BRACING FOR LOW BACK PAIN

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Key Points

- Proper orthotic prescription requires knowledge of the biomechanics of the thoracolumbar spine and general principles of bracing, including their indications and limitations.
- Spinal orthoses utilize the principle of three-point pressure control. The corrective component is typically and ideally located midway between the opposing forces.
- Spinal orthoses may be used as an adjunctive treatment for various conditions that can cause low back pain, including vertebral fractures, facet joint arthritis, degenerative intervertebral discs, scoliosis, neuromuscular disease, spinal cord injury, and myofascial and ligamentous injuries.
- Spinal orthotic prescriptions for uncomplicated low back pain should be discouraged.
- Prescription of a spinal orthotic should be made only after careful clinical assessment, including a detailed history and extensive physical examination. Ancillary testing helps the clinician to choose an orthotic that best meets the biomechanical demands of the lumbar spine disorder. Diagnostic imaging may not be needed in all cases.
- Prescription of spinal orthoses should be accompanied by specific activity restrictions to help ensure protection from injury progression.
- Lumbar spinal orthoses should be considered for short-term use as part of a comprehensive rehabilitation program; exceptions include spinal metastasis and severe cases of osteoporosis.
- When indicated, the patient may perform therapeutic exercises while wearing the orthosis. In certain cases, such as acute spondylolysis or acute compression fracture, the patient should not exercise even while wearing an orthosis until adequate healing is ensured.
- No lumbar orthosis provides absolute spinal immobilization. Rather, they partially limit spinal motion.
- Variations in body habitus (i.e., obesity) may render an appropriately selected orthosis ineffective.
- A poor response to bracing warrants a reevaluation of the diagnosis, treatment plan, and orthotic prescription.
- To prevent psychological dependence, patients should be weaned from their orthosis rapidly, when clinically appropriate.
- Like any prescriptive treatment, spinal orthotics involve the potential for abuse and noncompliance. The appropriateness of any prescribed orthosis may vary as the patient’s condition changes over time.

Illustrations by T. Cate Nguyen-Trate, M.D.
Long term use of lumbar orthoses should be discouraged in most cases secondary to potential adverse effects, including possible loss of strength of core body musculature, psychological dependence, and decreased spinal mobility.

Scientific literature has not conclusively demonstrated that lumbar supports significantly prevent low back injuries in the industrial population.

I. Goals of Spinal Orthotic Prescription
   A. Truncal support and control spine position by use of external forces.
   B. Restriction of gross spinal and segmental motion.
   C. Partial unloading of spinal segments (anterior vs. posterior).
   D. Stabilization of spine when soft tissues cannot adequately perform this function (i.e., fractures).
   E. Proprioceptive feedback and postural control.
   F. Reinforcement of proper body ergonomics.
   G. Warmth to underlying soft tissues.
   H. Compression or cushioning of paravertebral soft tissues by design.
   I. Apply corrective forces to abnormal curvatures.

II. Indications for Use of Spinal Orthotics
   A. Spondylolisthesis
   B. Spondylolysis with or without spinal instability
   C. Degenerative intervertebral disc, including herniation
   D. Rheumatic diseases
   E. Severe osteoporosis
   F. Vertebral compression fractures
   G. Chronic muscle weakness
   H. Pain that is not responsive to therapeutic exercise
   I. Scoliosis
   J. Spinal cord injury
   K. Neuromuscular disease

III. Principles of Orthotic Mechanism of Action
   A. Range of motion (ROM) is restricted by a 3-point pressure system that provides spinal support by means of opposing forces.
   B. Increases proprioception secondary to increased cutaneous input.
      1. Results in enhanced awareness of pelvis and spine and improved posture.
      2. Prevents motion into painful positions.
   C. Reflexive muscle relaxation through body heat containment by the orthosis.
   D. Soft-tissue swelling and edema control by compression of paravertebral soft tissues.
   E. Increased trunk support aids weak abdominal muscles and increases intraabdominal pressure (IAP), thus mechanically unloading the intervertebral discs.
      1. Increased IAP reduces the tension on the posterior spinal muscles.
      2. Nachemson et al. found an inflatable corset to decrease intradiscal pressure by 25–30%.
   F. Improved posture; more balanced load distribution through lumbar spine and pelvis.
   H. Possible decrease in muscle strength and endurance with long term use (controversial).

