On the treatment of tennis elbow. Effectiveness and prognostics of braces and physical therapy
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Chapter V

The predictive value of ultrasound for effectiveness of conservative treatment of tennis elbow

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Abstract

**Background**
Tennis elbow is a common complaint. Several treatment strategies have been described, but no optimal strategy has been identified. Ultrasound-imaging as a predictive factor has never been studied. In a randomised controlled trial, effectiveness of brace-only, physical therapy and the combination of both were compared. Aim of the presented subgroup analysis was to determine the diagnostic and predictive value of ultrasound for effectiveness of bracing as treatment strategy in patients with tennis elbow complaints.

**Methods**
Patients with tennis elbow complaints were randomised. Ultrasound imaging was performed before randomisation and was available for 57 patients. Outcome measures at 6 weeks follow-up were success rate, and decrease in pain (0-100 scale). Data were analysed using an intention-to-treat analysis.

**Results.**
In only 75% of the imaged patients, the clinical diagnosis could be confirmed. The following entities were identified: hypo-/hyper echogenicity, swelling, calcification, bursitis, enthesiopathy, tendinitis. Positive predictive value of different ultrasound entities varied between 0.78 and 0.82. Negative predictive value ranged between 0.23 and 0.71.

Predictive value as studied by subgroups 1) hypo-echoic image, 2) swelling present, 3) enthesiopathy, 4) any entity present or 5) no entity present showed no statistically significant differences for either success-rate (range 40-54%) or mean decrease in pain (range 16-28 percent point).

**Conclusion**
No predictive value of pathologic findings on ultrasound was identified. The diagnostic capacity of ultrasound in patients with tennis elbow is of limited value.
Introduction

Lateral epicondylitis, or ‘tennis elbow’, is a frequently reported condition in medical care. The complaint is characterised by pain over the lateral epicondyle of the humerus, which is aggravated with resisted dorsiflexion of the wrist. The incidence in general practice is approximately 4-7 per 1000 patients per year with an annual incidence of 1-3% in the general population. The complaint is thought to be self-limiting. The natural history of the entity can be positively influenced by means of therapeutic intervention. If untreated, it is estimated to last from 6 months to 2 years. In literature, over 40 treatment options are described. Examples include an expectant waiting policy, corticosteroid injections, orthotic devices and physical therapy. Surgery may be used for chronic, disabling cases. In Dutch primary care, 21% of the patients with lateral epicondylitis are prescribed an orthotic device as a treatment strategy, and physical therapy is described in approximately 28% of the patients.

Diagnostic strategies, such as ultrasound, have not been used to support the choice between different treatment strategies. Mafulli et al. reported the ultrasound findings in patients with tennis elbow and showed that six different entities could be identified: 1) enthesiopathy, 2) tendonitis, 3) peritendonitis, 4) bursitis, 5) intramuscular lesions, 6) mixed lesions. Mafulli et al. reported the possible prognostic value of ultrasound as a diagnostic tool in patients with tennis elbow. As ultrasound is a relatively cheap diagnostic tool, application might be useful for supporting choice of therapy. In the current study, the primary aim was to determine within a trial the prognostic value of ultrasound findings and the interaction of findings with effectiveness of three conservative treatment strategies: brace; physical therapy and the combination of both.

Patients and methods

Between January 1999 and May 2000, patients with tennis elbow complaints were recruited by regional general practitioners and primary care physical therapists and referred to the ‘tennis elbow consultation’ in an outpatient clinic setting. Patients were included if they had clinically diagnosed tennis elbow: pain on the lateral side of the elbow, aggravated with both pressure on the lateral epicondyle of the humerus and resisted dorsiflexion of the wrist. Complaints had to be present for at least 6 weeks. Patients were excluded in case of bilateral complaints, a definite decrease of pain over the last two weeks, treatment for the current tennis elbow episode in the last six months and inability to fill out questionnaires.

