Conservative Management of Posttraumatic Cervical Intersegmental Hypermobility and Anterior Subluxation

David J. BenEliyahu, D.C.*

ABSTRACT

Objective: To discuss the case of a young male football player who sustained a hyperflexion cervical injury, including radiographic evidence of intersegmental hypermobility and translational displacement with cervical hypolordosis and anterior subluxation.

Clinical Features: The patient suffered from neck pain, spasm, limited range of motion and mild sclerogenous referred arm pain. The results of neurological exams were normal. Radiographs of the cervical spine revealed cervical hypolordosis, intersegmental hypermobility and anterior subluxation. MRI was normal, with no evidence of disk herniation.

Intervention and Outcome: The patient was immobilized for the first 10 days with a cervical collar and was administered adjunctive physiotherapy. Light cervical manipulative techniques were added in the subacute stage, as were isometric and tubing exercises. The patient responded quickly and favorably to care. Subsequent radiographs revealed a reversal and resolution of the abnormal findings of the cervical hypolordosis, anterior subluxation and intersegmental hypermobility that were initially seen.

Conclusion: Conservative chiropractic management of hyperflexion injuries may be useful in reducing clinical symptoms, cervical hypolordosis, anterior subluxation and intersegmental hypermobility, as seen in follow-up radiographs. Chiropractic sports physicians have the diagnostic and therapeutic expertise to manage these types of athletic injuries. (J Manipulative Physiol Ther 1995; 18:315–21).

Key Indexing Terms: Cervical Vertebrae; Trauma; Manipulation, Chiropractic; Sports Medicine; Joint Instability.

INTRODUCTION

Cervical spine injury in athletes engaged in contact sports is a common finding in a sports medicine practice. It is common in such hyperflexion injuries to find radiographic evidence of ligamentous injury to the posterior ligamentous complex. Typically, management has consisted of immobilization, medication, rest and physiotherapy. This paper discusses the use of a short period of immobilization, then cervical manipulation with adjunctive physiotherapy and neck exercises in reducing the anterior subluxation, horizontal translation and angular rotation that are seen in stress flexion/extension radiographs. Informed consent was obtained to discuss this case.

CASE REPORT

A 16-yr-old high school football player with no prior history of neck pain or trauma hyperflexed his neck on a tackle as he hit the ground. As he walked off the field after the play, he felt neck pain, stiffness, headache, limited range of motion, dizziness and interscapular pain. He experienced no immediate radiation of pain into his upper extremities. Because of progressive stiffness and despite normal neurological findings, he was not permitted to return to play. Later the same day the patient was examined and X-rayed. Physical examination revealed reduced cervical range of motion, moderate cervical paraspinal spasm, normal pupillary light reflex and mild weakness of the deltoids and wrist extensors (probably attributable to pain as opposed to neurologic injury, because the neurologic exam was normal). Deep tendon reflexes and sensory exam were normal. There was no tuning fork pain-provocation over any of the cervical spinous or transverse processes. There was mild palpable spinnous process pain at the midcervical spine with muscle tenderness at the interscapular area.

The results of a cervical MRI were normal. Radiographic evaluation of the cervical spine included AP, oblique, pillar and flexion-extension stress views. The lateral cervical film displayed a loss of lordosis with normal atlantoaxial interspace and anterolisthesis of C2/C3 and C3/C4. After inspection of the lateral view, which revealed no evidence of fracture or facet dislocation, flexion/extension stress views were obtained. Flexion/extension views have been suggested in the literature to be necessary adjunctive views once fracture, dislocation and neurological deficit have been ruled out (1–6). The lateral view displayed 4.0 mm of horizontal translation at C2/C3 and 3.5 mm of horizontal translation at C3/C4 (Figure 1). The extension stress view showed 5.0 mm of translation at C2/C3 and C3/C4 (Figure 2A). The flexion stress views showed 4.8 mm of translation at C2/C3 and 3.0 mm of translation at C3/C4 (Figure 2B, Table 1). Angulation of C3 in the stress view was measured at 17.0° (normal is up to 11.0°).
Measuring techniques were taken from the work of White et al. and are illustrated in Figure 3 (7–9). Translation measurements were not taken from full flexion to full extension in this patient.