IV. Types of Orthoses
   A. Flexible orthoses
      1. Lumbosacral Corsets (Fig. 1)
         a. Corsets are soft, flexible spinal orthoses constructed from fabric (e.g., can-
FIGURE 1. Added support is provided by anterior and/or vertical stays.

...vas, Neoprene, elastic) that encircle the lumbosacral or thoracolumbosacral trunk.

b. Added support is provided by addition of posterior rigid or semi-rigid vertical stays.

c. Corset closure and/or compression is achieved with buckles, Velcro, or laces.

d. The lumbar spine is restricted and supported by means of cylindrical pressure on the truncal soft tissues.

e. Functions to reduce spinal motion and provide benefit via proprioceptive feedback.

f. Truncal muscles weakened by disuse, paralysis, injury (blunt or surgical), or multiple pregnancies can be supported by a tightly fastened corset, thus reducing discomfort.

g. Lantz et al. found that a corset can limit spinal motion by as much as two-thirds.

h. For optimal control of the thoracolumbar spine, the corset should extend from the xiphoid process to the symphysis pubis anteriorly and from just below the scapula to the apex of the buttocks (men) or the gluteal crease (women) posteriorly.

i. For adequate support, the corset length should be at least 16 inches, with the posterior vertical stay running the entire length. The corset should fit snugly over the iliac crests and accommodate the contour of the buttocks.

j. Corsets are usually prefabricated in various sizes and designs.

2. Lumbar belts (Fig. 2)

a. Fabric or elastic lumbar support belts reduce repositioning error in patients with low back pain.

i. Enhanced cutaneous input results in improved proprioception and improved posture.

ii. Reduced trunk motion

b. Increase in intraabdominal pressure (IAP) is controversial. The majority of studies do not find it to be significantly affected by bracing. However, some
studies report fabric lumbar belts increase the IAP and may decrease the load on the spine by up to 50%.
c. A lumbar belt provides improved proprioception and increased stability of the trunk with decreased ROM. Rotation and side-bending can be limited by up to 60% and lumbar flexion by up to 40%.
d. Research has not strongly confirmed protection from injury or any enhanced lifting ability while wearing a lumbar belt.
e. Majority of literature has demonstrated that the use of lumbar supports and/or education has not resulted in reduced incidence of low back pain or sick time in industrial workers.
f. With acute injury, a lumbar belt support can facilitate traditional means of pain control (ice and medications), and the patient should be weaned in 2–4 days.
g. Indicated for low back pain associated with degenerative disc disorders and acute flexion injuries.

3. Sacroiliac joint (SIJ) belts (Fig. 3) and corsets (Fig. 4)
a. SIJ corsets are usually made of cloth with adjustable side laces or cinch down-straps and are of a low-profile, low-riding design.
b. SIJ belts are usually made of a nonstretch canvas, leather, or nylon cloth with a width of 2.5–3 inches and a cinch or Velcro closure.
c. SIJ corsets are contoured garments that should be worn snugly over the anatomic curves of the buttock and anterior pelvis.
d. SIJ belts are aligned directly superior to the greater trochanters for proper fit.
e. SIJ belts and corsets restrict motion through the sacrum and innominates through compression.

B. Rigid orthoses
1. Chairback brace (Fig. 5)
a. Consists of a short spinal brace made of a plastic or aluminum frame with an inferior pelvic and superior thoracic band joined by two midaxillary anterior abdominal upright supports, and two posterior parsplanar uprights.
b. Biomechanics are based on a 3-point pressure system.
c. Functions to control lumbosacral flexion/extension and some lateral motion.
   It immobilizes the lumbar spine in a neutral position.

2. **Knight brace** (Fig. 6)
   a. Similar to the chairback brace with increased rigidity from additional lateral supports that extend from the axilla to the greater trochanter.
   b. More effective restriction of lateral motion.
3. **Williams flexion brace** (Fig. 7)
   a. Consists of a pelvic band, abdominal apron, and oblique lateral uprights.
   b. Limits lumbosacral extension and lateral flexion but allows flexion.

