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Bracing According to Best Practice Standards – Are the Results Repeatable?

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Abstract

Research Article

Background: As has been demonstrated before bracing concepts in use today for the treatment of scoliosis include symmetric and asymmetric hard braces usually made of polyethylene (PE) and soft braces. The plaster cast method worldwide seems to be the most practiced technique for the construction of hard braces at the moment. CAD/ CAM (Computer Aided Design/Computer Aided Manufacturing) systems are available which allow brace adjustments without plaster. As in the Ukraine the CAD/CAM technology is not affordable, we have tried to build our hand made braces according to this standard via cast modelling. Aim of this study is to compare in-brace corrections of our brace built according to Best Practice Chêneau standards by hand with the published results available in literature on Chêneau braces. In-brace correction and compliance clearly determine the outcome of bracing. Therefore the in-brace correction is one of the most important parameters to estimate brace quality.

Materials and methods: In-brace correction and compliance clearly determine the outcome of bracing. Therefore the in-brace correction is one of the most important parameters to estimate brace quality. We have been looking at the results achieved in our department after having been 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 have been reviewed for in-brace correction. As not all of the patients were in the normal range of brace indication, (Cobb 20-45°; age 10-14 years) we have been looking for the appropriate subset from our database fulfilling the following inclusion criteria: Girls only; diagnosis of an Adolescent Idiopathic Scoliosis (AIS); Cobb 20-45°; age 10-14 years).

Results: 92 Patients fulfilled the inclusion criteria (Cobb 20-45°; age 10-14 years). Average Cobb angle was 29.2° (SD 6), Average in-brace Cobb angle was 12.8° (SD 6.2). In-brace correction in the whole sample was 56%.

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 (1) to evaluate brace comfort and (2) effectiveness using the SRS inclusion criteria.

Keywords: Scoliosis; Brace treatment; Conservative management; CAD/CAM

Introduction

Bracing concepts in use today for the treatment of scoliosis include symmetric and asymmetric hard braces usually made of PE (Polyethylene) and soft braces [1]. The latest developments in the field of bracing, aim at (1) improving specificity and (2) at a restoration of a proper sagittal realignment [1-3].

Although the effect of brace treatment has been questioned [4], there is evidence that brace treatment can stop curvature progression [5-10], reduce the frequency of surgery [11-13] and improve cosmetic appearance [14-16]. Poor cosmetic appearance for the patient may be the most important problem, which can be solved or at least reduced by the use of advanced bracing techniques including the best possible correction principles available to date [1,14].

The plaster cast method worldwide seems to be the most practiced technique for the construction of hard braces at the moment. CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) systems are available, which allow brace adjustments without plaster. Another new development is the ScoliologiC[™] off the shelf system enabling the 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 upright [2]. 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 brace [3], which was used as the basis for the development of the latest up to date CAD/ CAM Chêneau brace.

The latest up to date CAD/CAM Chêneau brace, the Gensingen brace[™] in principle is a Chêneau derivate. The Chêneau brace was developed before 1978 [1,17]. As the first developments were made in Münster, Germany, the brace was initially called CTM-brace (Chêneau-Toulouse-Münster). Jacques Chêneau, who used to live in Toulouse, spent a few years in Münster, where he braced patients at the orthopedic 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 [8] and final results superior to the end-results of the Milwaukee study from the same centre [18]. The initial Chêneau brace

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was upgraded in 1995 and the 1999 standard of the Chêneau brace was described in a book in 1999 [19].

Theoretical Principles

Many 3-point pressure systems are applied on the frontal, coronal and sagittal plane in all other Chêneau derivates [1]. Opposite to every pressure area an expansion void is implemented. 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, as theoretically there might be an unlimited number of curve patterns with different geometrical entities. Therefore, a classification is necessary to come as close as possible to the individual pattern of the patient in order to address the biomechanical properties of the individual curve pattern of the patient treated to the best possible [1].

After the first curve patterns were identified by Ponseti and Friedmann [20,21], and Moe and Kettleson [22] for surgical means, in the late 70's a simple functional classification for approaching different curve patterns with the help of physiotherapy was established by Lehnert-Schroth [23,24]. This classification simply distinguished between 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 [1].

As in the Ukraine the CAD/CAM technology is not affordable, we have tried to build our handmade braces according to this standard via cast modelling. Aim of this study is to compare in-brace corrections of our brace built according to Best Practice standards by hand with the published results available in literature on CAD/CAM braces.

Materials and Methods

In-brace correction and compliance clearly determine the outcome of bracing [7]. Therefore the in-brace correction is one of the most important parameters to estimate brace quality. We have been looking at the results achieved in our department after having been trained in the construction, adjustment and use of Best Practice CAD/CAM Chêneau braces. All 207 braces made between January 2009 and December 2010 has been reviewed for in-brace correction. As not all of the patients were in the normal range of brace indication, (Cobb 20-45°; age 10-14 years) we have been looking for the appropriate subset from our database fulfilling the following inclusion criteria: Girls only; diagnosis of an Adolescent Idiopathic Scoliosis (AIS); Cobb 20-45°; age 10-14 years).

92 patients from our database have been 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 whole sample of 207 patients has been 46.6% including also 43 patients with curvatures exceeding 45° (up to 90°) at the start. 92 Patients fulfilled the inclusion criteria (Cobb 20-45°; age 10-14 years). Average Cobb angle was 29.2° (SD 6), Average in-brace Cobb angle was 12.8° (SD 6.2). In-brace correction in this sample was 56%. The results in the subsets of different curve patterns are presented in table 1.

