radiographs of both ankles. Talar tilt and anterior talar translation were assessed according to the criteria established by Lindstrand and Mortenson.²⁹ A standard load of 150 N was applied, using Telos apparatus (Forsta, Schenba and Weber, Hamburg, Germany).²⁸ Talar tilt was regarded as positive if the tibiotalar angle was more than 10° or when the difference between ankles was more than 6° . Anterior talar translation was regarded as positive when the anterior displacement of the talus relative to the tibia was more than 4 mm or the difference between the ankles was more than 3 mm.³⁰ Degenerative changes were graded according to the scale developed by van Dijk et al.³⁰ All radiographs were assessed by an independent observer (RK).

Statistical analysis. We analysed differences in baseline characteristics and final results between the different surgeons and operations. The comparison of mean values for anatomical reconstructions and tenodeses was calculated using analysis of variance (ANOVA). The comparison of proportions was calculated using the chi-squared test. A *p* value of <0.05 was considered to be statistically significant.

Results

Table I gives the details of the results.

Postoperative complications. One patient in the AR group and three in the ET group had a wound infection. One patient in the ET group had a deep-venous thrombosis. In the AR group, 11 patients had altered cutaneous sensation compared with 16 in the ET group. The number of postoperative complications did not differ significantly between the two groups ($p = 0.091$).

Reoperations. Seven patients in the AR group had a revision procedure. Three had arthroscopy to remove anterior tibial spurs, two had scar tissue removed, one had a revision of an anatomical reconstruction and one sustained an injury to the tibialis posterior tendon and underwent reconstruction. In the ET group, 17 ankles had a revision procedure. Nine had arthroscopy for anterior bony impingement with removal of osteophytes, three had reefing of the capsule because of persistent laxity, three had a partial synovectomy for anterior soft-tissue impingement and pain and two had exploration of a neuroma. One patient had a revision procedure for rupture of the peroneus brevis tendon. The number of patients who had a revision procedure was significantly higher in the ET group ($p = 0.004$).

Subjective. According to the scale developed by Karlsson et al.,²⁸ ten patients in the AR group had an excellent functional outcome (91 to 100 points) compared with four in the ET group ($p = 0.171$). There were significantly more patients with a good result (81 to 90 points) in the AR group ($n = 29$) than in the ET group ($n = 4$, $p < 0.001$). The number of patients with a fair result (61 to 80 points) was significantly higher in the ET group ($n = 21$) than in the AR group ($n = 13$, $p = 0.018$) and there were significantly more patients with a poor result (< 60 points) in the ET group ($n = 16$) than in the AR group ($n = 2$, $p < 0.001$). The mean Karlsson score was 83.7 ± 10.4 points in the AR group and 67.0 ± 15.8 in the ET group ($p < 0.001$).

With regard to the Good scale, there were significantly more patients with a good result in the AR group than in the ET group (29 v 9 , $p = 0.001$). Furthermore, there were significantly more patients with a fair outcome ($p = 0.001$) and with a poor outcome ($p = 0.001$) in the ET group (20 fair, 10 poor) than in the AR group (10 fair, 1 poor). An excellent result was obtained in 14 patients in the AR group and 6 in the ET group ($p = 0.120$).

Objective. Significantly more patients ($n = 15$) in the ET group had limited dorsiflexion than in the AR group ($n = 6$,

Table I. Details of the results in the 54 patients with AR and 45 with ET

	AR	ET	p value
Postoperative complications	1	4	0.091
Reoperations	7	17	0.004
Restricted ROM	6	15	0.007
Tenderness	15	27	0.001
Swelling	8	8	0.690
Anterior drawer sign	7	18	0.002
Mean ($\pm$ sd) Karlsson ² score (points)	83.7 $\pm$ 10.4	67.0 $\pm$ 15.8	<0.001
Excellent (91 to 100)	10	4	0.171
Good (81 to 90)	29	4	<0.001
Fair (61 to 80)	13	21	0.018
Poor (<60)	2	16	<0.001
Good ⁴ score (grade)			
Excellent	14	6	0.120
Good	29	9	0.001
Fair	10	20	0.001
Poor	1	10	0.001