4. **Taylor brace** (Fig. 8)
   a. Thoracolumbar orthosis (TLSO)
   b. Consists of a pelvic band with two posterior uprights joined by a short transverse bar that attach to the shoulders via axillary straps. Anteriorly, has abdominal support via apron or corset.
   c. Functions to restrict flexion and extension in the region of the thoracolumbar junction.
5. Knight-Taylor brace (Fig. 9)
   a. Combines the features of a Knight and Taylor brace.
   c. Provides flexion/extension and lateral flexion control.

6. Jewett hyperextension brace (Fig. 10)
   a. Consists of a lateral frame attached to sternal, suprapubic, and thoracolumbar pads.
   b. Provides flexion control while maintaining a hyperextended posture.
   c. Utilizes a 3-point system consisting of anteriorly directed forces from a pos-
terior thoracolumbar pad and posteriorly directed forces from sternal and suprapubic pads.

d. Hyperextension increases lumbar lordosis and stabilizes the spine through locking of the facet joints, thus restricting lateral and rotary movement.
e. Caution should be used when prescribing this orthosis in patients with spondylolysis or spondylolisthesis. If facet joint arthritis is present, even a properly adjusted Jewett brace may prove uncomfortable.

7. **Cruciform anterior spinal hyperextension brace** (CASH) (Fig. 11)
   a. Variation of the hyperextension brace with an anterior horizontal and vertical bars forming a large cross.

![Figure 9: Knight-Taylor brace.](image)

![Figure 10: Jewett hyperextension brace.](image)
b. The CASH brace is lighter than a Jewett brace and is usually easier to don and doff.
c. The CASH brace is better designed to accommodate large breasts and allows axillary pressure relief.
d. The CASH brace is not easily fitted for patients with large or protuberant abdomens.
8. **Custom-molded thoracolumbosacral orthosis (TLSO)** (Fig. 12)
   a. Custom-molded body jacket that controls flexion, extension, lateral and rotatory movement.
   b. Provides the highest degree of immobilization and control of all spinal orthoses.
   c. Fabricated in polypropylene from cast of the patient’s torso, thus providing a total-contact orthosis. Less intimate fitting, custom-measured, prefabricated orthoses are also available.
   d. Total-contact orthosis provides pressure distribution over a wide area, thus reducing the likelihood of localized pressure problems and skin ulceration.
   e. Lightweight, easier to clean, and relatively easy to don and doff, thus allowing for bathing and frequent skin inspection. Because of the simplicity of its design, with one molding and Velcro closures, a plastic TLSO is less likely to be adjusted or modified by the patient.
   f. A polypropylene TLSO can be uncomfortable in hot and humid conditions.
   g. A custom-molded TLSO increases the intracavitary pressure, thus decreasing the load on the intervertebral disc. It also provides a rigid cylinder, restricting motion at painful segments.
   h. Indicated for the treatment of spinal fractures or low back fusions. Allows for early mobilization and rehabilitation.

9. **Raney jacket** (Fig. 13)
   a. Custom-fitted, 2-piece acrylic lumbosacral orthosis that holds the lumbar spine in slight flexion and posterior pelvic tilt, potentially increasing interforaminal space and limiting spine extension.
   b. Side-lacing system joining anterior and posterior shells provides adjustable fit with slight weight fluctuations. Closed, foam-padded shells cushion bony prominences of spine.
   c. Lower profile than full-size thoracolumbosacral orthosis and therefore most appropriate for lower lumbar pathology.
   d. Must be custom-fitted by certified orthotist.

**FIGURE 13.** Raney jacket.
10. **Pneumatic decompression brace**
   a. Custom fit, low profile, adjustable pneumatic vest with anterior/posterior channels and adjustable lumbar support.
   b. Provides lumbar support and decompression. May offload 30%–50% of body weight from the lumbar spine onto the iliac crests.
   c. Indicated for mechanical low back pain with/without radicular pain, such as intervertebral disc disorders (discogenic pain), facet syndrome, foraminal stenosis and stable spondylolisthesis.
   d. Use multiple times daily (20–30 minutes/TID) as needed for relief or during functional activity. Avoid full time use.

V. **Specific Treatment Plans**

A. **Spondylolisthesis**

1. Treatment goals
   a. Maintain alignment of the fracture segments.
   b. Facilitate healing of the acute injury.

2. Proposed orthotic mechanism of action (MOA)
   a. Unload the posterior elements.
   b. Restrict motion between the fracture segments.

