Bracing according to ‘best practice’ standards - are the results repeatable?

M Borysov1, A Borysov1, A Kleban2, HR Weiss2*

Abstract

Introduction
"Racing concepts that are in use today for the treatment of scoliosis include symmetric and asymmetric hard braces, usually made of polyethylene, and soft braces. Currently, the plaster cast method seems to be the most practiced technique worldwide for the construction of hard braces. Computer aided design/computer aided manufacturing (CAD/CAM) systems are available that allow brace adjustments without plaster. Since the CAD/CAM technology is not affordable in the Ukraine, we have tried to build hand-made braces according to this standard technique via cast modelling. The aim of this study was to compare the in-brace corrections of hand-made braces built according to the ‘Best Practice’ Chêneau standards with the published results available in the literature on Chêneau braces.

Materials and methods

In-brace correction and compliance clearly determine the outcome of bracing. Therefore, in-brace correction is one of the most important parameters to estimate brace quality. We have been looking at the results achieved after being trained in the construction, adjustment and use of ‘Best Practice’ CAD/CAM Chêneau braces. All braces (of 207 patients) made between January 2009 and December 2010 were reviewed for in-brace correction. As not all patients were in the normal range of brace indication (Cobb 20–45°; age 10–14 years), we looked for the appropriate subset from our database fulfilling the following inclusion criteria: girls only; diagnosis of adolescent idiopathic scoliosis (AIS); Cobb 20°–45°; age 10–14 years.

Results

Ninety two patients fulfilled the inclusion criteria (Cobb 20°–45°; age 10–14 years). Average Cobb angle was 29.2° (SD 6) and average in-brace Cobb angle was 12.8° (SD 6.2). In-brace correction in the whole sample was 56%.

Conclusion

After appropriate training, an experienced CPO is able to provide hand-made braces of standards similar to the recent CAD/CAM standard of bracing. In principle, the results may be repeatable. Further studies on our hand-made series of braces are necessary to evaluate brace comfort and to assess effectiveness using the SRS inclusion criteria.

Introduction

Bracing concepts that are in use today for the treatment of scoliosis include symmetric and asymmetric hard braces, which are usually made of polyethylene (PE) and soft braces1. The latest developments in the field of bracing aim at improving specific correction principles available to date1,14.

The plaster cast method worldwide seems to be the most practiced technique for the construction of hard braces at the moment. Today, computer-aided design/computer-aided manufacturing (CAD/CAM) systems are available that allow brace adjustments without plaster. Another new development is the ScoliOlogiC™ off the shelf system, enabling a technician to construct a light brace for scoliosis correction from a variety of pattern specific shells to be connected to an anterior and a posterior upright2. This Chêneau light™ brace, constructed according to the Chêneau principles, promises a reduced impediment of quality of life in the brace. A satisfactory in-brace correction exceeding 50% of the initial Cobb angle has been achieved with this brace3, which was used as the basis for the development of the latest up to date CAD/CAM Chêneau brace.

The latest CAD/CAM Chêneau brace, the Gensisgen brace4, is a Chêneau derivative in principle. The Chêneau brace was developed before 1978.17. As the first developments were made in Münster, Germany, the brace was initially called Chêneau-Toulouse-Münster (CTM)-brace. Jacques Chêneau, who used to live in Toulouse, spent a few years in Münster, where he braced patients at the Orthopaedic Department of the
university there. In 1985, the first end-result study was published with in-brace correction effects of more than 40% of the initial value and final results were superior to the end-results of the Milwaukee study from the same centre. The initial Chêneau brace was upgraded in 1995 and the 1999 standard of the Chêneau brace was described in a book in 1999.

Many three-point pressure systems are applied on the frontal, coronal and sagittal plane in all other Chêneau-derivatives. An expansion void is implemented opposite every pressure area. This enables the desired corrective movement and—when adjusted properly—avoids compression effects leading to pressure sores. As a matter of fact, in today’s Chêneau Pattern, specific bracing is desirable to allow the correction of the individual curve patterns appropriately because theoretically, there might be an unlimited number of curve patterns with different geometrical entities. Therefore, a classification has to be used to come as close as possible to the individual pattern of the patient to address the biomechanical properties of the individual curve pattern of the patient at best.

After the first curve patterns were identified by Ponseti and Friedmann and Moe and Kettleison for surgical means in the late 70s a simple functional classification for approaching different curve patterns with the help of physiotherapy was established by Lehnert-Schroth. This classification simply distinguishes between the so-called (functional) 3- and 4-curve patterns.

Chêneau also used this simple classification for the construction of his braces, which has been augmented recently.

CAD/CAM technology is not affordable in the Ukraine. Thus, we have tried to build hand-made braces according to this standard technique via cast modelling. The aim of this review was to compare the in-brace corrections of hand-made braces built according to 'Best Practice' Chêneau standards with the published results available in the literature on Chêneau braces.

Materials and methods

In-brace correction and compliance clearly determines the outcome of bracing. Therefore, in-brace correction is one of the most important parameters to estimate brace quality. We looked at the results achieved in our department after being trained in the construction, adjustment and use of the 'Best Practice' CAD/CAM Chêneau braces. All 207 braces made between January 2009 and December 2010 were reviewed for in-brace correction. As not all patients were in the normal range of brace indication (Cobb 20°–45°; age 10–14 years), we looked for the appropriate sub-set from our database fulfilling the following inclusion criteria: girls only; diagnosis of adolescent idiopathic scoliosis (AIS); Cobb 20°–45°; and age 10–14 years. Ninety two patients from our database were included. The average age was 12.4 years (10–14 years); average Risser stage was 1.34 (0–3).

