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On the surgical treatment of chronic anterolateral ankle instability

Krips, R.

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Chapter VI

ANATOMIC RECONSTRUCTION AND EVANS TENODESIS OF THE LATERAL ANKLE LIGAMENTS. CLINICAL AND RADIOLOGICAL FINDINGS AFTER 15-30 YEARS OF FOLLOW-UP

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Abstract
In this retrospective study, functional stability and ligament laxity, as well as degenerative changes in the ankle joint, were assessed in 99 patients who had undergone a reconstruction of the lateral ankle ligaments for chronic anterolateral ankle instability 15 to 30 years earlier.

The study population was divided into patients who underwent anatomic reconstruction (AR group, n=54) and patients who underwent Evans tenodesis (ET group, n=45). The indication was surgeon-dependent and independent of the type of instability or other patient characteristics. The mean follow-up period was 19.9 (±3.6) years for the AR group and 21.8 (±4.6) years for the ET group. During the follow-up period, seven patients in the AR group were reoperated on, while 17 patients in the ET group required a reoperation (p=0.004). At the follow-up, physical examination revealed significantly more patients (n=15) in the ET group with limited dorsiflexion than in the AR group (n=6, 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). Fifteen patients in the AR group had pain on palpation of the ankle while the corresponding figure was 27 in the ET group (p=0.001). Stress radiographic evaluation demonstrated ligament 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). Degenerative changes as seen on standard radiographs were present in 32 patients in the AR group and 35 patients in the ET group (p=0.05). Four patients in the ET group had developed severe osteoarthrosis compared with none in the AR group (p=0.025). Functional stability was assessed by the Karlsson score and the rating system developed by Good et al. (1975). The mean Karlsson score was 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 rating system developed by Good et al., 43 patients in the AR group had good or excellent results compared with 15 in the ET group (p<0.001).

In contrast with an anatomic reconstruction, the non-anatomic Evans tenodesis does not prevent laxity in a large number of patients. Long-standing ligament laxity leads to the accelerated formation of osteophytes in the ankle joint. This results in a larger number of patients with chronic ankle pain and limited range of dorsiflexion and a larger number of reoperations in the long-term. Subsequently, the functional result of the index operation deteriorates more rapidly after Evans tenodesis than after anatomic reconstruction.


Introduction

Chronic anterolateral instability of the ankle can be effectively treated by the suturing and imbrication of the insufficient lateral ligaments; however, tenodesis or reconstruction using an autogenous tendon graft has been used in the majority of studies. Most of these procedures involve a tenodesis between the distal fibula and the calcaneus, the talus or the base of the fifth metatarsal. One method that has been widely used, is the Evans procedure, which has been a popular non-anatomic reconstruction due to its simplicity. It was originally described in 1953 and has undergone several modifications. While the short-term results of these reconstructions are satisfactory in most cases, it has been suggested that the results of the Watson-Jones tenodesis and the Evans tenodesis deteriorate after medium-term follow-up or longer. It has been reported that approximately 50% of patients had a poor result 10 to 17 years after the index Evans procedure. On the other hand, Sugimoto et al. reported satisfactory results after 10 to 18 years in 90% of patients who underwent a Watson-Jones tenodesis. Reports on the results after anatomic reconstruction are more consistent in outcome, with satisfactory results varying from 80 to 90%. To our knowledge, the long-term results of anatomic reconstruction (those seen after a mean duration of more than ten years) have not yet been reported. A comparison between anatomic reconstruction and tenodesis has recently been presented in a multicenter study by Krips et al. This study revealed superior results for anatomic reconstruction in terms of ankle joint function, functional stability and mechanical laxity and degenerative changes two to 10 years after the operation. The current literature does not, however, include any comparative studies of the long-term results (i.e. after 15 years or longer) of anatomic reconstruction and tenodesis. The aim of the present retrospective study was, therefore, to determine whether the results of Evans tenodesis deteriorate further in the long-term and whether the results of anatomic reconstruction showed the same tendency to deteriorate as tenodeses have shown in previous studies.
Patients and methods