3. Preferred orthosis—rigid orthosis in 0° of flexion (listed below in order of preference)
   a. Boston overlap brace—provides excellent unloading, restriction of range of motion, and is extremely lightweight. May be uncomfortable if fit is not intimate and/or used in hot and humid conditions.
   b. Raney jacket—reduces lumbar lordosis and holds the patient in posterior pelvic tilt. Thus, limiting lumbar extension and unloading posterior elements.
   c. Williams flexion brace—provides good limitation of lumbar extension.
   d. Chairback orthosis—provides good control of lumbosacral motion in the planes of extension and side-bending. It is heavier, less comfortable, and more difficult to fit.

4. Duration of treatment
   a. 3 to 6 months; brace should be worn at all times (may be removed for short periods with restricted activity, as for personal hygiene).
   b. Duration depends on degree of symptoms/pain and compliance with activity restriction. May discontinue after this time if asymptomatic and repeat bone scan with SPECT is negative.
   c. Some studies have shown controversial results: patients braced early did better than asymptomatic patients treated with activity restriction, relative rest, and no bracing.

5. Considerations
   a. If a bone scan reveals no increased activity at the fracture site, potential for additional healing is remote.
   b. Follow-up imaging such as CT scan to see if there is bone remodeling at fracture site (vs. well corticated) or complete healing. Another consideration is bone scan with SPECT.
   c. May consider a less restrictive orthotic that still offers enough support to minimize pain so that rehabilitation can be advanced more efficiently.

B. **Spondylolisthesis**

1. Treatment goals
   a. Control and minimize pain.
b. Decrease translation between spinal segments if spondylolisthesis is unstable on bending radiographs.

2. Proposed orthotic MOA
   a. Restrict spinal motion through 3-point restraint principle.
   b. Antilordotic lumbosacral orthosis. May reduce shear stress at the involved segment.

3. Preferred orthosis
   a. Low-profile, molded lumbosacral orthosis-maximal motion control through total-contact; often less comfortable.
   b. Semirigid designs—more comfortable than total-contact designs but also less restriction of spinal motion.
   c. Chairback brace—good restriction of motion but difficult to achieve comfortable fit.

4. Duration of treatment
   a. If spondylolisthesis is symptomatic but not unstable, brace may be worn as pain dictates on as-needed basis.
   b. If spondylolisthesis is unstable and/or neurologic deficits are present, the orthosis should be worn during all waking hours.

5. Considerations
   a. Establish the direction of instability (increased translation) with bending films (flexion, extension, and side-bending) to establish anterolisthesis, retrolisthesis, or laterolisthesis.
   b. Brace to limit this motion.

C. Disc degeneration
   1. Treatment goal
      a. Decrease intradiscal pressure
      b. Improve posture and reduce spinal motion
   2. Proposed orthotic MOA
      a. Cylindrical compression of the abdomen to increase intraabdominal pressure.
      b. This proposed MOA remains quite controversial; extensive research both supports and denies this claim.
      c. Reduce stress/pressure on lumbar disc.
   3. Preferred orthosis
      a. Soft corset (i.e., cloth, elastic, neoprene)
      b. Pneumatic lumbar vest—provides support and decompression
   4. Duration of treatment
      a. Indeterminate time
      b. Use on as-needed basis depending on symptom severity, activity level and aggravating factors

