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EVOLUTION OF ORTHOTIC MANAGEMENT IN SPINAL DEFORMITIES: THE EGE UNIVERSITY EXPERIENCE

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ABSTRACT

Spinal orthoses are a cornerstone of conservative management for spinal deformities, and their primary objectives are to halt curve progression, to reduce pain, and to preserve function. This study summarizes the historical development, current classifications, indications, fabrication principles, and institutional experience. Orthoses are classified by stiffness (flexible, semirigid, or rigid) and by mode of action (dynamic or passive). Historically, rigid devices were used first. Although effective, they had a propensity for complications such as fixed deformity, muscle atrophy, and pressure-related skin necrosis, which led to the development of semirigid alternatives. Custom cast-based design and accurate pad placement are critical for biomechanical effectiveness; material selection is also important, since overly rigid thermoplastics may diminish the intended dynamic effects. The most common indication is adolescent idiopathic scoliosis. Bracing is initiated for curves of approximately 20 to 40 degrees or when progression is documented; average daily wear of 21 hours and close radiographic follow-up are recommended. Night-time wear can exert greater corrective forces in the supine position, and treatment success improves when combined with physiotherapeutic scoliosis exercises. In addition to use in scoliosis, thoracolumbosacral orthoses are useful in the conservative management of fractures to reduce pain and kyphosis; device selection should consider age, comorbidities, and respiratory tolerance, particularly in young children. For more than three decades, thousands of patients have been treated at our center, and we believe that the outcomes, techniques, and practical insights we have gained will be instructive.

Keywords: Spinal deformity, scoliosis, orthosis, conservative treatment, bracing

INTRODUCTION

Spinal orthoses stabilize the spine and, by preventing the progression of developing spinal deformities[1-3], aim, when feasible, to correct the deformity, reduce pain associated with spinal pathologies, and restore lost function[4].

The use of orthoses in the treatment of spinal pathologies dates back to antiquity. Hippocrates (460 to 370 BCE) applied traction for the treatment of scoliosis. Galen of Pergamon (129 to 216 CE) proposed applying lateral pressure for deformity manipulation[5,6]. The emblem of orthopedics, the bent tree trunk braced to a straight stake, is among the most illustrative examples of orthosis use and of correction achieved by lateral pressure[7]. Before spinal fusion (Hibbs, 1915), now among contemporary treatment options, came into use, the only treatment for spinal pathologies was bracing. The "Milwaukee brace", which is currently used as a conservative treatment, was first used by Blount and Schmidt in 1946 following surgical treatment of spinal deformities. From 1958 onward, this method was also adopted as a nonoperative conservative treatment option[6,8].

Orthoses used in current practice are diverse and are generally classified as flexible, semirigid, or rigid. Historically, rigid orthoses were used first. Although effective, their tendency to cause complications such as fixed deformities, muscle atrophy, and pressure induced skin necrosis prompted the development of semirigid designs, which remain in use today as alternatives. Orthoses may also be classified by their mechanism as dynamic (active) or passive.

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While orthoses were initially used widely in the treatment of all spinal deformities, their indications have progressively narrowed with advances in surgical techniques. Although many different orthosis types have been described for spinal deformities, it is not feasible in practice for a physician to know and apply every type in detail. Moreover, most spinal orthoses are custom-fabricated from patient-specific casts[6]. This, in turn, means that owing to the technical capacity of workshops involved in orthosis production and the knowledge level of technicians, the manufacture of every type of orthosis may not be feasible in all centers. Similarly, procuring the required materials is not always possible. In Ege University Orthotics-Prosthetics Workshop, we initially used leather and metal in orthosis fabrication; subsequently, we began employing polyethylene commonly used in the footwear industry. The materials we used had a hardness of approximately 45-50 shore (Sh), suitable for fabricating orthoses with a thickness of 4-5 mm. With orthoses fabricated from materials with these properties, we achieved highly successful outcomes. Today, however, thermoplastic sheets with a hardness of approximately 65 Sh are used more commonly. This, unfortunately, tends to make an orthosis that is intended to be semi-rigid or flexible become more rigid. Consequently, the expected biomechanical benefit of the orthosis is reduced.