The hospital’s medical ethics committee approved the study.
Study Design

Baseline assessments were undertaken by a doctor (GK) before randomisation and in a blinded setting. Assessments included patient demographics, co-morbidity, and baseline values of the outcome measures. After retrieval of informed consent, patients were included in the trial by a researcher (PS) and randomised using a computer program with minimisation strategy for the duration of complaints (i.e. <3 months; 3-6 months and >6 months). Both patient and researcher were able to see the allocated treatment on the computer screen. Patients were allocated to either (1) brace only (2) physical therapy (3) brace + physical therapy. From a random sample of 75 patients, ultrasound images were made from both arms by a trained echocardioplist using a 7.5 MHz linear array transducer. A standardised imaging protocol was used, in which a good view of the tendon was achieved. These images were evaluated by another echocardioplist (MS) without knowledge of either the injured side or the assigned treatment. Evaluation was performed using a standardised scoring-form, assessing the following entities:

1) Echogenicity (hypo-, normal or hyper-echogenic),
2) Swelling (present or not present)
3) Calcifications (present or not present),
4) Bursitis (bursa under the inferior surface of the extensor carpi radialis brevis (ECRB) tendon)
5) Location of the lesion
   a. Enthesiopathy (proximal part of the tendon enlarged with echogenicity alterations)
   b. Tendinitis (tendon ECRB enlarged with echogenicity alterations and loss of normal tendon structure)
   c. Peri-tendinitis (thickening of the peritendinous lining).

Treatment

Patients in the combination group received the combination of both below mentioned protocols. Patients in the brace group were provided with the brace immediately after randomisation. The brace used was the Epipoint (manufacturer Bauerfeind, Zeulenroda, Germany) and use and application were instructed immediately, using a standardised protocol. Patients in the brace-only group were instructed to once visit a physical therapist participating in the trial during the first week of the intervention period. Patients were advised to wear the brace continuously during daytime, and especially when they were to perform activities of which they thought could provoke the pain, for the six weeks intervention-period. Activities causing pain despite the use of the brace were discouraged.

Patients in the physical therapy group were treated by a standardised protocol. During the 6 weeks intervention period patients underwent a total of nine sessions, respectively 3,2,1,1,1 and 1 session(s) per week. Every session consisted of a 7.5 minutes pulsed ultrasound treatment
according to the protocol by Binder et al. In addition, patients were treated by friction massage for 5-10 minutes. When pain subsided, patients were instructed a strengthening and stretching protocol by the physical therapist to perform at home twice daily.

Outcome assessment
Outcomes were assessed at six weeks after randomisation. The outcome measures used were
(a) global improvement assessed on a 6-point scale
   1. completely recovered;
   2. much improved;
   3. little improved;
   4. not changed;
   5. little worse;
   6. much worse). This measure was dichotomised: patients reporting to be completely recovered or much improved were noted as a success.
(b) pain intensity of the patient’s most important complaint (11-point numeric scale, 0 no pain 10 severe pain).

Statistical analysis
The diagnostic abilities of ultrasound were evaluated comparing the images of the injured arm and using images of the non-injured arm as control group. The predictive value of ultrasound was determined by comparing different subgroups based on ultrasound-entities. The differences in improvement between the groups with corresponding 95% confidence interval (95 % CI) were computed and were compared using one-way analysis of variance (ANOVA). Logistic regression was used to analyse dichotomous outcomes.

Results
In a total of 75 patients ultrasound scanning was performed. In 15 patients, the blinded endoscopist judged the images to be not suitable for evaluation. In addition, three patients did not return for 6 weeks follow-up. All three patients did not visit their treating physical therapist and did not respond on multiple letters. Of the 57 analysed patients, 20 were treated by physical therapy, 21 by brace-only treatment and 16 by both physical therapy and brace treatment. Mean age of the patients was 45.5 (SD 12.8) years and mean duration of complaints was 17.0 (SD 11.3) weeks. The patient’s dominant side was affected in 73%.
Diagnostic Value (table 1a,b)

Injured arm

When looked at echogenicity of the imaging, in 38 a hypo-echoic area was visualised and in three patients a hyper-echoic area was seen. Enthesiopathy was diagnosed in 37 patients (65%), tendonitis in 11 patients (19%). In 14 patients (25%) no abnormality was detected.