D. Myofascial pain and muscular strain
   1. Treatment goals
      a. Reduce pain and increase/maintain mobility, reduce deconditioning secondary to inactivity.
      b. Decrease muscle tension and spasm.
      c. Control edema if present.
   2. Proposed orthotic MOA
      a. Decrease muscle spindle and Golgi tendon organ activity through compression, warmth, and proprioceptive feedback.
      b. Mild compression of soft tissues to decrease edema of strained paravertebral musculature.
3. Preferred orthosis
   a. Neoprene or elastic low-profile corset without stays or inserts.
   b. Lumbar belt
4. Duration of treatment
   a. On as-needed basis, usually limited to the acute pain phase (usually 1–2 weeks).
   b. When pain complaints decrease enough to resume daily activities, wean use of the orthosis promptly.
5. Considerations
   a. Orthotic prescription is generally discouraged for simple injuries.
   b. Short term use may be indicated in some instances for treatment goals listed above.
   c. Patient should begin exercises as soon as pain allows even while wearing orthosis.
E. Sacroiliac joint dysfunction
1. Treatment goal
   a. Restrict motion between the sacrum and the innominate and at the pubic symphysis.
   b. Reduce pain
2. Proposed orthotic MOA
   a. Compression of the joints of the pelvic ring.
   b. Reduce motion
4. Duration of treatment
   a. On as-needed basis, particularly during acute pain period.
   b. During periods of ambulation and sitting.
   c. Supplemented and eventually replaced by a dynamic hip girdle musculature stabilization program as pain and healing allow.
5. Considerations
   a. Useful in conditions of connective-tissue disease, traumatic shear injuries, sacral ala or stress fractures, infections, or inflammatory sacroiliitis.
   b. Suboptimal outcome may result from improperly fitted orthosis. SIJ belts should be fastened snugly just superior to the greater trochanter and level with the pubis.
F. Compression fractures
1. Treatment goals
   a. Initial pain control and allow for early mobilization
   b. Restrict motion at the fracture segment and at the segments immediately above and below.
   c. Unload the anterior column.
   d. May help reduce progression of kyphosis.
2. Proposed orthotic MOA
   a. Prevent flexion of thoracolumbar spine with a 3-point restraint system.
   b. Reduce/restrict load on anterior column.
3. Preferred orthosis
   a. Molded polypropylene TLSO, such as a bivalved total contact TLSO. With lower lumbar involvement, consider the addition of a unilateral thigh cuff and lockable hip joint to improve control of flexion in the lower lumbar segments.
   b. Hyperextension orthosis, such as a Jewett or CASH brace, may restrict mo-
tion equally well and be more comfortable for treatment of thoracolumbar fractures.

c. Addition of a cervical extension (CTLSO) is useful in cases of upper thoracic injuries (T1-T6).

4. Duration of treatment
   a. Average 6-12 weeks, as pain requires (may be up to 4 months).
   b. With severe osteoporosis, may need to extend the spinal immobilization for several additional months.

5. Considerations
   a. Indicated—anteri or column fracture with intact posterior column and no neurological deficits.
   b. Compression fractures with loss of 40% or more vertebral body height are potentially more unstable and warrant more extensive orthotic management.
   c. May experience activity limitations for up to 1 year and some discomfort for up to 2 years. Nonoperative treatment with bracing usually has similar functional outcome to surgically treated patients after 2 years.

G. Osteoporosis
   1. Treatment goals
      a. Reduce incidence of compression fractures
      b. Reduce severity of compression fractures
   2. Proposed orthotic MOA
      a. Unload anterior spine with use of hyperextension orthoses
      b. Reduce/restrict flexion of thoracolumbar spine
   3. Preferred orthosis.
      a. CASH brace
      b. Posture Training Support orthosis

H. Lumbar facet-related pain
   1. Treatment goals
      a. Unload posterior elements
      b. Restrict motion of painful facet joints
   2. Proposed orthotic MOA
      a. Limit spine extension from either a slightly flexed or neutral position.
      b. Unload posterior elements
   3. Preferred orthosis
      a. Soft corset orthosis with either posterior steel stays or molded plastic insert posteriorly
      b. Pneumatic decompression brace (chronic cases only)
   4. Duration of treatment
      a. Orthosis is to be worn while standing and bending during acute phase only.
      b. Generally 2-3 weeks
   5. Considerations
      a. More recalcitrant posterior element pain may require more extensive bracing (such as a pneumatic decompression brace, chairback or semirigid orthosis set in neutral or slight flexion).

I. Pregnancy
   1. Treatment goals—accommodate skeletal changes associated with pregnancy.
      a. Increased lumbar lordosis.
      b. Elongated and weakened abdominal musculature.
      c. Ligamentous laxity and hypermobility due to the effects of relaxin.
   2. Proposed orthotic MOA
a. Support a protuberant abdomen, thus reducing the strain of paraspinal and abdominal musculature.
b. Restrain motion of hypermobile joints

3. Preferred orthosis
   a. Low-profile cloth corset orthosis with steel posterior stays
   b. “Iwata Obi” – maternity wrap style support

4. Considerations
   a. Custom fabrication may be necessary in patients with recurrent low back pain and SIJ pathology.
   b. Do not attempt to encircle the protuberant abdomen.