The most common use of spinal orthoses is the conservative treatment of scoliosis. In scoliosis management, the primary goal is to prevent curve progression. Winter et al.[9] stated that "the purpose of bracing is to keep small curves from getting bigger, not to make big curves smaller". Typically, curves of 20-40° constitute an indication to initiate orthotic treatment[1,10-12]. Another indication relates to the rate of progression; an increase of 5° over 3-6 months is also an indication to start bracing[13]. Severe thoracic lordosis is a contraindication to brace treatment. Before puberty, treatment should be reviewed every six months. During puberty, because spontaneous resolution is expected in infantile idiopathic curves, application of an orthosis may be deferred. In this period, follow-up every three months is appropriate. Although bracing is not directly effective in the childhood management of congenital spinal curves, it aims to gain time for surgery by helping the trunk remain upright and stable.

Spinal orthoses may also be used postoperatively in patients who have undergone surgery. They are employed to control compensatory curves, maintain stability, and reduce pain. In older or osteoporotic patients, particularly in kyphotic spinal pathologies, they are used to prevent pullout and failure of surgically placed screws.

Optimal brace wear is approximately 21 hours per day (range, 16-23 h/day, adjusted for age and tolerance); wearing the brace for fewer than 12 hours per day is ineffective[10]. Weaning should be gradual: after skeletal maturity, reduce daily wear time by about 2 hours every 3 months. A standing radiograph should be obtained with the brace in place. Thereafter, obtain radiographs every six months, both in-brace and out-of-brace. The difference in Cobb angle between the two should not exceed 3-4°; if it does, revert to the previous wear schedule.

Corrective forces are greater in the supine than in the upright position[5]. Therefore, nighttime wear of the brace is more commonly recommended. Patients who use a brace should always be prescribed an individualized exercise program. A well-designed home program will increase the success of bracing[14]. In particular, physiotherapeutic scoliosis-specific exercises such as the Schroth method, scientific exercise approach to scoliosis, Barcelona Scoliosis Physical Therapy School, the fixation, elongation, derotation method, functional ındividual therapy of scoliosis, and side-shift exercises should be recommended[15].

At the initiation of orthotic treatment, the patient's height and weight should be measured; these data are important for monitoring the course of treatment and for decisions regarding brace adjustment or replacement. Failure to gain more than 1 cm in height within six months is a criterion for discontinuing bracing[10]. Conversely, an increase of more than 5 cm is an important criterion for replacing the brace. Orthoses are also used in patients with diverse etiologies such as cerebral palsy, myelomeningocele, spinal muscular atrophy, and trauma. Neuromuscular deformities may be spastic or flaccid, and sensory deficits may be present. To prevent pressure necrosis, initial wear periods should be short, and the skin should be inspected very frequently.

When orthoses are used in conditions such as kyphosis and scoliosis, dynamic corrective orthoses should be selected. However, the use of corrective braces invariably entails various challenges. These challenges are borne first and foremost by the patient, and also by the family, the physician, the physical therapist, and the orthotist/prosthetist. The fabrication and fitting of a brace is an art. Weakness in any of these components reduces success and may even negate it. Accordingly, with the growing popularity of the three-dimensional (3D) concept in designs[16], 3D computer-aided design/computer-aided manufacturing (CAD/CAM) braces have recently been developed. The concept is not new. The Milwaukee brace already provides 3D control in the coronal, sagittal, and axial planes[2].

In our country, commercial concerns have led to a separation between those who fabricate braces and those who fit them. This has resulted in manufacturing based on digital measurements and probabilistic assumptions. In practice, fabricators produce the brace without seeing the patient, and fitters apply it to the patient without having observed its fabrication. However, the curve's response to treatment and its progression vary for each patient. Despite many years of clinical experience and approximately 10.000 orthotic applications, we cannot predict the outcome in advance. Although a correction of at least 50% is anticipated at the first fitting, a correction of 30% to 50% is considered adequate[17].

In cases with large curves, laterally applied forces have limited effect, whereas distraction forces are more effective. Conversely, in small curves, lateral forces are more effective. The site of application of lateral forces is crucial in practice. For correction of thoracic deformities, the force-transmitting pad should be positioned just below the apex, with placement adjusted according to curve magnitude. If, in pronounced curves, the pads are placed above the apex, the corrective effect of lateral forces diminishes and may even worsen the deformity.

While achieving correction, the orthosis should impose minimal restriction on pulmonary expansion. Orthoses are most often used in growing children. In these cases, particularly in younger age groups who cannot adequately communicate discomfort, circumferential application should be avoided (Figure 1). Excess pressure over the chest must be prevented, as it may lead to complications such as the development of new deformities and respiratory difficulties.