Between 1970 and 1985, a total of 112 patients were operated on for chronic anterolateral ankle instability using either anatomic reconstruction or Evans tenodesis at the Sahlgrenska University Hospital in Göteborg, Sweden. Four different surgeons were involved. All the patients had experienced problems for at least six months and had undergone rehabilitation with range of motion and proprioceptive training prior to surgery. The indication to perform an anatomic reconstruction or an Evans tenodesis was surgeon-dependent and independent of the type of instability or other patient characteristics.

The following inclusion criteria were employed: 1) age at operation between 16 and 40 years; 2) an uninjured contralateral ankle; 3) no history of previous fracture; 4) no prior surgery other than an anatomic reconstruction or Evans tenodesis on the affected ankle; 5) no prior surgery on the unaffected ankle; 6) no history of bilateral hyperlaxity; 7) no history of subtalar instability; 8) no generalized neuromuscular disorder.

At follow-up, 15-30 years after the operation, the following demographic data were recorded; age, sex, profession and affected side. The review protocol consisted of the registration of postoperative complications, reoperative procedures and recurrent sprains. Functional outcome was assessed using two ankle scores: the Karlsson score and the rating system developed by Good et al.\textsuperscript{6,28}. Absence of symptoms was considered to be an excellent result.

At physical examination, the range of ankle motion was determined by measuring dorsiflexion and plantar flexion to the nearest five degrees using a goniometer. A reduction of more than five degrees in comparison with the contralateral ankle was considered to represent a limited range of ankle motion. Moreover, the presence of swelling and pain on palpation were determined. Ligament laxity was tested using the anterior drawer test with the ankle in 15° of plantarflexion. This test was regarded positive if there was a difference of more than 5 mm compared with the contralateral ankle. Standardized radiographic examination consisting of antero-posterior (AP) and lateral radiographs of both ankles, as well as stress radiographs, including measurements of both talar tilt (TT) and anterior talar translation (ATT), were performed at the follow-up. The TT and ATT values were assessed according to the criteria established by Lindstrand and Mortensson\textsuperscript{29}. The standard load of 150 Newtons was applied, using Telos® apparatus\textsuperscript{28}. TT was regarded as positive if the tibio-talar angle was more than 10° or when the difference between ankles was more than 6°. ATT 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\textsuperscript{30}. The development of degenerative
changes was graded according to the scale developed by van Dijk et al. The standard and stress radiographs were assessed by an independent observer (RK).
**Statistical analysis**

Differences in baseline characteristics and final results between the different surgeons and anatomic reconstructions and tenodeses were analysed. The comparison of mean values for anatomic reconstructions and tenodeses was calculated using an Analysis of Variance (ANOVA). The comparison of proportions was calculated using the chi-square test. A p-value of <0.05 was considered statistically significant.
Results

Selection of patients

Between 1970 and 1985, a total of 112 reconstructions for chronic anterolateral instability of the ankle were performed. Fifty-nine patients underwent anatomic reconstruction and 53 patients tenodesis. Of these patients, 13 were lost to follow-up, of whom four underwent anatomic reconstruction and nine tenodesis. As a result, 99 patients (88%) could be included. There were no significant differences in baseline characteristics between the included patients and the patients that were lost to follow-up. A total of 54 patients were included in the anatomic reconstruction group (AR group), while 45 patients were included in the tenodesis group (ET group).

Baseline characteristics

All the patients in the AR group underwent an anatomic reconstruction as described by Karlsson and co-workers. In the ET group, all the patients underwent an Evans tenodesis. Postoperatively, all the patients had a plaster cast for six weeks, whereafter range of motion and proprioceptive training were started.

