Management of chronic lateral ankle instability: alternatives for diagnosis and treatment

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Chapter 4

Arthroscopic capsular shrinkage for chronic ankle instability with thermal radiofrequency

- a prospective multicenter trial -

Abstract

The study was designed as a prospective multicenter longitudinal trial. Adult patients with symptomatic mechanical chronic ankle instability, not improving with conservative therapy, were included and operated on. The primary outcome measures were radiological and manually tested mechanical laxity. Secondary outcome measures were number of complications, re-operations and symptoms, range of motion, and functional (ankle) scores (Karlsson and SF-36 score). The latest follow-up was 9 months for each patient.

Thirty-nine patients underwent surgery (19 male, 16 right ankles, median age: 27 years). Mechanical stability showed no clinically relevant improvement whereas most secondary outcome measures showed a substantial and statistically significant improvement. There was 1 operation related complication without functional consequences and three patients underwent a secondary procedure. One was considered as a treatment failure, requiring an open anatomic ligament reconstruction. The second patient sustained a severe supination trauma by starting intensive training too early, also requiring an open anatomic reconstruction. The third patient suffered from posterior ankle pain, which was successfully treated by posterior ankle arthroscopy.

Arthroscopic thermal capsular shrinkage of the ankle is a safe procedure, leading to resolution of symptoms in the majority of patients with chronic ankle instability.
Chapter 4

Introduction

Chronic ankle instability occurs in ten to twenty percent of the patients after an acute ankle sprain.\textsuperscript{18} If conservative treatment fails and increased laxity of the lateral ankle ligaments is present, a surgical stabilization of the ankle joint is indicated. Anatomical reconstruction of the involved ligaments is the preferred method of treatment.\textsuperscript{22}

Arthroscopic thermal capsular and ligament shrinkage is a new option for the treatment of joint instability. The earliest reports about thermal capsular and ligament shrinkage concern mainly animal and cadaver studies.\textsuperscript{9,11,24} Length reduction up to 60\% has been described but excessive heating leads to an increased potential for creep (deformation of tissue under a constant load).\textsuperscript{11,26,37,38} Due to remodelling, this potential for creep diminishes in two to three months but warrants careful rehabilitation in the early postoperative period.

Most clinical experience exists with thermal capsular shrinkage of the glenohumeral joint capsule for shoulder instability. Initial results were promising but a recent prospective trial with the longest (mid-term) follow-up period thus far, showed a failure rate in more than one-third of the patients, probably due to recurrence of capsular laxity.\textsuperscript{4}

The ankle joint is intrinsically more stable compared to the shoulder due to its bony congruency and is therefore more appropriate for the application of arthroscopic thermal capsular shrinkage in case of increased capsular and ligament laxity. Five retrospective studies on the treatment of chronic ankle instability with capsular shrinkage have been published, showing good results in the vast majority of patients at up to 2.5 years follow-up.\textsuperscript{2,3,14,25,29}

Potential advantages of the procedure, compared to an open procedure, are the minimally invasiveness, reduced operating time, outpatient setting, less surgical morbidity, fast recovery and quick return to work and sports. A more extensive prospective clinical study is required to determine the efficacy of arthroscopic thermal shrinkage in chronic ankle instability in a general population.

The aim of this prospective study was to assess the mechanical and clinical benefit, including proprioception, of nonablative thermal capsular shrinkage by application of radiofrequent energy to the lateral ankle-joint capsule and ligaments to determine if normal ankle laxity and functional ankle stability would be restored.
Materials and Methods

Study design
The study was designed as a prospective longitudinal multicenter trial. Eight centers participated. In each center 1 surgeon, experienced in ankle arthroscopy, performed the operations. The Medical Ethical Review Board of all centers approved of the study, and participating patients gave written informed consent. The study period from first inclusion to last follow-up was from February 2002 until February 2005.

Patients
Patients were selected from the outpatient clinic. Chronic ankle instability was defined as recurrent sprains or giving way for more than six months after an acute ankle sprain, in spite of a period of conservative treatment. Specific inclusion criteria were: adult patients (≥ 18 years of age), who were able to give informed consent and had chronic ankle instability with increased mechanical laxity.