Another area of use for orthoses is in older and osteoporotic patients. In this group, varying results have been reported. In patients with osteoporotic vertebral fractures, the effects of rigid, flexible, and dynamic orthoses have been investigated, with no significant differences observed[18]. In patients with age-related postural hyperkyphosis, spinal orthoses used to address impaired balance and the increased risks of falls, new fractures, and pain have been reported to be effective[19]. In our clinic, we employ lumbosacral orthoses fabricated from polyethylene in a total contact design.

When an orthosis completely encircles the trunk, it forms a semi-rigid cylinder around the spine and torso. The abdominal contents are compressed. In the literature, the view that increased intra-abdominal pressure reduces spinal pressure is not strongly supported. It was reported (1964) that the use of an abdominal orthosis reduced lumbar intervertebral disc pressure by approximately 30%, although intra-abdominal pressure generally remained low, at most 6 kPa[20]. Orthoses affect all structures in the region to which they are applied, and they may therefore cause unintended adverse effects. Potential issues that warrant attention include muscle weakening, loss of body water (dehydration), skin injury under pads due to increased pressure, and declines in renal function[21,22].

Over more than thirty years of clinical practice, we have followed over 10.000 patients with scoliosis managed conservatively with bracing, for whom long-term outcomes have not been reported. In the study we conducted between 1989 and 1995, we evaluated a total of 206 patients: 48 treated with the Milwaukee brace and 158 with the Boston brace. In our series, braces were worn a mean of 21 hours per day, and the mean follow-up duration was 38 months. At the end of follow-up, curve progression was absent at completion of treatment in 88 patients; progression was <5° in 50 patients and >5° in 11 patients. Fifty-seven patients were excluded due to loss to follow-up. At baseline, the Cobb angle was 30.12° (14°-57°), the Risser stage was 1.73 (0-5), and rotation was 1.85° (0°-4°). Of the patients, 126 were female and 80 were male, and the mean age was 12.2 years (3-20 years). At the last follow-up after treatment, the mean improvement in Cobb angle was 33%.

In this review, we aimed to introduce the orthoses that we frequently fabricate and apply in our clinic for spinal pathologies and to share our long-standing experience, practical insights into their application, and, perhaps most importantly, the conclusions we have drawn.

Boston Brace Thoracolumbosacral Orthosis (TLSO)

Boston brace TLSO is among the most important orthoses reported to be successful in the treatment of scoliosis[3,4,14,21]. Developed in 1972 by Bill Miller, certified prosthetist-orthotist, and John Hall, MD, at Boston Children's Hospital. The original brace was produced by adapting six prefabricated molds to the patient[10]. It is applied by repositioning the pads according to patient-specific needs. Based on my experience, in 1992 I had the opportunity to discuss with John Hall, MD, the method of application of the brace. In our clinical experience, I consider braces fabricated after taking a patient-specific cast, which is