Table II. Results of stress radiological examination in the 54 patients who received anatomical reconstruction (AR group) and the 45 who had the Evans tenodesis (ET) for chronic anterolateral instability of the ankle

	AR (n = 54)	ET (n = 45)	p value
Mean ($\pm$ sd) talar tilt in degrees			
Affected ankle	3.3 $\pm$ 3.8	7.9 $\pm$ 5.9	<0.001
Unaffected ankle	3.2 $\pm$ 3.8	5.1 $\pm$ 4.4	0.024
Difference	0.13 $\pm$ 3.4	2.9 $\pm$ 5.5	0.003
Mean ($\pm$ sd) anterior talar translation (mm)			
Affected ankle	3.6 $\pm$ 2.1	5.0 $\pm$ 3.1	0.007
Unaffected ankle	3.5 $\pm$ 2.1	3.1 $\pm$ 2.2	0.444
Difference	0.083 $\pm$ 2.3	1.8 $\pm$ 3.6	0.004

p = 0.007). Seven patients in the AR group had a positive anterior-drawer test compared with 18 in the ET group (p = 0.002). Tenderness of the ankle was reported by 15 patients in the AR group and 27 in the ET group (p = 0.001). Eight patients in both groups had swelling of the ankle (p = 0.690).

Radiological. On stress radiographs the mean talar tilt was $3.3 \pm 3.8^\circ$ in the AR group and $7.9 \pm 5.9^\circ$ in the ET group (p < 0.001). As shown in Table II, the mean anterior talar translation was 3.6 ± 2.1 mm in the AR group compared with 5.0 ± 3.1 mm in the ET group (p = 0.007). The number of patients with degenerative changes on standard AP and lateral radiographs was 32 in the AR group and 35 in the ET group (p = 0.050). The distribution of the grade of degenerative change showed that 29 patients had osteophytes (grade I) in the AR group compared with 24 in the ET group (p = 0.957). Three patients in the AR group had

grade-II osteophytes with narrowing of the joint space (grade II) compared with seven in the ET group (p = 0.100). Four patients in the ET group had severe osteoarthritis (grade III) compared with none in the AR group (p = 0.025) (Table III). Ten patients in the ET group and 22 in the AR group had normal joints (p = 0.050).

Discussion

The principal findings of our study were that, when compared with anatomical reconstruction, patients who underwent a tenodesis required more revision procedures and significantly more had chronic pain in the ankle, limited dorsiflexion, tenderness, instability and osteoarthritis.

The primary aim of treatment in patients with chronic anterolateral instability of the ankle is to relieve the discomfort caused by recurrent injury. Many authors have reported good short-term results after tenodesis.^{5,7,11,20,31} Rosenbaum et al³² compared the outcome after anatomical reconstruction and the Evans tenodesis in a randomised controlled trial and showed that both methods produced comparable clinical and functional outcome within one year of surgery. Kaikkonen et al³³ have recently reported that ligamentous laxity usually recurs five years after the Evans tenodesis, that the range of movement of the ankle is significantly impaired, and swelling of the ankle is frequently found. A long-term patient-orientated outcome study by Barnum, Ehrlich and Zaleske³⁴ revealed satisfactory results in 85% of 20 patients who had had an Evans tenodesis, but these results were evaluated by questionnaires and not clinically.

By contrast, most long-term clinical studies show poorer results after tenodesis. Van der Rijt and Evans¹⁸ were the first to report unsatisfactory long-term results. In their series of nine patients, who were followed for a mean of 22 years, the early, favourable results deteriorated seven to ten years after surgery. In our study, according to the rating system developed by Good et al,⁶ we found good to excellent results in 80% 15 to 30 years after anatomical reconstruction and good to excellent results in only 33% after the Evans tenodesis.