Increased mechanical laxity was defined as a positive anterior talar translation or talar tilt on stress radiographs using the Telos-stress apparatus, with anterior talar translation ≥ 4 mm or a difference with the ipsilateral side ≥ 3 mm and talar tilt ≥10° and ≤15° or a difference with the ipsilateral side ≥ 6°. A talar tilt >15° was considered an exclusion criterion since it was assumed to represent multiple ligament laxity.

Additional exclusion criteria were: previous operative therapy for chronic ankle instability, constitutional hyper laxity, systemic diseases affecting the locomotor system and osteoarthritis grade II or III.

Sample size
An estimate of the required sample size was calculated from mean values with standard deviations (SD) for improvement of the anterior talar translation and talar tilt found in the literature. An average decrease in anterior talar translation of 3 mm, SD 2.6, or a decrease in talar tilt of 3°, SD 3.8, was considered to be clinically relevant. Given an α of 0.05 and a power of 0.9, the required number of patients was 16 for anterior talar translation and 34 for talar tilt.
**Surgical procedure**

The operation was performed in an outpatient setting according to a standardized procedure. The procedure was captured on video to share with the surgeons of the participating centers.

![Arthroscopic image of anterolateral side of the ankle joint](image)

**Figure 1** – Arthroscopic image of anterolateral side of the ankle joint with an indication of the fibula, tibia and the course of the anterior talofibular ligament that is part of the joint capsule. The shrinkage procedure is performed by moving the active radiofrequency probe over the anterior talofibular ligament and adjacent capsule. Abbreviations: ATFL, anterior talofibular ligament; RF, radiofrequency.

The patient was placed in a supine position. Anteromedial and lateral portals were made by stab incisions. A 4.0 mm arthroscope was introduced through the medial portal and the instruments were introduced through the lateral portal. Initially, treatment of additional pathology such as removal of osteophytes, synovitis or a loose body was performed. Intraoperative testing of the ankle instability was performed. Shrinkage was performed by
application of radiofrequent energy (figure 1), using an arthroscopic probe with a 3.5 mm side-effect tip, mode V1 (Vapr®, Depuy Mitek, Amersfoort, NL). The initial energy level was 20 watt, but could be adjusted to a maximum of 50 watt. In all patients shrinkage of the ATFL and adjacent joint capsule was performed. A standard operation report was written for all patients, with registration of the operation time.

Rehabilitation
Postoperatively, a compression bandage was applied for 3 to 5 days, during which patients were advised to rest and avoid weight bearing. After application of an inelastic tape bandage, patients were allowed to mobilise with full weight bearing as tolerated. The tape was replaced every 2 weeks over a 6-week period. During this period patients were allowed to resume work as tolerated, but were restricted from participating in activities with a high risk of spraining the ankle. In the following 6 weeks patients were allowed to resume sports as tolerated.

Outcome measures
At inclusion patient’s characteristics were registered. The primary outcome measure was difference in pre- and postoperative mechanical laxity measured with ankle stress radiographs (anterior talar translation and talar tilt) and the manual anterior drawer test. Secondary outcome measures were: subjective instability, pain, subjective and objective swelling, ankle joint stiffness, range of motion, time to return to work and sports, changes in level or abandoning of work and sports, ankle (Karlsson), sports (Tegner) and general (SF-36) functional scores, patient satisfaction, operation time, and number, nature and severity of complications. Limited range of motion was defined as >5° negative difference with the contralateral side.

An additional outcome measure was balance, as a measure of proprioception, assessed by a one-leg stance test. Patients were instructed to stand on 1 leg on a compliant floor (eg, gymnastics mat) for 1 minute. When loosing balance, defined as touching the floor with the contralateral foot, the patients had to resume their position and continue until 1 minute was completed. Four conditions were tested preoperatively and at 6-months follow-up: left and right leg, both with eyes open and eyes closed. The time until the first balance disturbance and the total number of disturbances were registered.
Follow-up
All patients were evaluated preoperatively, at 6 weeks and 6 and 9 months postoperatively. At 6 weeks and 9 months, the outcome measures were taken by questionnaires alone. At 6 months measures of outcome were taken by questionnaires, physical examination, stress radiographic assessment, and the balance test was performed.