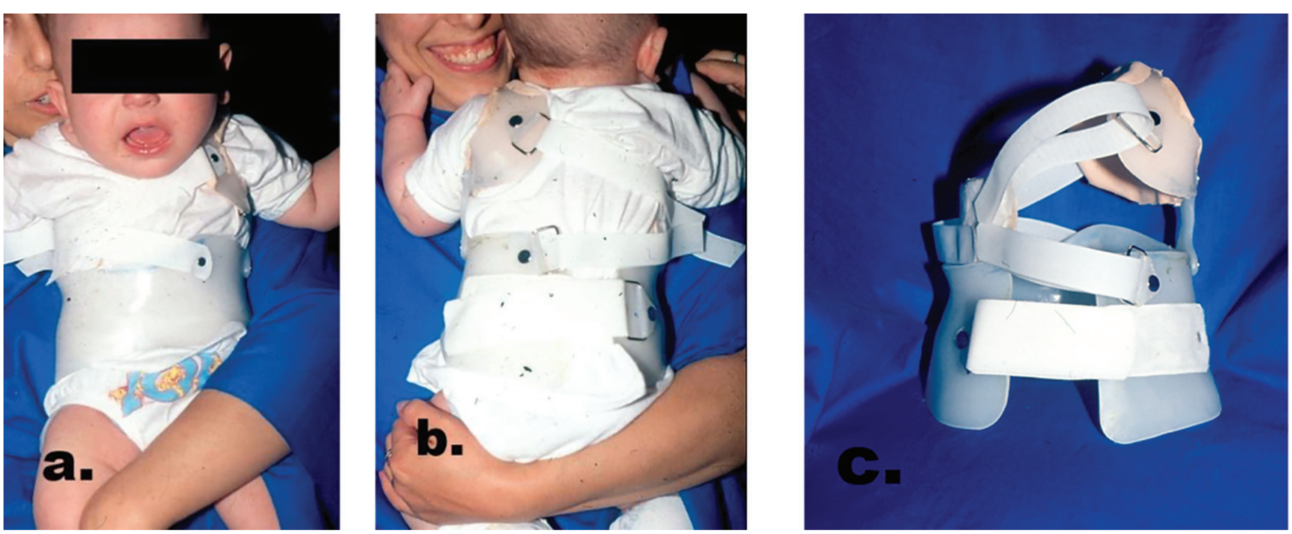

Figure 1. TLSO used in children. Because of the risk of complications, circumferential designs should be avoided in younger children. **a)** anterior view; **b)** posterior view; **c)** lateral view. TLSO: Thoracolumbosacral orthosis

the general rule[20], to be more successful. After discussing this view with John Hall (International Society for Prosthetics and Orthotics, 1992), we began producing in the Ege University Faculty of Medicine workshop a design similar to a modified Boston brace that is fabricated on a cast. In line with this approach, the 2003 manual of Boston Brace International also modified the brace by increasing the number of prefabricated molds, consistent with our view (Figure 2)[14]. Likewise, Jones and Uustal[20] in their 2024 guideline on the use, fabrication, and principles of spinal orthoses, made statements aligned with our approach.

The same orthosis design has been used for 32 years. The orthosis is indicated for deformities with an apex at or below the eighth thoracic vertebra (T8)[22]. It is lightweight, compact, and cosmetically acceptable, and its low cost is a major reason for preference. The orthosis is classified as semiflexible and dynamic. Casting technique plays a key role in fabrication. Plain radiographs should be reviewed carefully beforehand, with attention to torsion, thoracic kyphosis, and lumbar lordosis. During casting, the patient should be kept supine under traction, and the plaster should be allowed to harden after the necessary reductions have been achieved. The design should permit hip flexion up to 95°.

The presence of 15°-20° of lumbar lordosis is important for treatment. Although this degree of lordosis may negatively affect pelvic stability, the overall effect is more favorable. In this context, it has been suggested that lumbar flexibility is more effective in lateral (coronal) curves (Figure 3).

The Boston brace is particularly more effective in the treatment of lumbar spinal curves. If appropriate traction can be achieved during casting, there is no need for additional pads. This is a major advantage of the cast-fabricated modified Boston brace over the original prefabricated Boston brace system.

After the cast is removed, the patient's body should be checked for pressure points. In this method, a space is created from the outset on the concave side of the curve. Subsequently, new windows (fenestrations) should be carefully opened to avoid obstruction and to provide better rotational control. Orthoses should deliver maximum performance with minimum weight and surface area.

The Boston brace orthosis can stabilize the shoulder from one side to control rotation in the thoracic region. To achieve this, when necessary, the thoracic side that rotates anteriorly is reinforced by adding an aluminum rod to the plastic[23]. The opposite side is left free to allow passive correction[14]. Our primary reason for the widespread use of this orthosis is that the Boston brace is the most suitable device to meet all of these requirements. After the orthosis is fabricated, a standing plain radiograph must be obtained within 3 to 15 days for evaluation.

Milwaukee Brace [Cervicothoracolumbosacral Orthosis (CTLSO)]

Developed by Blount et al.[2] in 1946, the Milwaukee brace has been shown to be statistically successful in the treatment of spinal deformities. It includes a pelvic component, which was originally made of leather and was later replaced by thermoplastics. In our practice, we use polyethylene, which provides good moldability. During shaping, pressure-sensitive areas require relief; therefore, space should be left over the anterior superior iliac spines and beneath the costal margins. The anterior shell should extend to the xiphoid process. The brace has two posterior uprights and one anterior upright. These were initially made of iron; we now fabricate them from aluminum bars. We also employ high-density polyethylene uprights, which can be easily formed with a heat gun; their elasticity enhances the dynamic effects of the brace. All three