Some examples from the whole sample can be seen in figures 1-4. Unfortunately not all patients agreed to have their pictures published, so we had to take also pictures of patients from the full sample of 207 patients. Therefore the patients from figures 1 and 2 did not fulfill the

inclusion criteria. The girl on figure 1 is younger than 10 years and is not a subject from this study.

Discussion

The Chêneau brace has been widely reviewed. As early as 1985 the first end-result study was published [8]. The average in-brace correction reported on within this study was 40%. Landauer [7] 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 [10]. After growth only 8% from the SpineCor sample were not progressive and 80% of 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 et al. [7] two factors are influencing the outcome of brace treatment, both of them being as important as the other: In-brace correction (1) clearly correlates with the final result. The better the in-brace correction, the better the end-result. Compliance (2)

Pattern	n	$\varnothing \text{Cobb}$	SD	Ø Cobb (Br)	SD	Ø corr
Thoracic	31	28.4°	5.7	11.9°	6.4	58%
Double Major	33	30°	6.2	15°	6.2	50%
Lumbar	10	26.9°	6.7	9.4°	4.7	65%
Thoracolumbar	18	28.6°	4.8	11.7°	4.2	59%
All (20-45°)	92	29.2°	6	12.8°	6.2	56%

Table 1: Patterns of curvature from the sample of patients in the range of Cobb angles 20.45° . The distribution of curve patterns is provided as well as the Cobb angle without brace (\oslash Cobb), Standard deviations (SD), Cobb angle in the brace \oslash Cobb (Br) and the amount of in-brace correction in % of the initial Cobb angle (\oslash Cobb).



Figure 1: Full correction of a single curve idiopathic scoliosis in a custom made 3C hand made Chêneau brace according to ,Best Practice' standards. Patients age was 8 years, major Cobb angle was 29°, in-brace Cobb angle was -5°.



Figure 2: Full correction of a single curve idiopathic scoliosis in a custom made 3C hand made Chêneau brace according to ,Best Practice' standards. Patients age was 12 years, major Cobb angle was 27°, in-brace Cobb angle was 0°.

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is the other important factor. The best possible in-brace correction will not change the prognosis of the patient when the brace is not worn as prescribed.

Therefore one should aim at the best possible in-brace correction and by the same time the best possible comfort for the patient to foster compliance.

In-brace corrections exceeding 50% have been reported in literature in a sample of patients treated with the Chêneau light^{**} brace having an average Cobb angle of 36° [3].

The results of this Chêneau derivate are promising, as none of the patients undergoing this treatment has been operated [25]. Also in infantile scoliosis it has been shown that improvements can be achieve in curvatures exceeding 45° [26]. However there are also Chêneau standards still today with rates of surgery of more than 40% [27]. This shows that Chêneau brace standards are differing to a high extent and therefore standardization seems appreciable. This can be provided by current CAD/CAM derivates as here the standard is reproducible [1]. It does not seem necessary that other centers firstly gain experience over years while their patients could be treated with much more comfort and much more effectiveness immediately. Recently Maruyama et al. have published a study with the first series of handmade Chêneau braces in Japan [28,29]. The results achieved nourishes 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 the appropriate training by a very specialist. In table 2 we have provided a synopsis of the corrective effects as found in literature on the Chêneau brace. Like the in-brace corrections achieved also the final results may vary widely [7,25,27].

Of course it seems important to note that the average Cobb angle in our series smaller than the Cobb angle as found in the other papers. As a matter of fact in-brace correction is negatively related to curve magnitude [3]. Nevertheless, even if we respect this fact in our discussion we should be allowed to say that our in-brace corrections are at least comparable to what may be achieved with well established CAD/CAM series [3,30,31]. This may also be reflected by the examples as presented in the figures 1-4.

Conclusions

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 (1) to evaluate brace comfort and (2) effectiveness using the SRS inclusion criteria.



Figure 3: More than 50% correction of a double curve idiopathic scoliosis in a custom made 4C hand made Chêneau brace according to ,Best Practice' standards. Patient's age was 13 years, major Cobb angle was 50°, in-brace Cobb angle was 23°.



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

Authors	Year	n	Ø corr	Ø Cobb	Sign.
Hopf and Heine [8]	1985	52	41%	36°	ns
Rigo et al. [29]	2002	105	31%	37°	p< 0.01
Rigo [30]	2007	32	42%	33°	ns
Weiss et al. [3]	2007	81	51%	36°	ns
Maruyama et al. [28]	2012	54	36%	37°	p< 0.05
Weiss and Werkmann [31]	2012	34	59%	31°	ns
Borysov and Borysov		92	56%	29°	

Table 2: Papers on the Chêneau brace treatment of patients with Adolescent Idiopathic Scoliosis as can be found in Pub Med and the journal ,Scoliosis' where the average in-brace correction (\emptyset corr) is documented (\emptyset corr and \emptyset Cobb angle have been rounded). Statistical analysis revealed significant differences of the inbrace 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).

Competing Interests

Maksym Borysov, Artem Borysov and Alexander Kleban declare to have no competitive interest. Hans-Rudolf Weiss is advisor of Koob GmbH & Co KG, Abtweiler, Germany.

Authors' Contributions

Maksym Borysov and Artem Borysov contributed equally to this paper. Alexander Kleban made the statistical analysis. Hans-Rudolf Weiss has written the paper with the data as provided by Maksym Borysov and Artem Borysov.

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