The In-Brace X-Ray, Critical Analysis for Successful Outcomes

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“Do not confuse poor bracing results with the results of poor bracing” – Dr John Hall, former orthopedist-in-chief, Boston Children’s Hospital.

As orthotists, we have ownership of Dr. Hall’s statement. Collectively, we are only as good as the last orthosis fit. Regardless of design, the end user and the end result is how we are measured as a group. Since we are the “device people,” we carry the responsibility of providing the service and care that will help patients achieve their goals. The Academy Consensus papers on scoliosis (15) discuss the importance of having a stable spine in adulthood—the same theme as the international group SOSORT, (Society On Spinal Orthopedic and Rehabilitation Treatment) has included in its consensus (1) (www.scoliosisjournal.com). Globally we are on the same page, and we have the same issues: Compliance, quality design, fit, and continuum of care. Studies have shown that bracing can alter the natural history and prevent (2, 3, 4, 6, 8, 10) the progression of idiopathic curves; that success, however, as shown by Moon’s study,(5) is directly related to orthotist skill and training.

When fitting patients with idiopathic scoliosis, we need to realize that their treatment really begins the moment their physician refers them to us. Since their first line of information may be the Internet, friends, family members, or preconceived ideas about scoliosis, we need to allow time at the first appointment for validating or correcting their previous information. This first meeting is an opportunity to set the parameters for success, and we feel education is a key factor in achieving success. As Dr. Emans stated, compliance is probably more a result of the motivation and education of the patient and family than of the brace itself. (2, 3)

The day the orthosis is fit is another step in the process; it’s not a completion of our role as a quality care (11) provider. Goals previously set and the purpose of bracing, understanding patient and family concerns, and keeping the communication lines open are important parts of the fitting appointment. We need to assess the patient’s posture and balance in all three planes. Setting a user-friendly wear schedule and a follow-up appointment should assist in compliance. Future studies will report the function of the brace check before x-ray, including whether or not it is beneficial. A question arises: if patients are noncompliant with the orthotist’s follow-up, are they just as non-compliant with the physician’s follow-up? It remains to be seen.

In-Brace X-Ray: Its Importance

The in-brace x-ray is one aspect of the continuum of care that provides immediate visual feedback to validate our brace design and helps us predict outcome. Our goal should be to obtain correction and balance while not compromising wear tolerance. As Dr. Winter states the brace does no good if it is sitting in the closet. (6)

There has been literature on the amount of reduction of the Cobb angle necessary for success. (2, 3, 4, 7, 8, 9, 12 ) Emans et al broke down reduction by apex, the average of which is 50 percent. Katz (7) shows 25 percent is needed along with full-time wear for certain curves. The amount of reduction and the maximum number of hours of wear time required are still subjects for study. However, there is more we can derive from the in-brace x-ray than the percentage of reduction of the Cobb angle. Smith & Carlson (12, 14, 16) [reference?] point out the role of balance, and how we can be fooled into a false sense of success by focusing only on the Cobb angle. Scoliosis is triplanar, so we need to think three-dimensionally.

Critical analysis of the orthosis and the ability to articulate our thought processes and rationales to both physicians and families is important to achieve and maintain success. The concept that the “brace does not work,” simply because we have not achieved 50 percent reduction of the Cobb angle is allowing the system to fail.

Presented below are case scenarios in which less than desirable initial results are achieved. Discussion follows on observations and adjustments required for success. To quote Dr. Hall] (17) once again, “Knowing what not to do is just as important as knowing what to do.” (The comments focus on coronal plane alignment. Future articles should encompass the sagittal and transverse planes).

We have seen slides that show great in-brace correction and balance (Figure 1).
This result is encouraging for the patient and rewarding for the orthotist. However, what do we do when this outcome is not obtained? Or, how do we maintain correction, compliance, and interest in the growing adolescent? We believe regularly scheduled follow up appointments have a positive influence; the advent of user friendly compliance monitors may shed some light on these questions.

Viewing the initial in-brace x-ray in Figure 2, we see a reduction in Cobb angle, Lumbar 34 reduced to 20; Thoracic 33 reduced to 22; however balance has not improved. Was the patient seen prior to x-ray? Is the orthosis donned correctly? Did we set a goal and instruct the patient how to reach this goal? Perhaps more importantly, is this how the patient thinks the orthosis should be donned? Or is this the reality of how the orthosis will be worn? If so, what can we do to correct that? When was the last time it was re-donned or self-adjusted? Did we talk with the patient and teach him or her how to assess the fit? Is the lumbar pad sufficient enough in the posterior lateral corner? Do we have contact along the lumbar pad? Did our clinical exam reveal a stiff curve? Does the patient require a stretching program?