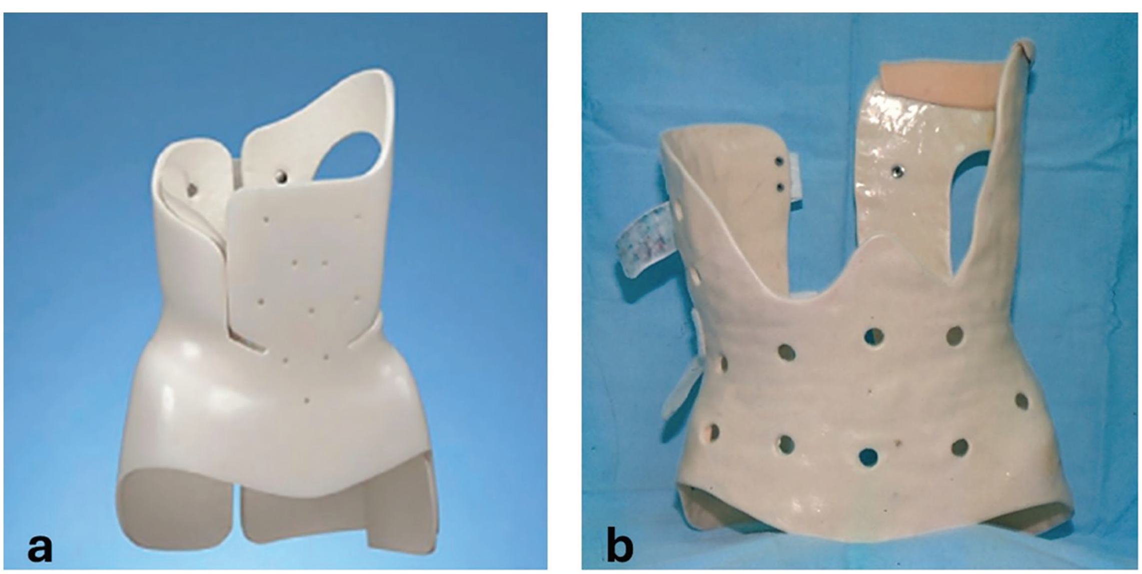

Figure 2. a) Original Boston Brace manufactured using prefabricated molds[23], **b)** Modified Boston Brace fabricated on a patient-specific cast

vertical bars attach to the neck ring and continue to form two occipital pads and one anterior mandibular pad. The vertical bars must be aligned precisely with the pelvic component and the neck ring. Occipital supports permit the application of axial forces through muscle contractions.

Milwaukee brace can be used for all types of spinal deformity (Figure 4). However, it is less preferred in children under three years of age and in curves whose apex lies below the seventh thoracic vertebra (T7), because application is more difficult in these settings. Although it can be effective for more proximal curves such as T2-T3, practical difficulties may arise. For braces fabricated for curves at these levels, the axillary pad is critical. This pad determines the position of the neck ring and applies a superiorly directed force, which may cause discomfort. It can also lead to arm swelling or neurologic symptoms. Because its use is technically demanding, both the prescribing physician and the orthotist/prosthetist who fabricates the brace should be experienced in this technique[24].

The Milwaukee brace can be used in kyphotic deformities with a high apex. It is employed to arrest progression and reduce pain, particularly in kyphoses of about 50° and in Scheuermann kyphosis. For this purpose, a dorsal pad is placed at the same level as the apex. If the pectoral muscles are tight, pads may also be applied to these areas. The pelvic band should be positioned according to the degree of lumbar lordosis.

Although the Milwaukee brace used in the treatment of kyphosis is effective, its use is challenging with respect to comfort and cosmetic acceptability. The brace can place families and children