The baseline characteristics are shown in Table I. The patients were on average 25 (5.4) years old in the AR group and 24 (4.2) years old in the ET group (p=0.426). The male/female ratio was 32/22 in the AR group and 30/15 in the ET group (p=0.448). The left/right ratio was 28/26 in the AR group and 18/27 in the ET group (p=0.239). The mean duration of follow-up was 19.9 (3.6) years in the AR group and 21.8 (4.6) years in the ET group (p=0.022).

Postoperative complications

The overall results are shown in Table II. 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 experienced disturbed skin sensitivity after the operation. This was the case for 16 patients in the ET group. The number of postoperative complications did not differ significantly between the two groups (p=0.091).

Reoperations

A total of seven patients in the AR group had a reoperative procedure after the index operation; three patients underwent arthroscopy to remove anterior tibial spurs, in two patients scar tissue was removed, one patient underwent a new anatomic reconstruction and one patient sustained an injury to the tibialis posterior tendon for which a surgical reconstruction
was required. In the ET group, a total of 17 patients were reoperated on; nine patients underwent arthroscopy for an anterior bony impingement syndrome, for which osteophytes were removed, in three patients the joint capsule was reefed due to persistent laxity, in three patients a partial synovectomy was performed for an anterior soft tissue impingement and pain and in two patients a neuroma was explored. One patient was reoperated on for a rupture of the peroneus brevis tendon. The number of patients who underwent a reoperative procedure was significantly higher in the ET group (p=0.004).

Subjective results
According to the scale developed by Karlsson et al., 10 patients in the AR group had an excellent functional outcome (91-100 points) compared with four in the ET group (p=0.171). There were significantly more patients with a good result (81-90 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 (61-80 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 (SD) was 83.7 (10.4) points in the AR group and 67.0 (15.8) in the ET group (p<0.001). In terms of the Good scale, there were significantly more patients with a good result in the AR group than in the ET group (p=0.001). Furthermore, there were significantly more patients with a fair outcome (p=0.005) and with a poor outcome (p=0.001) in the ET group than in the AR group.

Objective results
At physical examination, significantly more patients (n=15) in the ET group had a limited dorsiflexion than in the AR group (n=6, 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). Fifteen patients had pain on palpation of the ankle in the AR group and 27 patients in the ET group (p=0.001). Eight patients in both groups had swelling of the ankle (p=0.690).

Radiographic results
At stress radiographic examination, the mean talar tilt (SD) was 3.3° (3.8) in the AR group and 7.9° (5.9) in the ET group (p<0.001). The mean value for anterior talar translation (SD) was 3.6 mm (2.1) in the AR group compared with 5.0 mm (3.1) for the ET group (p=0.007) (Table III). The total number of patients with degenerative changes as seen on standard AP
and lateral radiographs was 32 in the AR group and 35 in the ET group (p=0.050). The distribution of grades was 29 patients with osteophytes (grade I) in the AR group compared with 24 in the group (p=0.971). Three patients in the AR group had grade II osteophytes with joint-space narrowing (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 IV).
Discussion

The aim of the present study was to compare the functional, clinical and radiological outcome of anatomic reconstruction with Evans tenodesis in patients with chronic anterolateral ankle instability. To the best of our knowledge, there are no studies in the literature with such a long duration (15-30 years) of follow-up.

The principal findings in this study were that patients were reoperated on more frequently after Evans tenodesis than after anatomic reconstruction. Significantly more patients suffered from chronic ankle pain with a limited range of dorsiflexion and pain on palpation at physical examination after Evans tenodesis than after anatomic reconstruction. With regard to both functional stability and laxity, a larger number of ankles were found to be unstable after Evans tenodesis when compared with anatomic reconstruction. Finally, we found more patients with osteoarthrosis of the ankle and the functional outcome was worse after Evans tenodesis than after anatomic reconstruction.