Boston Brace’s fabrication facility consistently places the middle strap and chafe at the same height as the center of the crest roll. Therefore, when we look at the x-ray, we see how the orthosis is “sitting” on the patient. (This x-ray reveals the orthosis is too low). We can continue to adjust and modify the orthosis, but if the base line is incorrect, then pad placement is questionable. If misaligned, then we need to evaluate fit on the patient. Is the crest roll at the center of the waist? If so, then we need to adjust pads accordingly. Is the opening correct? Having the proper width (= to L5 width) assure the pads vectors are positioned properly. If we look at the distance between rivets at the waist level, we may find that the brace is simply too loose. We should discuss tolerance with the patient, as Don Katz (9) has pointed out, stating that in-brace correction is important, but shouldn't be at the expense of brace tolerance. Is the orthosis too small? Remember, the x-ray is one picture. Clinical evaluation reinforces what is seen in the x-ray. Radiographic markers at the full thickness of the pad (lumbar and thoracic) allow us to see where the pads are located.

Now let’s look at the same patient two months later (Figure 3).
Cobb angle reduction has improved, Lumbar reduced to 20 degrees, Thoracic to 22 degrees; and the patient’s balance has improved. The distance between rivets is smaller, the length of the lumbar pad was adjusted so it does not bridge the pelvis, a belly pad was added, and donning was reviewed so the orthosis “sits” at the waist. Patient reports compliance.

Figure 4 shows the patient’s curve is holding and that balance has improved. Note the patient was requested to be out of brace 24 hours prior to x-ray.

Here are two curves with similar curve patterns (Figure 5). Both are decompensated to the right. However, the in-brace x-rays, (Figure 6) reveal different initial results
In the orthosis to the left (Figure 6), the orthosis is sitting too low. Thus, all vectors are low. The width of the opening appears to be fine; however, the orthosis is rotated to the patient’s left. Note the waist crease chafe: the loop is not completely in the coronal plane, but rather posterior lateral. The radiographic markers of the lumbar pad are positioned at full thickness of the pad, and at the edge of the posterior opening, so we can see the orthosis is too far lateral and not as effective on the lumbar spine as is the pad on the right. By consistently placing these markers, we can see exactly how the orthosis is donned. Having the orthosis donned low means both thoracic and axillary extensions are low, with sub-par results.

For the patient on the left, we would evaluate fit. If the orthosis is sitting too low, we review donning, if this is how the patient is comfortable, then we adjust the height of the pad accordingly. Perhaps we were off with our waist position in our blueprint. We then revisit the blueprint. With tissue displacement, has the orthosis become too loose? We may need to add a belly pad and or trim the posterior opening. Are our reliefs enough? Is the thoracic window large enough? Adjustments are discussed with the clinical team and family, and then completed.

Much study has been done on The Boston Brace and its effectiveness in treating scoliosis. Much remains to be done and new technologies will assist us in doing so. We all need to focus on patient outcomes. To do so effectively, we need to understand common adjustments necessary to maximize our results. Treating idiopathic scoliosis is challenging and rewarding. As with most things, it takes skill, hard work, and dedication.

1) Rigo1, S Negrini2, HR Weiss3, TB Grivas4, T Maruyama5 and T Kotwicki SOSORT consensus paper on brace action: TLSO biomechanics of correction (investigating the rationale for force vector selection)


5) Wendy Moon, CNP; William Shaughnessy, MD; Anthony Stans, MD; Mark Dekutoski, MD; Stacey Stoll, CO. BENEFICIAL EFFECTS OF ORTHOTIST TRAINING ON BRACING SUCCESS FOR ADOLESCENT IDIOPATHIC SCOLIOSIS Work performed at the Mayo Clinic, 200 1st St, SW, Rochester, MN 55905, Association of Children’s Prosthetic-Orthotic Clinics 2006 Annual Meeting, May 17-20, 2006


10) Nachemson: Effectiveness of Brace Treatment on Moderate Adolescent Idiopathic Scoliosis. (SRS Prospective Study) JBJS 77A, pp815-22, 1995

11) Conversation with Scott Cummings, New England Chapter meeting, 2006

12) Smith, KM, Spinal Balance and In-Orthosis Correction, JPO,2003 Vol.15,Num,4s


14) Carlson, JM, Clinical Biomechanics of Orthotic Treatment of Idiopathic Scoliosis, JPO 2003, Vol.15, Num. 4s 17 – 30

15) Gavin, TM, Points of Consensus: Idiopathic Scoliosis, JPO 2003, Vol.15, Num. 4s, 14 – 16

16) Carlson, JM, Editorial, JPO, 2007, June