Data analysis
Data were entered into a personal computer and analyzed using SPSS 11.5 for Windows. Pre- and postoperative values were compared. Due to the skewed distribution of most data, continuous data are presented as median with a range and non-parametric statistical tests were used for analysis: the Wilcoxon signed ranks test for continuous data and the McNemar chi-square test for dichotomous data. Statistical significance level was determined at p<0.05.
Results

Thirty-nine patients (19 male, 20 female; 16 right, 23 left ankles) were included. The median preoperative duration of symptoms was 4 years (range, 0.5-30 years). The median patient age at the time of operation was 27 years (range, 18-66 years). No patients were lost to follow-up. One female patient did not allow radiographic stress evaluation at 6-months follow-up because of anticipated pain, but the 9-months follow-up was completed. At 9 months, 28 patients (72%) rated the result of the operation as good (33%) or excellent (39%), 9 (23%) as fair, and 2 (5%) as poor.

Operation

Median operation time was 24 minutes (range, 6-47 minutes). In 30 of the 39 patients (77%), excessive synovitis or scar tissue in the lateral aspect of the ankle was present. Synovectomy or debridement of the lateral side of the ankle joint was performed in all patients.

Complications and re-operations

Complications were seen in seven patients (18%). One postoperative complication occurred: injury to a branch of the superficial peroneal nerve, possibly caused by the incision for the lateral arthroscopic portal. The subsequent numbness of the lateral foot had not resolved at final follow-up, but the patient did not suffer from functional limitations and had no complaints.

Three patients were scheduled for re-operation at the closure of the study, of which 1 was related to the study intervention. Two patients had symptoms of giving way at 9-months follow-up. One of which was a triathlon athlete who started training 4 weeks after the initial operation and sustained a new severe ankle inversion injury in which the lateral ankle ligaments were torn. The second patient had persistent instability and laxity with a sedentary activity level. Both patients were scheduled for an open anatomic ligament reconstruction. The third patient had posterolateral ankle pain due to a posterior impingement syndrome. Preoperatively, posterolateral pain symptoms were already recognized but it was decided to only perform the ligament reconstruction. It was expected that better mechanical stability would decrease the posterior impingement symptoms. The stability had improved but the posterior symptoms remained. He was successfully treated by posterior ankle arthroscopy.
Two patients developed an allergy to the tape. In 1 patient the tape was replaced by an elastic bandage and in the second patient the tape was removed after four weeks and then replaced by an elastic bandage. One patient had prolonged postoperative pain at the anterolateral side of the ankle joint. The pain was still present at 9-months follow-up, but the intensity of the pain had significantly decreased.

**Figure 2** - Radiographically determined effect of thermal shrinkage of the anterolateral ankle capsule, including the anterior talofibular ligament, on the mechanical stability, preoperative and 6 months postoperative. The solid line is the median, the box represents the interquartile range, the error bars the 95% range, and the asterisks indicate the extremes. Abbreviations: TT = talar tilt (degrees); ATT = anterior talar translation (mm). § Wilcoxon signed ranks test.

**Mechanical laxity**

Radiographically and manually tested increased laxity was present in all patients at the time of inclusion. The difference between radiographically measured preoperative and 6 months
postoperative anterior talar translation, in favour of the postoperative result, was statistically significant \((p=0.036, \text{figure 2})\). No preoperative - and postoperative difference was found for the talar tilt \((\text{figure 2})\). One patient did not allow for postoperative ankle stress radiographs and was excluded from this part of the analysis.

At 6-months follow-up, a reduction of mechanical laxity as judged by the manual anterior drawer test was seen in 20 patients. Twenty-six patients still had a positive anterior drawer test. The difference with the preoperative number of patients (all patients positive anterior drawer test) was statistically significant \((p=0.001)\). Deterioration was not seen in any of the patients.