The primary aim of treatment in chronic anterolateral ankle instability is to relieve the patients' discomfort due to recurrent sprains and pain. Many authors have stressed the value of tenodesis for the treatment of chronic anterolateral instability of the ankle on the basis of the good short-term results of both methods for ankle ligament reconstruction produced a comparable clinical and functional outcome one year after surgery. In a recent study by Kaikkonen et al., it was found that on average five years after the Evans tenodesis ligament laxity was well restored, but the range of ankle motion was significantly impaired, and swelling of the ankle was a frequent finding at the follow-up. A long-term patient-oriented outcome study by Barnum et al. revealed 85% satisfactory results in 20 patients who underwent Evans tenodesis. However, these results were evaluated by questionnaires and not clinically.

In contrast, most long-term clinical studies reveal inferior results after tenodesis. Van der Rijt and Evans were the first investigators to report unsatisfactory long-term results after tenodesis. In their series of nine patients, who were followed for a mean of twenty-two years, the early, favourable results were found to have deteriorated seven to ten years after the operation. In the present study, we found 80% good/excellent results 15-30 years after anatomic reconstruction and only 33% good/excellent results after Evans tenodesis according to the rating system by Good et al.

The reason for the deterioration in functional results after Evans tenodesis is insufficient restoration of ligament laxity. This has been reported in both experimental studies and several
clinical studies with a long-term follow-up\textsuperscript{18,22,26,27,35-38}. A study by Karlsson et al. demonstrated that persistent laxity is correlated with a poor functional result, as the anterior talar translation is being more significant than talar tilt\textsuperscript{22}. A recent multicenter study by Krips et al. reported higher mean values for anterior talar translation and talar tilt at stress radiographic examination two to 10 years after tenodesis in comparison with anatomical reconstruction\textsuperscript{27}. Orava et al. reported an almost 50\% incidence of a radiographically documented increase in anterior talar translation two to seven years after Evans tenodesis\textsuperscript{39}. In the present study, we found higher mean values for anterior talar translation and talar tilt at stress radiographic examination after Evans tenodesis than after anatomic reconstruction. This can be explained by the fact that the Evans procedure reconstructs neither the anterior talo-fibular nor the calcaneo-fibular ligament, but acts on the resultant of both. The talus can therefore still sublux forward when the foot is plantarflexed, making the ankle joint less stable.

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 subsequently lead to the development of degenerative changes\textsuperscript{27,30,40}. This can result in the accelerated development of degenerative changes in the ankle joint. In 1979, Harrington reported 34 cases of osteoarthrosis of the ankle in patients with chronic ligament laxity; in all 34 patients, the degenerative changes were on the anteromedial side of the joint\textsuperscript{41}. Karlsson found marginal osteophytes in most ankles after Evans tenodesis and these were more numerous in those subjects with the greatest instability\textsuperscript{22}. Krips et al. found significantly more medially-located degenerative changes two to 10 years after tenodesis than after anatomic reconstruction\textsuperscript{27}. Rosenbaum et al. reported a high incidence of long-term problems such as pain and a remaining feeling of instability after Evans tenodesis\textsuperscript{35}. In their study population, they found a high incidence of anterior tibial and talar osteophyte formation and osteoarthrosis.

Any ligamentous reconstruction for chronic anterolateral ankle instability is thought to protect the cartilage of the ankle joint from further damage from micro-movements and recurrent sprains. Since the tenodeses result in more laxity when compared with anatomic reconstructions, we can expect to find more patients with degenerative changes in the ankle joint after tenodesis than after anatomic reconstruction. Four patients in the Evans tenodesis group had severe osteoarthrosis (grade III) compared with none in the anatomic reconstruction group. This was a significant difference. A significantly larger number of
patients underwent a reoperative procedure after Evans tenodesis than after anatomic reconstruction. The majority of cases had an anterior bony impingement syndrome. The arthroscopic removal of anteriorly or anteromedially located osteophytes that had become symptomatic after many years was successfully performed in these patients.