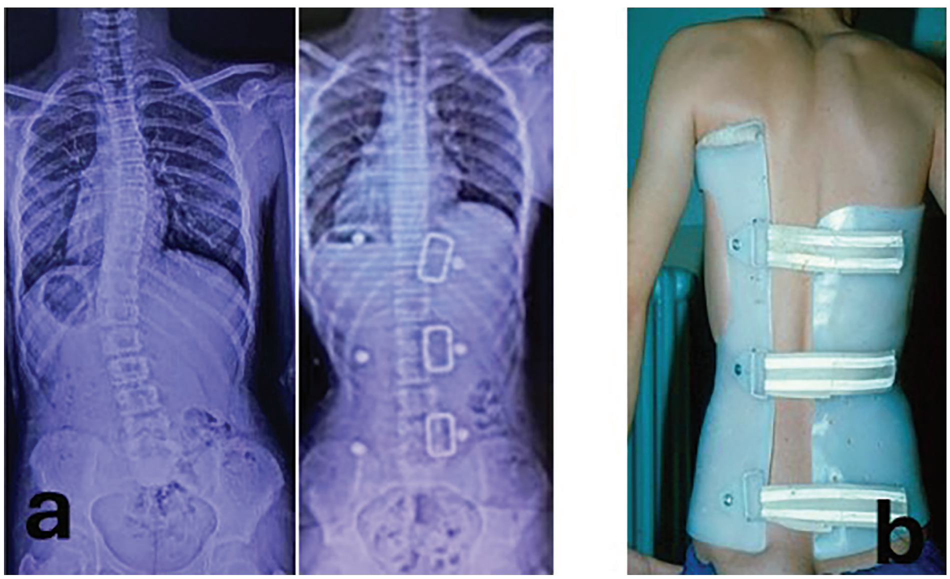

Figure 3. a) Correction achieved with the Boston Brace in a lateral spinal curve; standing radiographs in-brace and out-of-brace, **b)** Lateral deviation of the trunk (thorax) in a patient wearing a Boston Brace

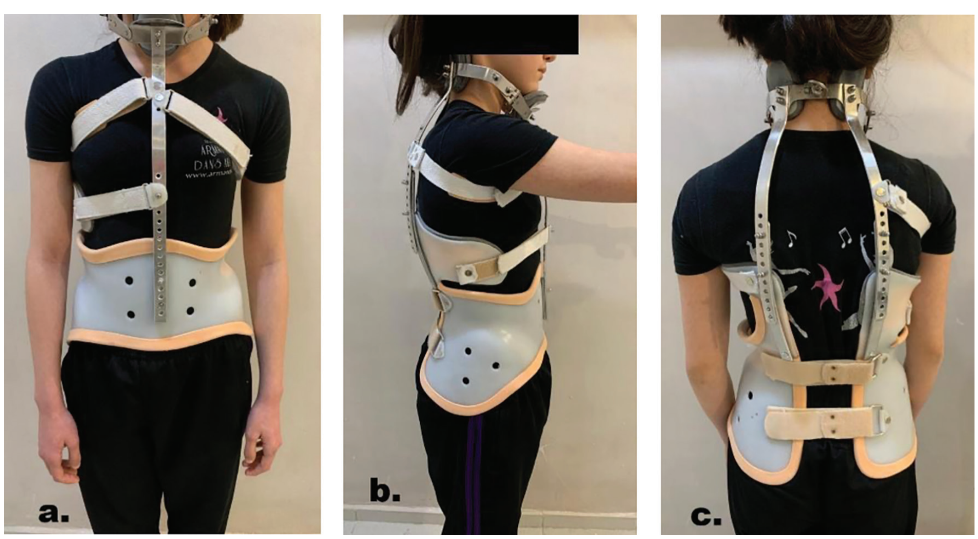

Figure 4. Milwaukee brace (CTLSO) with bilateral straps centering the neck ring; **a)** anterior view; **b)** lateral view; **c)** posterior view. CTLSO: Cervicothoracolumbosacral orthosis

in a difficult process. For this reason, it may be modified to extend only to the axillary level. The modified Milwaukee brace includes one sternal pad and two dorsal supports. The pelvic band is adjusted according to the degree of lumbar lordosis. The sternal pad is secured bilaterally to the posterior supports with hook-and-loop straps (Figure 5).

Jewett TLSO

Used solely to control spinal flexion. It has no controlling effect on lateral bending or rotational motion. Although not directly recommended for vertebral fractures, it may be used in mild to moderate compression fractures with minimal pain, particularly T6-L1. In such cases, it helps prevent kyphosis and maintain reduction. However, using it as a primary corrective orthosis may increase or prolong pain. It should not be used in unstable fractures. Likewise, it is not effective in the treatment of kyphosis or scoliosis[25].

Charleston Bending Brace (TLSO)

A nighttime-only TLSO used for the treatment of scoliosis. It employs overbending to the contralateral side of the curve. The biomechanical rationale follows the Hueter-Volkmann law, which states that increased mechanical pressure suppresses growth, whereas decreased pressure accelerates bone growth[26]. Although theoretically useful, treatment is challenging. Fabrication requires an experienced technician who can accurately interpret plain radiographs, and the workshop must have a special casting table to obtain optimal molds. Because the brace exerts high localized pressures, meticulous skin care is necessary to prevent pressure ulcers. Weaning is relatively short. In our clinic, we applied the Charleston brace to three patients. Two discontinued the brace due to complaints and were switched to a Boston brace; the third patient was lost to follow-up.