J. Orthoses in the workplace
   1. Treatment goals
      a. Improve posture and body ergonomics during lifting and other functional activities.
      b. Reduce injuries and lost time from workplace.
   2. Proposed orthotic MOA
      a. Provide enhanced cutaneous input and proprioception to encourage decreased lumbar flexion and increased hip flexion during lifting activities. Certain movements may produce discomfort.
      b. Decreasing forward flexion encourages lifting closer to the trunk and center of gravity, thereby lessening load on the spine.
      c. Controversy exists regarding whether lumbar belts and corsets significantly increase IAP, provide support of the spine and alter intradiscal pressure.
   3. Preferred orthosis
      a. Heavy-duty, elastic lumbar corset with adjustable suspenders and Velcro closure.
      b. Lumbar belt of nonstretch material of at least 4 inches width and with either Velcro or buckle closure.
   4. Duration of treatment
      a. Some controversy exists. Some studies suggest that long term use has been associated with secondary deconditioning, while others have demonstrated no significant decrease of trunk strength and endurance.
      b. Consider intermittent limited duration of use when possible. Consider core body strengthening exercises if prolonged use is anticipated.
   5. Considerations
      a. Scientific literature has not conclusively demonstrated that either education and/or lumbar supports significantly prevent low back injuries in the industrial population.
      b. The US Occupational Safety and Health Administration (OSHA) and the US National Institute for Occupational Safety and Health (NIOSH) do not consider back supports to be personal protective equipment for the prevention of low back injuries.

VI. Compliance and Wearing Guidelines
   A. Compliance
      1. Patient compliance is a significant variable in the success of any orthotic prescription.
      2. Issues of cosmesis, comfort, fit, and function should be addressed prior to orthotic prescription.
   B. Orthotic check-out
1. Check the orthosis to ensure that it is fabricated as prescribed and functions as desired.
2. Check the fit in sitting, standing, and lying positions.
3. For corsets with steel stays, confirm that the steel stays conform to the contour of the spine, buttocks, and pelvis.
4. For corsets with molded plastic inserts, confirm that the inserts are well molded, properly oriented, and seated in the pocket.
5. For rigid orthoses, confirm that the orthosis is well molded and set in the desired degree of flexion or extension.
6. Confirm that the rigid orthosis is not compressing the patient at pressure-intolerant locations such as the pubic symphysis, breasts, axilla, or groin (while seated).

C. Wearing schedule
1. A rigid orthosis should be worn on the initial fitting for 20–30 minutes and then evaluated by the physician for areas of undue pressure, as evidenced by persistent redness of skin after removal of the orthosis.
2. Once a proper fit is ensured and regular wearing schedule initiated, the skin should be carefully inspected daily by the patient for areas of undue pressure.
3. Corset or soft-wrap orthoses are generally well tolerated in initial wearing periods and can be worn as long as tolerated.

D. Comfort concerns
1. Rigid orthoses can be fabricated with ventilation holes for wearing in warm or humid conditions.
2. Foam padding or liner can be added to a rigid orthosis to protect bony prominences and increase comfort.
3. Wearing a cotton T-shirt or thin tube-top beneath an orthosis can help to absorb perspiration.
4. Talc or antifungal powder also helps to absorb perspiration and reduces the likelihood of developing a fungal infection.

E. Adverse effects of prolonged bracing
1. Controversy still exists about whether more prolonged orthotic wearing may weaken musculature and contribute to inactivity-related osteoporosis.
2. Psychological dependence
   a. Prescribing an orthosis without appropriate explanation and justification may lead the patient to believe that a relatively minor condition is very serious and cause psychological dependence on the orthosis.
   b. The patient should be given an estimated duration of use rather than linking use to level of discomfort.
   c. When the orthosis is no longer required, a weaning schedule should be developed.
3. Posttreatment flexibility deficits—in an effort to immobilize certain vertebral segments, prolonged spinal orthotic prescription may cause shortening of the overlying myoligamentous structures with resultant capsular and soft-tissue contractures.

References
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