Objective assessment of brace wear times and the impact on physical activities in adolescent idiopathic scoliosis patients

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Introduction
Adolescent idiopathic scoliosis (AIS) is a deformity of the spine characterized by lateral curvature and vertebral rotation [2]. Depending on the severity of the curve the treatment can either be conservative (e.g. bracing and physiotherapy) or surgical. AIS patients with a Cobb angle of 25° to 40° are being treated with braces to prevent progression of spinal curvature. The effectiveness of bracing depends on the patient’s compliance. Rahman et al. showed that in a highly compliant group of AIS scoliosis progressed in one of nine subjects (11%). In the less compliant group 14 of 25 subjects showed a progression (56%). Due to an ongoing debate concerning the efficacy of bracing, the objective monitoring of brace wear times appears necessary. Furthermore, the importance of regular physical activities in childhood and adolescence is well established but patients may feel restricted by wearing the brace.

Therefore, we developed a new approach for an objective assessment of physical activities by means of an ankle-worn accelerometer before and after application of Chêneau-type braces with simultaneous measurements of brace wear times. This procedure allows for the determination of the relationship between the conservative treatment of scoliosis by means of braces and its impact on daily physical activities.

Methods
The study was approved by the local ethics committee. Written informed consent was obtained from all patients and their parents. Currently, 20 AIS patients (mean age 13.2 ± 2.4 years) are enrolled in this study. Brace wear times were determined with a small temperature sensor embedded in the Chêneau brace above the anterior superior iliac spine. A pedometer-based accelerometer (StepWatch 3.0 Activity Monitor, Orthocare Innovations) was used to assess daily physical activities. This ankle-worn device was used for one week before brace application. After eight weeks of wearing the brace a thermal sensor was embedded and worn simultaneously with the accelerometer for another week. Six out of the 20 patients already participated in the second trial.

Physical exercises are generally recommended during the brace treatment even though activities like therapeutic exercises should be performed without wearing them. Therefore the time spent exercising was determined by a physical activity log and added to the brace wear time. This time value was divided by the recommended wear time of 23 hours in order to determine the percentage of compliance. To gain insight into brace wear habits, days in the second trial were subdivided into night time (8 pm to 7.30 am), school time (7:30 am to 3 pm) and leisure time (3 pm to 8 pm). SPSS 15 was used for statistics including descriptive data analyses, with Wilcoxon signed rank tests for the paired comparison (before vs. after brace application). Spearman correlation analyses were performed for investigating relationships between physical activities and brace wear times.

Results
Braces were worn for a daily mean time of 13:43±4:56 h, corresponding to a mean compliance of 59.6% (ranging from 33.2% to 85.7%). Compliance was better in female (67.1%) compared to male patients (32.9%), which is in accordance to Karol [2]. The physical activity level was comparable for the second trial with 5,600 gait cycles as compared to 5,461 gait cycles.

<table>
<thead>
<tr>
<th>Total</th>
<th>Compliance</th>
<th>Gait Cycles (per day)</th>
</tr>
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<tr>
<td></td>
<td>Week</td>
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<tr>
<td>Mean</td>
<td>Total</td>
<td>Week</td>
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<tr>
<td></td>
<td>59.6</td>
<td>58.5</td>
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<tr>
<td>SD</td>
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</tr>
<tr>
<td>Min</td>
<td>33.2</td>
<td>31.6</td>
</tr>
<tr>
<td>Max</td>
<td>85.7</td>
<td>79.4</td>
</tr>
</tbody>
</table>

Tab. 1: Compliance and physical activity levels of AIS patients, comparing weekdays and weekend days

Discussion
We presented a new approach for an objective assessment of brace wear times which will allow a detailed and objective description of the impact of bracing on daily physical activities in adolescent idiopathic scoliosis (AIS) patients. Several studies already described the use of objective methods to determine brace wear times and patient compliance by means of temperature sensors to investigate whether patients accept their treatment regimen. This method extends the information content by delivering possible explanations for poor compliance in scoliosis patients. Compliance in our AIS patient group was slightly lower compared to previous reports with 65% [4] or 67.5% [1] but higher compared to findings of Morton [47% [3]].

The observation that male adolescents are more active during everyday life than females [6] might be an explanation for poorer compliance in male AIS patients [2] than in female patients. A further explanation would be a lack of acceptance of peers which could explain a decline in brace wear times during school and leisure time. In our subjects we found that almost half of the time (48.4%) braces were worn during leisure time, 22.7% at school and 28.8% during night times. Differences were not statistical significant due to the currently small sample size.

A minimal difference of brace wear times between week days and weekend days was not significant. The same holds true for the weekday and weekend-day comparison of physical activity levels, although our subjects were 20% less active on the weekends compared to weekdays which is in accordance to previous findings [7]. Hence a trend towards lower physical activities but a higher compliance with regard to brace wear times at weekends can be observed but has to be verified in this ongoing study.

Surprisingly the overall physical activity level was higher in the second trial, when braces were applied, compared with the first trial without braces. However, subjects showed a poor overall compliance of 59.6% even though the patient with the highest compliance of 87.4% was the most active in this study with more than 10,000 gait cycles per day. Due to the currently small sample size no final conclusions can be drawn.

References:
1) HELFENSTEIN A Spine (31)2006, pp. 339-44.