Table 1a - Diagnostic value: results of ultrasound imaging

<table>
<thead>
<tr>
<th>Injured side</th>
<th>Non-injured side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypo-echoic</td>
<td>38/57 67%</td>
</tr>
<tr>
<td>Hyper-echoic</td>
<td>3/57 5%</td>
</tr>
<tr>
<td>Swelling</td>
<td>35/57 61%</td>
</tr>
<tr>
<td>Calcifications</td>
<td>3/57 5%</td>
</tr>
<tr>
<td>Bursitis</td>
<td>1/57 2%</td>
</tr>
<tr>
<td>Enthesiopathy</td>
<td>37/57 65%</td>
</tr>
<tr>
<td>Tendinitis</td>
<td>11/57 19%</td>
</tr>
<tr>
<td>Any entity</td>
<td>43/57 75%</td>
</tr>
<tr>
<td>No entity</td>
<td>14/57 25%</td>
</tr>
</tbody>
</table>

Table 1b – Diagnostic value per entity, injured arm.

<table>
<thead>
<tr>
<th>Entity</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictive Value</th>
<th>Negative Predictive Value</th>
<th>Likelihood Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypo-echoic</td>
<td>0.67</td>
<td>0.81</td>
<td>0.78</td>
<td>0.71</td>
<td>3.52</td>
</tr>
<tr>
<td>Swelling</td>
<td>0.61</td>
<td>0.84</td>
<td>0.80</td>
<td>0.69</td>
<td>3.81</td>
</tr>
<tr>
<td>Enthesiopathy</td>
<td>0.65</td>
<td>0.86</td>
<td>0.82</td>
<td>0.71</td>
<td>4.64</td>
</tr>
<tr>
<td>Tendinitis</td>
<td>0.19</td>
<td>0.95</td>
<td>0.79</td>
<td>0.46</td>
<td>3.80</td>
</tr>
<tr>
<td>Any entity</td>
<td>0.75</td>
<td>0.81</td>
<td>0.80</td>
<td>0.23</td>
<td>3.95</td>
</tr>
</tbody>
</table>

Table 2 – Prognostic Value: results per entity, injured arm

<table>
<thead>
<tr>
<th>Pathologic Entity</th>
<th>All Treatments</th>
<th>Physical Therapy</th>
<th>Brace</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total group</td>
<td>40 (23/57)</td>
<td>45 (9/20)</td>
<td>38 (8/21)</td>
<td>38 (6/16)</td>
</tr>
<tr>
<td>Hypo-echoic</td>
<td>47 (18/38)</td>
<td>50 (7/14)</td>
<td>46 (6/13)</td>
<td>45 (5/11)</td>
</tr>
<tr>
<td>Swelling</td>
<td>49 (17/35)</td>
<td>54 (7/13)</td>
<td>50 (6/12)</td>
<td>40 (4/10)</td>
</tr>
<tr>
<td>Enthesiopathy</td>
<td>49 (18/37)</td>
<td>50 (7/14)</td>
<td>50 (6/12)</td>
<td>45 (5/11)</td>
</tr>
<tr>
<td>Any Entity</td>
<td>44 (19/43)</td>
<td>50 (8/16)</td>
<td>40 (6/15)</td>
<td>42 (5/12)</td>
</tr>
<tr>
<td>No Entity</td>
<td>29 (4/14)</td>
<td>29 (2/7)</td>
<td>33 (1/3)</td>
<td>25 (1/4)</td>
</tr>
</tbody>
</table>

* Success defined as completely recovered or much improved
† Improvement on a 0-100 scale
**Non-injured arm**

In 11 of 57 non-injured arms (19%), a hypo-echoic area in the tendon was seen. In the remaining 46 patients, no abnormalities were visualised.