![Figure 3 - Pre- and postoperative number of patients with symptoms. *McNemar chi-square test.](image)

**Symptoms and Functional outcome**

The number of patients with subjective instability, pain and swelling had significantly diminished at follow-up \((\text{figure 3})\). The decrease in number of patients with limited capacity for stair climbing, running, work or sports was less sharp but statistically significant for all parameters at most recent follow-up \((\text{figure 4})\). At 9 months, running was limited in 20 patients, a significant increase of 15 patients compared to 6-months follow-up.
Most patients reported they performed work (37 patients) and participated in sports (36 patients) at the same or a higher level than before the operation. Three patients reported they participated in sports at a lower level. The median time to return to work was 3 weeks (range, 1-8 weeks). Median time to return to sports was 9.5 weeks (range, 2-36 weeks).

The number of patients with pain on physical examination had significantly decreased at 6-months follow-up (30 versus 14 patients, \( p<0.001 \)). Swelling was pre- and postoperatively present in 4 patients (only 1 patient had pre- and postoperative swelling). Pre- and postoperative sagittal range of motion did not differ significantly. At 6-months follow-up, 2 patients had a limited range of motion: respectively 10° and 15° less compared to the contralateral side.

When compared to the preoperative score, the median Karlsson and Tegner score had increased significantly at all follow-up periods (table 1, figure 5). According to the Karlsson score, 27 patients had a good or excellent result (74%) and 1 patient a poor result (3%). The Tegner score at 9 months showed a significant improvement compared to the score at 6 months (table 1).
Table 1 - Pre- and postoperative Tegner-score

<table>
<thead>
<tr>
<th></th>
<th>Median (range)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>3 (0-9)</td>
<td>n/a</td>
</tr>
<tr>
<td>6 weeks</td>
<td>2 (0-7)</td>
<td>n/a</td>
</tr>
<tr>
<td>6 months</td>
<td>4 (1-7)</td>
<td><strong>0.011</strong></td>
</tr>
<tr>
<td>9 months</td>
<td>4 (1-9)**</td>
<td>&lt;<strong>0.001</strong></td>
</tr>
</tbody>
</table>

*compared to preoperative, **p=0.004, compared to 6 months, both Wilcoxon signed ranks test

**Figure 5** - Pre- and postoperative Karlsson-scores. The solid line is the median, the boxes represent the interquartile range, and the error bars indicate the 95% range. *Wilcoxon signed ranks test
Figure 6 - SF-36 - Preoperative and 6 months postoperative scores of the Standardized Physical and Mental Component Scales. The solid line is the median, the boxes represent the interquartile range, the error bars the 95% range, and the asterisk indicates the extremes. §Wilcoxon signed ranks test.

Table 2 - SF-36 score: the result according to the 8 domains. Postoperative data were acquired at six months follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>p-value*</th>
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<tr>
<td></td>
<td>median</td>
<td>range</td>
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<tr>
<td>PF</td>
<td>75</td>
<td>25-100</td>
<td>95</td>
</tr>
<tr>
<td>RP</td>
<td>75</td>
<td>0-100</td>
<td>100</td>
</tr>
<tr>
<td>BP</td>
<td>62</td>
<td>21-100</td>
<td>80</td>
</tr>
<tr>
<td>GHP</td>
<td>72</td>
<td>25-100</td>
<td>77</td>
</tr>
<tr>
<td>V</td>
<td>65</td>
<td>20-95</td>
<td>70</td>
</tr>
<tr>
<td>SF</td>
<td>75</td>
<td>38-100</td>
<td>100</td>
</tr>
<tr>
<td>RE</td>
<td>100</td>
<td>0-100</td>
<td>100</td>
</tr>
<tr>
<td>MH</td>
<td>80</td>
<td>48-96</td>
<td>80</td>
</tr>
</tbody>
</table>

Proprioception

Thirty-five of the 39 patients performed the balance test. Four patients were not tested at the start of the study because the facilities were not yet available. Two patients were not able to perform the test with eyes closed and in 1 patient the pre-operative values of ‘time to first balance disturbance’ were not registered.