The reason for the deterioration in functional results after tenodesis is inadequate restoration of ligamentous tension. This has been reported in both experimental and clinical studies with a long-term follow-up.^{18,22,26,27,35-38} A study by Karlsson et al²² showed that persistent laxity is correlated with a poor functional result, and that anterior talar

Table III. Details of standard radiological examination (AP + lateral) in the 54 patients who had AR and the 45 who had ET

Grade		AR	ET	p value
0	Normal joint	22	10	0.050
I	Osteophytes without narrowing of the joint space	29	24	0.957
II	Osteophytes with narrowing of the joint space	3	7	0.100
III	Osteophytes with total disappearance or deformation of the joint space	0	4	0.025

translation is more significant than talar tilt. The recent multicentre study by Krips et al²⁷ reported higher mean values for anterior talar translation and talar tilt on stress radiological examination two to ten years after tenodesis in comparison with anatomical reconstruction. Orava et al³⁹ reported an incidence of almost 50% of a radiologically evident increase in anterior talar translation two to seven years after the Evans tenodesis. In our study, we found higher mean values for anterior talar translation and talar tilt on stress radiological examination after the Evans tenodesis than after anatomical reconstruction. This can be explained by the fact that the Evans procedure reconstructs neither the anterior talofibular nor the calcaneofibular ligament, but acts on the resultant of both. The talus can therefore still sublux forward when the foot is plantar flexed.

Persistent laxity leads to recurrent inversion trauma during which repetitive shear stresses weaken the cartilage on the medial talar facet and the anteromedial rim of the medial malleolus and cause degenerative changes.^{27,30,40} In 1979, Harrington⁴¹ reported osteoarthritis of the ankle in 34 patients with chronic ligamentous laxity; the degenerative changes were all on the anteromedial aspect of the joint. Karlsson et al²² found marginal osteophytes in most ankles after the Evans tenodesis and these were more numerous in those with the greatest instability. Krips et al²⁷ found significantly more medially-located degenerative changes two to ten years after tenodesis than after anatomical reconstruction. Rosenbaum et al³⁵ reported a high incidence of persistent long-term symptoms such as pain and a feeling of instability after the Evans tenodesis. In their study population, they found a high incidence of osteoarthritis in the anterior aspect of the ankle.

Any ligamentous reconstruction for chronic anterolateral instability of the ankle should protect the cartilage of the ankle from further damage caused by micromovement and recurrent injury. As there is more laxity after tenodesis than after anatomical reconstruction a higher incidence of osteoarthritis would be expected after tenodesis, and four patients in the ET group had severe osteoarthritis (grade III) compared with none in the AR group. A significantly larger number of patients had a revision procedure after a tenodesis than after anatomical reconstruction, most being for anterior bony impingement. Arthroscopic removal of symptomatic anterior or anteromedial osteophytes was successfully undertaken in these patients.

The lower surface of the anterior tibia and the anterior part of the medial malleolus are normally covered by articular cartilage. The anterior joint capsule attaches to the tibia above this rim of cartilage, about 5 mm above the joint line. It is this non-weight-bearing rim of anterior cartilage which undergoes degenerative change and is known to be damaged by inversion injuries.^{30,42} A repair reaction with proliferation of cartilage, the formation of scar tissue and calcification will follow. Recurrent direct (micro) trauma to this area will lead to the formation of osteophytes and more

soft-tissue thickening. Tol, Verheijen and van Dijk⁴³ concluded that the cause of pain is not the osteophyte, but impingement of hypertrophic synovial tissue between the osteophytes during dorsiflexion. Removal of the soft tissue alone may lead to symptomatic relief. The presence of talar and tibial osteophytes, however, reduces the anterior joint space. After the arthroscopic removal of soft tissue, new scar tissue will develop causing pain and limitation of dorsiflexion. The removal of the soft tissue and the bony spurs, which was successful in all our patients, is therefore recommended.

When compared with the Evans tenodesis, anatomical reconstruction leads to better functional results, more effective restoration of stability and less osteoarthritis of the ankle, even after 15 to 30 years. Anatomical reconstruction, rather than the more complex Evans tenodesis, should therefore be the primary choice of treatment in patients with chronic anterolateral instability of the ankle.

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