**Figure 1 – Success rate per entity**

![Graph showing success rates per entity](image)

**Prognostic Value (table 2)**

Subgroup analyses were made for five subgroups: 1) hypo-echoic image, 2) swelling present, 3) enthesiopathy, 4) any entity present or 5) no entity present. Neither of these subgroups showed statistically significant differences for either success-rate or mean improvement for pain. Success rates in groups 1-4 varied between 40% and 54%. Success-rate in the ‘no entity’ group was 29%. Decrease in pain varied in groups 1-4 from 26-28 percent-point and was 16 percent-point in the ‘no entity’ group. These results differed, however, not statistically significant. When success-rates and pain-improvement were compared between all different entity-groups,

<table>
<thead>
<tr>
<th>Mean improvement in Pain (SD) †</th>
<th>All Treatments</th>
<th>Physical Therapy</th>
<th>Brace</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22 (24)</td>
<td>28 (29)</td>
<td>21 (23)</td>
<td>22 (24)</td>
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<tr>
<td></td>
<td>26 (28)</td>
<td>28 (27)</td>
<td>25 (27)</td>
<td>26 (27)</td>
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<tr>
<td></td>
<td>26 (29)</td>
<td>28 (29)</td>
<td>24 (29)</td>
<td>26 (27)</td>
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<td></td>
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<td>27 (28)</td>
<td>26 (26)</td>
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<tr>
<td></td>
<td>26 (27)</td>
<td>27 (26)</td>
<td>24 (26)</td>
<td>28 (30)</td>
</tr>
<tr>
<td></td>
<td>16 (21)</td>
<td>30 (29)</td>
<td>15 (15)</td>
<td>0 (10)</td>
</tr>
</tbody>
</table>
no statistically significant differences were identified. Thence, none of the with ultrasound identified subgroups differed in prognosis.

**Discussion**

The results of this study show no significant differences in effectiveness when looked at subgroups based on entities identified by ultrasound. Therefore, the pathologic findings on ultrasound examination seem to have no predictive value for treatment outcome in patients with tennis elbow.

However, caution should be applied in drawing definitive conclusions. The study is of limited size. Different subgroups identified might be too small to identify differences in prognosis. Evaluation based on printed images is an additional limitation of this study. Since ultrasound is a dynamic diagnostic tool, real-time evaluation could lead to a different interpretation of the ultrasound findings.

Mafulli et al. were one of the first to report on ultrasound imaging of tennis elbow. They showed different pathologic entities in patients with tennis elbow. Mafulli et al. stated the possible prognostic value of ultrasound imaging. Our hypothesis was that these different pathologic entities are predictive factors for effectiveness of different conservative treatment strategies. The results of our study do not confirm this hypothesis. Mafulli et al. were able to confirm the diagnosis by ultrasonographic abnormalities in 93% of their patients. In our study, this was possible in 75% of the patients. A possible explanation might be the relatively mild complaints of patients in our study. Another explanation might be a difference in technical parameters of the ultrasound equipment used, causing abnormalities to be beyond the resolution of the used scanner. In addition, our findings differed slightly compared to the Mafulli findings, in particular concerning the locations of the lesion.

Notable finding was the relatively low success-rate in the ‘no entity’ subgroup. No significant differences, however, could be identified. It seems a logical finding that prognosis of treatment is worse in patients where no pathology is found. Treatment might be aimed at the wrong patho-anatomical substrate. This finding may be the clearest finding from our study and warrants further research.

Because ultrasound is more and more used in physical therapy practices, identifying prognostic value of ultrasound for patients with tennis elbow would be useful. The results of our study show no prognostic value of ultrasound for effectiveness of brace, physical therapy or a
combination of these strategies in patients with tennis elbow. Using more advanced ultrasound equipment, abnormal findings might be found in a higher number of patients, allowing more reliable conclusions concerning prognostic and diagnostic value of ultrasound in tennis elbow. A future study therefore might be useful and should incorporate this advanced equipment and real-time evaluation of the imaging.

**Funding**

This study was partly funded by Bauerfeind, manufacturer of orthotic devices.

**Reference List**