![Figure 7](image)

**Figure 7** – One-leg stance test of the affected leg: preoperative and 6 months postoperative ‘time to first balance disturbance’ (timepre and timepost) with eyes open en eyes closed. The solid line is the median, the boxes represent the interquartile range, and the error bars indicate the 95% range. *Wilcoxon signed rank test.

Analysis of the affected leg showed a significant difference between pre- and 6 months postoperative values for ‘time to first disturbance’ with eyes closed and for the ‘number of balance disturbances’ with both eyes open and closed, whereas for the healthy leg none of the differences was significant (*table 3, 4; figure 7, 8*).
### Table 3 - One-leg stance test: ‘time to first balance disturbance’. Postoperative data were acquired at 6 months follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Eyes open</th>
<th></th>
<th></th>
<th>Eyes closed</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>preop*</td>
<td>postop*</td>
<td>p-value**</td>
<td>preop*</td>
<td>postop*</td>
<td>p-value**</td>
</tr>
<tr>
<td>Both legs</td>
<td>50 (1-60)</td>
<td>60 (3-60)</td>
<td>0.03</td>
<td>3 (1-35)</td>
<td>5 (1-45)</td>
<td>0.06</td>
</tr>
<tr>
<td>Affected leg</td>
<td>42 (1-60)</td>
<td>56 (3-60)</td>
<td>0.08</td>
<td>3 (1-11)</td>
<td>5 (1-16)</td>
<td>0.008</td>
</tr>
<tr>
<td>Healthy leg</td>
<td>58 (2-60)</td>
<td>60 (5-60)</td>
<td>0.20</td>
<td>3 (1-35)</td>
<td>4 (1-45)</td>
<td>0.94</td>
</tr>
<tr>
<td>p-value***</td>
<td>0.32</td>
<td>0.84</td>
<td></td>
<td>0.11</td>
<td>0.50</td>
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</tr>
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</table>

*median (range), **Wilcoxon signed ranks test, ***for difference between legs, Wilcoxon signed ranks test

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**Figure 8** – One-leg stance test of the affected leg: Preoperative and 6 months postoperative ‘number of balance disturbances of the affected leg’ (ratepre and ratepost). The solid line is the median, the boxes represent the interquartile range, and the error bars indicate the 95% range. §Wilcoxon signed ranks test.
Comparing the affected leg with the healthy leg, the preoperative differences for the ‘number of disturbances’ in both the eyes open en eyes closed condition were significant, whereas the postoperative differences were not (table 4). The pre- and postoperative differences for the ‘time to first disturbance’ with eyes open and closed were not significant (table 3).

Table 4 - One-leg stance test: number of balance disturbances during 1 minute. Postoperative data were acquired at 6 months follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Eyes open</th>
<th></th>
<th>Eyes closed</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>preop*</td>
<td>postop*</td>
<td>p-value**</td>
<td>preop*</td>
</tr>
<tr>
<td>Both legs</td>
<td>1 (0-27)</td>
<td>0 (0-18)</td>
<td>&lt;0.001</td>
<td>14 (1-37)</td>
</tr>
<tr>
<td>Affected leg</td>
<td>1 (0-27)</td>
<td>1 (0-18)</td>
<td>0.002</td>
<td>16 (2-37)</td>
</tr>
<tr>
<td>Healthy leg</td>
<td>1 (0-15)</td>
<td>0 (0-14)</td>
<td>0.09</td>
<td>13 (1-27)</td>
</tr>
<tr>
<td>p-value</td>
<td>0.009</td>
<td>0.44</td>
<td>0.001</td>
<td>0.88</td>
</tr>
</tbody>
</table>

*median (range), **Wilcoxon signed ranks test, ***for difference between legs, Wilcoxon signed ranks test
Discussion