In normal anatomy, the lower surface of the anterior tibia and the anterior part of the medial malleolus are covered with cartilage. The anterior joint capsule attaches to the tibia above this cartilage rim, some 5 mm above the joint line. It is this non-weightbearing anterior cartilage rim that undergoes osteophytic transformation. Damage to this anterior cartilage rim is known to occur in the majority of inversion traumas. Depending on the degree of damage, a repair reaction with cartilage proliferation, scar tissue formation and calcification will follow. Additional damage as a result of recurrent instability or forced ankle movement will further increase this process. Recurrent direct (micro) trauma to this anteriorly located cartilage rim is another important factor. As a result, osteophytes form and additional soft tissue impediments may be present. Tol et al. concluded that the cause of pain is not the osteophyte but the occurrence of a soft tissue impingement between the osteophytes. During dorsiflexion hypertrophic synovial tissue impinges between the osteophytes. It can be hypothesised that the removal of the soft tissue impediment without the removal of spurs would be sufficient. The presence of talar and tibial osteophytes, however, reduces the anterior joint space. After the arthroscopic removal of soft tissue impediments, new scar tissue is likely to develop. This scar tissue will instantly act as a new anterior soft tissue impediment which results in chronic ankle pain and a limited range of dorsiflexion. The removal of the soft tissue impediment as well as the bony impediments (spurs), as was successfully performed in all our patients, is therefore recommended. In spite of the fact that these patients were successfully treated, the majority of the remaining patients developed degenerative changes leading to a high incidence of chronic ankle pain, limited dorsiflexion and pain on palpation. These patients did not undergo arthroscopic debridement but instead accepted their handicap and reduced their activity level.

The present long-term follow-up study revealed 80% satisfactory results after anatomic reconstruction and only 33% after Evans tenodesis. When compared with the Evans tenodesis, anatomic reconstruction leads to superior functional results, laxity is more effectively restored and the risk of the development of osteoarthrosis of the ankle joint is subsequently reduced, even 15-30 years after the index operation. Anatomic reconstruction, rather than the more complex Evans tenodesis should therefore be the primary choice in patients with chronic anterolateral ankle instability.
Conclusion
In contrast with anatomic reconstruction, the Evans tenodesis is not able to prevent long-standing ligament laxity because the procedure reconstructs neither the anterior talo-fibular nor the calcaneo-fibular ligament. In this way, recurrent giving-way leads to the accelerated development of degenerative changes in the ankle joint. Subsequently, the risk of the development of osteophytic formation and the need for a reoperative procedure to remove these osteophytes increases over time. This has a negative influence on the overall functional results after Evans tenodesis. Nowadays, anatomic reconstruction of the lateral ankle ligaments can be regarded as the surgical treatment of choice in patients with chronic anterolateral ankle instability.
### Table I.
#### Baseline characteristics

<table>
<thead>
<tr>
<th></th>
<th>AR n=54</th>
<th>ET n=45</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs; mean ± SD)</td>
<td>25 (± 5.4)</td>
<td>24.2 (± 4.2)</td>
<td>0.426</td>
</tr>
<tr>
<td>Male/female ratio</td>
<td>32 / 22</td>
<td>30 / 15</td>
<td>0.448</td>
</tr>
<tr>
<td>Left/right ratio</td>
<td>28 / 26</td>
<td>18 / 27</td>
<td>0.239</td>
</tr>
<tr>
<td>Follow-up (yrs)</td>
<td>19.9 (± 3.6)</td>
<td>21.8 (± 4.6)</td>
<td>0.022</td>
</tr>
</tbody>
</table>

SD = standard deviation
AR = anatomic reconstruction
ET = Evans tenodesis
### Table II. Final results