TLSO

Used in the conservative or postoperative management of spinal fractures (Figure 6)[27]. In the treatment of vertebral fractures, TLSOs have been shown to be effective, particularly for reducing pain and correcting kyphotic deformity[28]. When postoperative stabilization is desired, and especially when conservative treatment is planned, the TLSO should be custom-fabricated on a patient-specific cast. If conservative treatment is planned, fracture reduction during casting is critical; appropriate compression and traction should be applied during the procedure.

To avoid complications, physician supervision is required during casting, and orthotist-prosthetist technicians must be knowledgeable and experienced. The orthosis should be adjusted according to the fracture level. The distal portion must control the pelvis. The proximal portion should be higher for high-level and multiple fractures to provide rotational control. If necessary, it can be extended to the cervical region and used as a CTLSO.

Complications related to orthosis use can be serious. Frequent follow-up reduces risk. One should be vigilant for mesenteric syndrome, bowel perforation, and neurologic deficits, and reduction should be verified on plain radiographs. If needed, pads should be placed to maintain reduction. The orthosis should be open on both sides and secured with hook-and-loop

Figure 5. Modified Milwaukee brace (CTLSO). **a)** anterior view; **b)** lateral view; **c)** posterior view.
CTLSO: Cervicothoracolumbosacral orthosis

straps. While the patient is supine, the anterior shell may be removed in a controlled manner.

Full-time wear for approximately three months is recommended, followed by part-time wear during high-risk activities. In postoperative cases, wear for 1.5 to 2 months is advised. In neuromuscular patients, because active muscle contraction is lacking, this type of orthosis should be preferred over dynamic orthoses.

Lyon (Stagnara) Brace (TLSO)

This orthosis, which we have used only in a limited number of cases in our clinic, was employed successfully in Germany and across Europe in the 1940s. However, because of its metal components, hinges, and locks, complexities arise in both fabrication and use. The procurement and quality of these parts may also pose problems.

The Lyon (Stagnara) brace is a dynamic yet rigid orthosis. It opens anteriorly. To achieve rotational control, it stabilizes both pectoral regions . For this reason, its impact on pulmonary function is greater than that of the Boston brace[23].

Lumbosacral Orthosis (LSO)

Used for lumbar-level pathologies such as scoliosis, spondylosis, and spondylolisthesis. The orthosis should conform closely to the pelvis. It is a semi-rigid orthosis fabricated from thermoplastic materials.

Lumbosacral Corset with Steel Stays (LSO)

Made of fabric and classified as flexible. It minimally restricts lumbar spinal motion. Its prefabricated design makes it cost-effective. Used in conditions such as osteoarthritis. It increases intra-abdominal pressure, thereby enhancing stability.

Cervical Orthosis (CO)

Soft type: Made of foam or Plastazote. It is easy to use, provides warmth, and mildly restricts cervical motion. By maintaining warmth, it is used to relieve muscle spasm and reduce pain[29].

Rigid type: Made of 1 mm polyethylene. When occipital and mandibular extensions are present, it restricts cervical motion, providing partial control particularly of flexion and extension. It has no effect on rotation, lateral bending, or axial movements.

Philadelphia Collar (CO)

It consists of two pieces and is made of Plastazote. It is effective for pathologies from C6 to T2. It restricts flexion and extension by approximately 60-65%. Control of lateral bending is limited, and rotation can be controlled only to about 50%. Because it retains warmth around the neck, it may cause sweating and skin ulceration. It is lightweight.

Four-post Collar (CTO)

A rigid, conventional orthosis. It controls flexion, extension, and rotation at various levels of the cervical spine. The four uprights that stabilize the head via the cervical spine are height-adjustable (Figure 7). Consequently, it is generally well tolerated. It reduces lateral bending by approximately 50%[30].

Dynamic Torticollis Orthosis (CTO)

It is custom-molded. The device consists of a head-controlling component and a trunk component, which are connected by a plastic rod (Figure 8). Because torticollis is a 3D deformity, correction must occur simultaneously in all three planes. Simple collars cannot accomplish this. The dynamic torticollis orthosis is distinctive in that it can act on all three planes at once.