Treatment in the acute stage consisted of immobilization with a soft collar, manual traction, physiotherapeutic modalities of ultrasound and high-voltage galvanism with cryotherapy every two hours (first 10 days). In the subacute stage, light supine cervical manipulation, range of motion and isometric exercises as well as theraband tubing exercises were employed. The patient was seen daily during this period of treatment. After three weeks, the patient was greatly improved and asymptomatic, except for mild stiffness. He then returned to light practice. After four weeks of care and exercises, the patient returned to competition. Before release to competitive football, repeat neutral and stress cervical radiographs were obtained as suggested by protocols in the literature for management of cases with anterior subluxation, loss of lordosis and vertebral misalignment (7, 9, 10). The repeat radiographs showed marked improvement in transitory displacement and intersegmental hypermobility, and the extension views showed a return to normal 4 wk after the injury. Radiographs at 8 wk, 6 months and 1 yr follow-up did not reveal any evidence of progressive degenerative changes, delayed onset instability or angular kyphosis as suggested in the literature as possible late complications (1–12). Subsequent radiographs revealed resolution of horizontal translatory displacement, angular rotation and loss of lordosis (Figure 4).
**Table 1.** Chronological measurements of translatory displacement and angulation, pre- and posttreatment

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<tr>
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<th>Translatory Displacement</th>
<th>Angulation</th>
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<td>9/91 10/91 11/91 4/92</td>
<td>17°</td>
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<tr>
<td>Neutral lateral view</td>
<td>C2/C3: 4.0 mm 2.5 mm 1.8 mm 0.3 mm</td>
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<td>C3/C4: 3.5 mm 2.0 mm 1.0 mm 0.5 mm</td>
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<td>Extension stress view</td>
<td>C2/C3: 5.0 mm 0 0 0</td>
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<td>C3/C4: 5.0 mm 0 0 0</td>
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<td>Flexion stress view</td>
<td>C2/C3: 4.8 mm 3.0 mm 4.8 mm 1.8 mm</td>
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<td>C3/C4: 3.0 mm 2.0 mm 3.0 mm 1.8 mm</td>
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**DISCUSSION**

Posttraumatic “anterior subluxation,” loss of lordosis or kyphosis and intersegmental injury of the cervical spine as a result of hyperextension injury has been profusely documented in the literature (1–18).

Anterior subluxation, by “medical” standards and definition, can be characterized by a loss of lordosis or a local acute kyphosis at the level of injury; anterior, translatory displacement of the subluxed vertebra; anterior narrowing and posterior widening of the disk space at the level involved; discontinuity of the articular facets; widening of the interspinous spaces or fanning of the spinous processes (1–18). Anterior subluxation represents injury and partial disruption of the “posterior ligament complex” (interspinous ligaments, capsular ligaments, supraspinous ligaments and ligamentum flavum). These findings may be exaggerated by stressing the cervical spine in flexion and extension. Before taking stress radiographs, one must exercise caution and first rule out the existence of cervical spine fracture, facet dislocation or neurological deficit. There is general agreement in the literature that dynamic stress studies in flexion/extension should be done after neurologic deficit, fracture/dislocation and significant myospasm restricting the range of motion have been ruled out (2, 3). Films should be taken in erect position; the supine position can hide significant findings (16).

Fig. 4 Posttreatment radiographs in neutral, showing reversal of the initial abnormal findings.

Yochum has described radiographic findings of soft tissue injury in cervical trauma that include: kyphotic reversal of the cervical curve (acute or arcual kyphosis), fanning of the spinous processes and anteroligamentosis with increased superior movement of the articular pillar in the flexion stress view (4). Yochum further states that radiological signs of ligamentous instability/hipermobility may be absent on neutral lateral views, necessitating flexion/extension stress views to demonstrate intersegmental ligamentous instability. Jaeger and Howe have made similar observations (5). Watkins and Dillin have also discussed the importance of flexion/extension X-rays subsequent to cervical trauma once fracture or dislocation is ruled out (6). They note that flexion views can often isolate hypermobile segments that are indicative of an acute ligamentous injury. They also agree with the criteria of White and Southwick for translation and angulation, as discussed earlier (7).

Colter has emphasized the importance of regular radiographic evaluation to diagnose occult delayed instability or progressive deficit (15). In this case, there were no neurological deficits, fractures or dislocations and the patient was assessed as having a stable cervical spine injury; therefore, stress views were obtained. If doubt exists, it is best to delay stress views in flexion/extension and have the patient evaluated by a neurosurgeon or orthopedic spine surgeon. It is important to determine if the patient has a stable or unstable cervical spine injury. When fracture or dislocation is evident on neutral

Fig. 3 Radiographic criteria and technique to measure for signs of cervical ligamentous injury (7–9).
films it is obvious that the patient must be referred to a medical specialist for treatment. The situation above most likely represents clinical instability.