Results

In-brace correction for the entire sample of 207 patients was 46.6%, including 43 patients with curvatures exceeding 45° (up to 90°) at the start. There were 92 patients that fulfilled the inclusion criteria (Cobb 20–45°; age 10–14 years). Average Cobb angle was 29.2° (SD 6), while average in-brace Cobb angle was 12.8° (SD 6.2). In-brace correction in this sample was 56%. The results of the sub-sets with different curve patterns are presented in Table 1.

Discussion

The authors have referenced some of their own studies in this review. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964) and the protocols of these studies have been approved by the relevant ethics committees related to the institution in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies. The Chêneau brace has been widely reviewed. The first end-result study was published as early as 1985. The average in-brace correction reported was 40%. Landauer presented a case series of patients treated with the Chêneau brace with comparable in-brace corrections and comparable end-results.

A prospective controlled study comparing the Chêneau brace with SpineCor has clearly shown the superiority of the Chêneau brace in a sample of patients at actual risk for being progressive, fulfilling the SRS criteria for studies on bracing. After growth, only 8% from the SpineCor sample were not progressive and 80% from the Chêneau group. The Cobb angle at the start of treatment, however, was 21° for the SpineCor sample and 33° for the Chêneau brace sample of patients.

According to Landauer and collaborators, two factors influence
the outcome of brace treatment, both of them being equally important. In-brace correction is the factor, it clearly correlates with the final result: the better the in-brace correction, the better the end-result. Compliance is the other important factor. The best possible in-brace correction will not change the prognosis of a patient when the brace is not worn as prescribed.

Therefore, one should aim at the best possible in-brace correction that is most comfortable for the patient to foster compliance.

In-brace corrections exceeding 50% have been reported in the literature in a sample of patients treated with the Chêneau light™ brace having an average Cobb angle of 36°.

The results of this Chêneau derivative are promising because none of the patients undergoing this treatment were operated. Also, in infantile scoliosis, it has been shown that improvements can be achieved in curvatures exceeding 45°. However, there are also Chêneau standards till date with surgery rates of more than 40%. This shows that Chêneau brace standards vary to a great extent, and therefore, standardisation seems appropriate. This can be provided by current CAD/CAM derivates, because the standard is reproducible. It does not seem necessary that other centres first gain experience over years, while their patients could be treated with much more comfort and much more effectiveness immediately. Recently, Maruyama et al. published a study with the first series of hand-made Chêneau braces in Japan. The results achieved strengthen the expectation that this team will need a few more years to gain the results as can be achieved with the latest CAD/CAM standard (or what we can achieve in our experienced team after appropriate training by a specialist). In Table 2, we have provided a synopsis of the corrective effects found in the literature on the Chêneau brace. Similar to the in-brace corrections, the final results achieved may also vary widely.

Of course, it seems important to note that the average Cobb angle in our series is smaller than the Cobb angle found in other papers. As a matter of fact, in-brace correction is negatively related to curve magnitude. Nevertheless, even if we respect this fact in our discussion, we should be allowed to mention that our in-brace corrections are at least comparable to what may be achieved with well-established CAD/CAM series. This may also be reflected by the examples presented in Figures 1 and 2.

Table 2: Papers on the Chêneau brace treatment of patients with Adolescent Idiopathic Scoliosis as can be found in PubMed and the journal ‘Scoliosis’ where the average in-brace correction (ø corr) is documented (ø Cobb angle have been rounded). Statistical analysis revealed significant differences of the in-brace correction achieved when the results from our sample (Borysov et al.) were compared to [28] and [29] (t = 2.4 and 3.64, respectively, in a statistical test to compare two different proportions)

<table>
<thead>
<tr>
<th>Authors</th>
<th>Years</th>
<th>n</th>
<th>ø Cobb</th>
<th>ø corr</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hopf &amp; Heine</td>
<td>1985</td>
<td>52</td>
<td>41%</td>
<td>36°</td>
<td>ns</td>
</tr>
<tr>
<td>Rigo et al.</td>
<td>2002</td>
<td>105</td>
<td>31%</td>
<td>37°</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td>Rigo</td>
<td>2007</td>
<td>32</td>
<td>42%</td>
<td>33°</td>
<td>ns</td>
</tr>
<tr>
<td>Weiss et al.</td>
<td>2007</td>
<td>81</td>
<td>51%</td>
<td>36°</td>
<td>ns</td>
</tr>
<tr>
<td>Maruyama et al.</td>
<td>2012</td>
<td>54</td>
<td>36%</td>
<td>37°</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>Weiss &amp; Werkmann</td>
<td>2012</td>
<td>34</td>
<td>59%</td>
<td>31°</td>
<td>ns</td>
</tr>
<tr>
<td>Borysov et al. (this study)</td>
<td>2012</td>
<td>92</td>
<td>56%</td>
<td>29°</td>
<td>ns</td>
</tr>
</tbody>
</table>

Figure 1: Full correction of a single curve idiopathic scoliosis in a custom made 3C hand-made Chêneau brace according to ‘Best Practice’ standards. Patient’s age was 12 years, major Cobb angle was 27° and in-brace Cobb angle was 0°.

Conclusion
After appropriate training, the experienced CPO is able to provide a hand-made standard of braces comparable to the recent CAD/CAM standard of bracing. In principle, the results may be repeatable. Further studies on our hand-made series of braces are necessary to evaluate brace comfort and effectiveness using the SRS inclusion criteria.

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Figure 2: Full correction of a double curve idiopathic scoliosis in a custom made 4C hand-made Chêneau brace according to the ‘Best Practice’ standards. Patient’s age was 12 years, major Cobb angle was 28° and in-brace Cobb angle was 0°.

Competing interests
MB, AB and AK declare to have no conflict of interest. HRW is advisor of Koob GmbH & Co KG, Abtweiler, Germany.

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References