Figure 6. TLSO used in the conservative treatment of vertebral fractures. **a)** anterior view; **b)** lateral view.
TLSO: Thoracolumbosacral orthosis

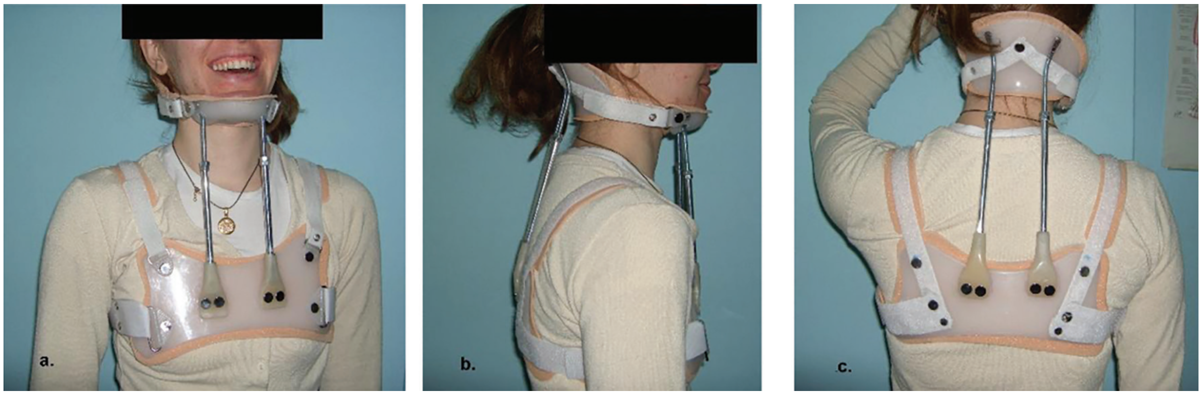

Figure 7. Four-post collar. **a)** anterior view; **b)** lateral view; **c)** posterior view

Figure 8. Dynamic torticollis orthosis. The amount of correction at the cervical level can be adjusted. **a)** anterior view without the orthosis; **b)** anterior view with the orthosis; **c)** lateral view with the orthosis

It can be used conservatively and postoperatively. To enhance the effectiveness of the cranial component, the hair should be kept short. Although it can be applied at any age, control of the head piece is difficult in very young children; in such cases, application should be deferred.

Halo-thoracic Orthosis (CTO)

A metal or carbon-epoxy ring that encircles the head circumferentially and is secured with pins, connected by rods to a thoracic orthosis. It is used postoperatively after surgery for cervical spine fractures. Application requires a surgeon, an orthotics team, and appropriate equipment. The halo is fixed to the skull with four pins. After the thoracic brace is fitted, the head ring is connected to the thoracic section with four rods. Vigilance is required for infection at the halo and thoracic interfaces and for pressure necrosis. Most systems are prefabricated today; however, if a thoracic pathology coexists, the thoracic component should be custom-molded.

CONCLUSION

Bracing remains a cornerstone of conservative care for spinal deformities, with the primary goal of preventing curve progression and preserving function. Effectiveness depends on correct indications, individualized cast-based design and precise pad placement, close radiographic follow-up, and high adherence supported by physiotherapeutic scoliosis-specific exercises. In our practice, the Boston brace is preferred particularly for lumbar curves; the Milwaukee brace is reserved for high apex kyphosis, scoliosis and selected proximal thoracic curves; the Jewett orthosis is used for flexion control rather than correction; nighttime devices such as the Charleston brace are options for carefully selected single curves but have practical limitations; and custom TLSOs are valuable in fracture care. Material choice and fabrication technique matter, since overly rigid builds may diminish the intended biomechanical benefit, and circumferential designs in small children can compromise ventilation and comfort. Complications, including skin injury and deconditioning, must be anticipated and mitigated through multidisciplinary supervision. Drawing on more than three decades of institutional experience, including a cohort treated between 1989 and 1995, we find that outcomes vary with patient factors and craftsmanship, and that success relies on coordinated work among physicians, orthotists, therapists, patients, and families. Future studies should include prospective designs with standardized indications, objective wear monitoring, and direct comparisons of cast-based custom orthoses versus CAD/CAM approaches to refine best practice.

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Footnotes

Authorship Contributions

Surgical and Medical Practises: A.Ö., D.B., M.H.Ö., Concept: A.Ö., D.B., M.H.Ö., Design: A.Ö., D.B., M.H.Ö., Data Collection or Processing: A.Ö., D.B., M.H.Ö., Analysis or Interpretation: A.Ö., D.B., M.H.Ö., Literature Search: A.Ö., D.B., M.H.Ö., Writing: A.Ö., D.B., M.H.Ö.

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