Spinal instability has been defined by Denis as a “three-column” spine concept: injury to the anterior, middle and posterior column is necessary to establish clinical instability (14). The anterior column consists of the anterior longitudinal ligament, anterior annulus, anterior vertebral body; the middle column is composed of the posterior longitudinal ligament, posterior annulus, posterior vertebral body and the posterior column consists of the posterior arch and ligaments. Biomechanic evidence suggests that injury to the posterior ligamentous complex is not by itself sufficient to establish clinical instability (3, 10, 14, 18). A stable injury is one in which the injured spine can withstand stress without progressive deformity or neurologic damage. An unstable injury is one that can lead to increased deformity or neurologic injury. Denis describes three subdivisions (14):

First Degree Instability: mechanical instability with risk of chronic kyphosis, posterior column disruption and compression fracture.

Second Degree Instability: neurological instability with vertebral burst fracture.

Third Degree Instability: mechanical and neurologic instability with fractures and dislocations.

White et al. define clinical instability as “the loss of ability of the spine under physiologic loads to maintain relationships between vertebrae in such a way that there is neither damage nor subsequent irritation to the spinal cord or nerve roots and no development of deformity with pain” (8). They proposed a point system and checklist for the diagnosis of clinical instability in the middle or lower cervical spine (7-9), (Table 2).

McGregor and Mior defined clinical instability as

the pathological state of motion at an intervertebral level in the cervical spine that results in clinically intolerable symptoms, as in cord or root damage, requiring prolonged bracing or surgery. Also involved are aberrations in neutral and/or flexion/extension X-rays such as greater than 3.5 mm translation or greater than 11° difference in vertebral angulation (19).

Bougé et al. discuss the controversy of clinical instability vs. a stable hyperflexion injury (20). They conclude that the White et al. criteria should be followed in defining clinical instability and that manipulation is contraindicated in such cases. In the case report, their patient had scored above 10 points on the Stability Checklist of White et al. (7-9), indicating cervical instability.

Controversy does exist in the literature regarding the differences between joint instability and hypermobility. Hubka & Hubka differentiated patients with lumbar instability from those with idiopathic hypermobility, defining joint hypermobility as stable articulations with excessive motion but without abnormal coupled or translational movement (21). Paris states that one can differentiate lumbar instability from hypermobility by visual inspection and palpation, watching for a “catch or slip” or angulation while the patient is moved through ranges of motion (22). Cybulski proposed that all three columns or divisions of the spine should be involved to be considered unstable; however, if only two columns are involved, with the coexistence of facet dislocations, angulation, translatory displacement or shear vertebral dislocation, then clinical instability exists (23). Harris classified acute cervical spine injuries into stable vs. unstable (17). Anterior subluxation is considered a stable cervical spine injury. Given the above criteria, the injury in this case report would be classified as a stable cervical spine injury because there were no fractures, no facet dislocations and involvement of only one of the three columns. This patient had an injury to only the posterior column, with partial disruption of the “posterior ligamentous complex,” causing the radiographic findings described: horizontal translatory displacement on neutral and stress X-rays greater than 3.5 mm, sagittal plane angulation greater than 11° on neutral and stress radiographs and interspinous space widening. In the White et al. point system, this injury would only score 4 points for its radiographic criteria, which would classify it as a stable injury. This patient did sustain an injury to his posterior ligament complex because his neutral cervical films did show anterior subluxation and a loss of lordosis, and dynamic stress X-rays showed increased horizontal translation and angular rotation (Figures 1 and 2). Radiographic criteria and measurement methods used were those of White et al. (7-9).

Radiographic criteria are also well established in the literature and include horizontal translatory displacement greater than 3.5 mm, angulation greater than 11°, 50% loss of facet parallelism, interspinous space widening with fissure fanning (1-3, 7-10, 12, 17) (Figure 3). To measure translatory displacement, a point is placed at the posterosuperior angle of the vertebral body below the interspace involved. A line is drawn along the upper end plate of the vertebra below the interspace of the level involved. At the point of intersection on the posterior portion of the end plate, a line perpendicular to the first is drawn. A mark is made at the posteroinferior angle of the vertebral body above the interspace evaluated. A line is drawn through the second mark and is perpendicular to the line across the end plate (Figure 3). This line or distance is mea-
sured and should be less than 3.5 mm. This criteria is also advocated by other authors (2-10).

White et al. suggest that normal limits of horizontal or sagittal translation are 3.5 mm above C4 and 2.5 mm below C4 in neutral, lateral and flexion stress X-rays (7-9). Sagittal plane angulation should not exceed 11° (7-9).