This multicenter prospective longitudinal study was conducted to evaluate the effect of arthroscopic thermal capsular and ligament shrinkage on chronic lateral ankle instability. Subjective stability had improved in the majority of patients at follow-up. Mechanical laxity reduction was small but statistically significant for anterior talar translation but not for talar tilt. The primary outcome measure was radiographically and manually tested mechanical stability. The improvement of the radiographic anterior talar translation, although statistically significant, is considered clinically of less relevance, in accordance with the beforehand-specified difference of 3 mm used for sample size calculation. The result of manual anterior drawer test showed a similar statistical significant effect. An important finding was a substantial and statistically significant improvement of almost all secondary outcome measures at follow-up, compared to the preoperative scores. Additionally, 72% of the patients rated the outcome as good or excellent. This functional improvement correlated with the significant improvement seen with the balance test of the affected leg, indicating better postoperative proprioception.

Four reports on thermal capsular shrinkage for chronic ankle instability have been published since the study by Ollof et al.\textsuperscript{2,3,14,25,29} These 4 studies all have follow-up periods longer than the current study. The strength of this series as compared to these reports is its prospective multicenter design, the larger group representing a normal population, and that no patients were lost to follow-up. The functional improvement is in accordance with the other studies on shrinkage for chronic ankle instability. In 3 of the 5 studies a marked improvement of radiographic mechanical stability is reported as well.\textsuperscript{2,3,14}

An explanation for the difference in improvement of mechanical stability might be that in the other studies the operated ankles were immobilized in a cast for 2 to 6 weeks, whereas rehabilitation in this study was functional and ambulation with full weight bearing as tolerated was allowed as soon as 5 to 7 days postoperatively. Although early functional rehabilitation may seem to contradict with the initial potential for creep (deformation of tissue under a constant load) with a possible relapse of ligament laxity, an animal study showed that early mobilisation of thermally treated ligaments enhances remodelling of ligament tissue and even diminished the potential for creep compared to immobilization.\textsuperscript{5,39} Avoiding high-risk activities, the tape is thought to provide sufficient support to prevent for re-spraining the ankle.
in the early postoperative period. The functional rehabilitation program was chosen to allow for early return to normal daily activities, an advantage of arthroscopic procedures in general. Another explanation for the lack of substantial reduction of ligament laxity might be that the preoperative increased mechanical laxity in this study was less marked than in other studies, with less room for improvement.\textsuperscript{3,25,29}

Apart from improvement in mechanical laxity, there are alternative explanations for the functional improvement. The functional improvement could be the improved proprioception as caused by the surgical procedure. The relation between proprioception and functional ankle stability with or without mechanical stability in general has been pointed out by several authors.\textsuperscript{1,12,13,15,34} The influence of surgical procedures for chronic instability on proprioception is less extensively evaluated. Larsen et al and Rosenbaum et al found postoperative improved peroneal electromyogram activity, as compared to preoperative measurements.\textsuperscript{23,31} More recently, Halasi et al reported improved joint position sense after surgical stabilization.\textsuperscript{8}

The mechanism responsible for the improved proprioception in this study could be the thermal changes of mechanoreceptors in the lateral capsule and ligaments although their contribution to proprioception is unclear.\textsuperscript{21,27,28,30,32} Konradsen et al found, after injection of the lateral ankle ligaments with a local anaesthetic, that active joint position sense was unaffected but passive joint position sense was disturbed.\textsuperscript{21} It is suggested that this might influence correct placement of the foot during walking, making patients prone to sprains. Myers and Riemann et al found that injection of the lateral ankle ligaments with both a local anaesthetic and a placebo led to a decreased ‘muscle protective response’ measured with electromyography.\textsuperscript{28} This implies that the edema caused by the injection, and not the anaesthetic, is responsible for the altered proprioception.