<table>
<thead>
<tr>
<th></th>
<th>AR n=54</th>
<th>TE n=45</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postop. Complications</td>
<td>1</td>
<td>4</td>
<td>0.091</td>
</tr>
<tr>
<td>Reoperations</td>
<td>7</td>
<td>17</td>
<td>0.004*</td>
</tr>
<tr>
<td>Restricted ROM</td>
<td>6</td>
<td>15</td>
<td>0.007*</td>
</tr>
<tr>
<td>Pain on palpation</td>
<td>15</td>
<td>27</td>
<td>0.001*</td>
</tr>
<tr>
<td>Swelling</td>
<td>8</td>
<td>8</td>
<td>0.690</td>
</tr>
<tr>
<td>Anterior drawer sign</td>
<td>7</td>
<td>18</td>
<td>0.002*</td>
</tr>
<tr>
<td>Karlsson* score (points)</td>
<td>83.7 (± 10.4)</td>
<td>67.0 (± 15.8)</td>
<td>&lt;0.001 b</td>
</tr>
<tr>
<td>Excellent (91-100 pts)</td>
<td>10</td>
<td>4</td>
<td>0.171</td>
</tr>
<tr>
<td>Good (81-90 pts)</td>
<td>29</td>
<td>4</td>
<td>&lt;0.001 b</td>
</tr>
<tr>
<td>Fair (61-80 pts)</td>
<td>13</td>
<td>21</td>
<td>0.018 b</td>
</tr>
<tr>
<td>Poor (&lt; 60 pts)</td>
<td>2</td>
<td>16</td>
<td>&lt;0.001 b</td>
</tr>
<tr>
<td>Good** score (grade):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>14</td>
<td>6</td>
<td>0.120</td>
</tr>
<tr>
<td>Good</td>
<td>29</td>
<td>9</td>
<td>0.001*</td>
</tr>
<tr>
<td>Poor</td>
<td>10</td>
<td>20</td>
<td>0.001*</td>
</tr>
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</table>

SD = standard deviation

* Significantly different, chi-square, p<0.05

* Significantly different, ANOVA, p<0.05

*Acc. to Karlsson et al. 28

** Acc. to Good et al. 4
Table III.
Results of stress radiographic examination

<table>
<thead>
<tr>
<th></th>
<th>AR n=54</th>
<th>TE n=45</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT affected ankle (°)</td>
<td>3.3 (± 3.8)</td>
<td>7.9 (± 5.9)</td>
<td>&lt;0.001 *</td>
</tr>
<tr>
<td>TT unaffected ankle</td>
<td>3.2 (± 3.8)</td>
<td>5.1 (± 4.4)</td>
<td>0.024</td>
</tr>
<tr>
<td>TT difference</td>
<td>0.13 (±3.4)</td>
<td>2.9 (± 5.5)</td>
<td>0.003 *</td>
</tr>
<tr>
<td>ATT affected ankle (mm)</td>
<td>3.6 (± 2.1)</td>
<td>5.0 (± 3.1)</td>
<td>0.007 *</td>
</tr>
<tr>
<td>ATT unaffected ankle</td>
<td>3.5 (± 2.1)</td>
<td>3.1 (± 2.2)</td>
<td>0.444</td>
</tr>
<tr>
<td>ATT difference</td>
<td>0.083 (± 2.3)</td>
<td>1.8 (± 3.6)</td>
<td>0.004 *</td>
</tr>
</tbody>
</table>

* Significantly different, ANOVA, p<0.05
SD = standard deviation
TT = talar tilt
ATT = anterior talar translation
<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>AR</th>
<th>TE</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Osseous with joint-space narrowing</td>
<td>0.005</td>
<td>0.074</td>
</tr>
<tr>
<td>2</td>
<td>Osseous with joint-space narrowing</td>
<td>0.90</td>
<td>3.7</td>
</tr>
<tr>
<td>3</td>
<td>Osseous with joint-space narrowing</td>
<td>0.25</td>
<td>0.4</td>
</tr>
<tr>
<td>4</td>
<td>Osseous with joint-space narrowing</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>5</td>
<td>Normal joint</td>
<td>0</td>
<td>0</td>
</tr>
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</table>

* p<0.05

Table IV.

*Significantly different chi-square, p<0.05*
References