Local tissue swelling and edema being the cause of altered proprioception is in accordance with a second possible explanation for altered sensory input: the removal of intra-articular pathologic soft tissue. In order to get access to the anterior talofibular ligament for thermal shrinkage, debridement of the synovial tissue of the anterolateral ankle joint was performed in all of the patients. Abundant pathologic tissue in the lateral gutter might lead to soft tissue impingement and disturbed proprioceptive function, leading to symptoms of recurrent giving way. This theory is supported by a study reporting the presence of anterolateral impingement lesions in two-thirds of 61 patients in whom the lateral ankle joint was inspected during ligament reconstruction for chronic ankle instability.\textsuperscript{6}
An important question is how arthroscopic capsular shrinkage for chronic ankle instability compares to open reconstructions of the lateral ankle ligaments. Karlsson et al reported 77-90% good and excellent results according to the Karlsson score in a randomized trial comparing two anatomical reconstructions with preoperative severe functional instability with mechanical laxity and a minimum follow-up of 2 years.\textsuperscript{17} Maiotti et al reported 86% good and excellent results after arthroscopic capsular shrinkage for chronic ankle instability in 22 soccer players at a minimum of 2.5 years follow-up, whereas this study showed 69% good and excellent results in 39 patients at a minimum of 9 months follow-up.\textsuperscript{25} In both this and Maiotti’s study the ankle score used by Karlsson was applied, making the results comparable.

Considering the potential for creep seen in biomechanical studies, shrinkage at temperatures higher than 65\textdegree\ to shorten the ligaments > 20\% to 30\% cannot be recommended. This makes thermal capsular shrinkage, in theory, less appropriate for severe mechanical instability. However, Maiotti et al reported 55\% reduction of radiographic anterior talar translation and even 80\% reduction of talar tilt after shrinkage for chronic ankle instability.\textsuperscript{25} This is even a greater reduction than reported by Karlsson et al for anatomic reconstructions (30\% to 44\% reduction of talar tilt and anterior talar translation).\textsuperscript{17}

A possible advantage of the shrinkage procedure is the short operative time. In our series the mean operation time was 27 minutes (SD 10.3). In the study by Karlsson, the mean operation time for the anatomic reconstruction with the Karlsson modification (35 minutes (SD 11)) and the Brostrom modification (44 minutes (SD 6)) were substantially longer.\textsuperscript{17}

An advantage of arthroscopy is the short rehabilitation time required for most procedures. In this study, patients were advised about return to previous activities according to rather liberal guidelines: return to work in 6 weeks, and return to sports in 12 weeks. The median time to return to work in this study compares favourably to the rehabilitation period reported by Karlsson in two randomized trials about rehabilitation after an anatomic reconstruction (a mean of 6.0 to 8.5 weeks versus a mean of 4.0 weeks in our study).\textsuperscript{19,20} The less marked difference in time to return to sports might be explained by the supervised rehabilitation program that all patients in the studies by Karlsson et al underwent. In the current study there was no supervised rehabilitation program.

The total number of complications in this study (7 in 39 patients, 18\%) was high. However, 2 (5\%) were minor complications related to the after treatment (allergy to tape) that resolved with simple measures. There was only 1 (3\%) surgery related complication (ie, damage to a branch of the superficial peroneal nerve in 1 patient that did not lead to
functional impairment at final follow-up). This percentage of surgery-related complications is much lower than other reports in literature. In a review, Ferkel reported a 9% complication rate with ankle arthroscopy and Karlsson et al found 10% surgery-related complications in the randomized trial comparing different reconstructions.\cite{7,17} None of the patients in the shrinkage study had wound healing problems.

All 3 re-interventions were marked as late complications, but only 1 (persisting instability without a severe recurrent sprain) can be considered as a treatment failure. The second patient with recurrent instability sustained a severe re-injury before the sixth postoperative week due to early return to intensive training activity. This was not in accordance with the advised rehabilitation scheme and can be considered a protocol violation. Exclusion of this patient does not affect statistical significance of radiographic mechanical laxity measures. The third patient had unrelated posterolateral ankle pain, which was successfully treated with posterior ankle arthroscopy.

**Conclusions**

Thermal arthroscopic capsular and ligament shrinkage for chronic lateral ankle instability is a safe procedure that requires limited operation time and results in a high percentage of good and excellent clinical results with a significant functional improvement. Since the reduction of mechanical laxity was only moderate, debridement of the synovial tissue in the anterolateral part of the ankle joint may have led to better proprioception and ankle coordination.
References

Arthroscopic capsular shrinkage for chronic ankle instability