Radiographic interpretation of infants and children is different. A study of 115 children found that 40% of the children up to the age of 8 had hypermobility and anterior translatory displacement at C2/C3 (24). Many researchers have termed this phenomena “pseudosubluxation” (3, 7, 9, 12, 17, 22, 23). In a study of 500 children up to the age of 14, Swischuk found that physiologic and pathologic anterior displacement at C2/C3 could be determined by using a posterior cervical line connecting the posterior arches and spinous processes of C1, C2 and C3 (25). If the line passes through, touches or passes in front of the anterior cortex of the C2 arch by 1.0 mm or less, the physiologic displacement is normal. If the line passed 2.0 mm anterior, it was pathologic secondary to a hangman’s fracture of C2. He also found that 20 out of 22 children had C3/C4 pseudosubluxations associated with C2/C3 pseudosubluxations. The posterior cervical line applied to the patient’s flexion cervical X-ray found that the anterior cortex of C2 aligned with C1 and C3 within 1.0 mm.

The patient described in the present report, however, was a 16-yr-old at the time of injury; the work of Swischuk was on youths up to the age of 14 and the work of Cattell and Filtzer was on children up to the age of 16. However, Cattell and Filtzer’s work found pseudosubluxation of C2/C3 predominantly through the age of 10, with no anterior displacement of C2/C3 seen past the age of 14. Furthermore, the patient in this case also had interspinous space gaping with spinous process fanning, which was not evident in the pseudosubluxation work of Cattell and Filtzer and Swischuk. Interspinous widening is suggestive of injury according to Scher, Green et al., Yochum, White et al., Herkowitz & Rothman, Torg & Sennett and Fielding & Hawkins (2-4, 7-13).

Scher has characterized spinous process divergence as the most valuable radiographic sign of potential instability and cervical ligamentous injury (2). It was therefore my opinion that this 16-yr-old patient sustained a stable hyperflexion cervical injury resulting in “anterior subluxation,” loss of lordosis and ligamentous hypermobility and laxity allowing translatory movement on stress views. Cotler states that stable cervical spine injuries may be treated nonsurgically (15). There was no evidence of fracture, facet dislocation or neurologic deficit, and only posterior column was injured; the anterior and middle column were left intact. His injury would only score 4 points in the White et al. Stability Checklist, indicating a stable injury. However, “anterior subluxation” has been suggested by Scher, Green et al. and Cheshire to be potentially unstable because of the 20% chance of future delayed instability as a result of impaired ligamentous healing (2, 3, 11). Scher defines anterior subluxation as “anterior displacement of a vertebra in relation to the vertebra below when the two articular surfaces of the apophyseal joints remain in contact” (2). Anterior subluxation was attributable to injury of the posterior ligamentous complex, which was confirmed by surgical and pathologic studies (1). In Scher’s study, 25 asymptomatic control subjects with no history of neck pain or trauma were X-rayed in neutral and stress flexion/extension. No observations of spinous fanning, lack of facet parallelism or anterior vertebral displacement were seen (2). Webb et al. reported on three cases of anterior subluxation that, despite immobilization, resulted in delayed instability characterized by clinical instability associated with pain, delayed vertebral dislocation and progressive vertebral collapse (1). Cheshire reported that in a series of 257 cervical trauma cases, there was a 21% incidence of delayed instability (11).

Torg and Sennett found that anterior subluxation is often a result of axial-loading flexion injury in the cervical spine (12). In one of their cases, radiographs taken 5 months after the injury in a 16-yr-old male still showed significant displacement and angulation despite traction and immobilization. In another case they performed a surgical fusion noting interspinous ligament disruption at the level of injury. X-rays taken 5 months after the injury still showed persistent anterior subluxation and angulation. Scher reported that in his two cases, despite immobilization, there was increased vertebral malposition and delayed instability (2). Because of the 20% incidence of delayed instability, repeat X-rays at prescribed intervals have been suggested by White et al. and Herkowitz & Rothman (7-10). Herkowitz and Rothman suggest radiographic re-evaluation at three weeks, and White et al. suggest radiographic follow-up at 3 wk, 6 wk, 3 months, 6 months and 1 yr to detect delayed instability (7-9). Radiographic follow-up in this case report found not only no evidence of delayed instability but also a reversal of the translatory displacement, vertebral angulation and anterior subluxation at 6 months and 1 yr (Figure 4).

Cervical spine manipulation was employed in the subacute and chronic stages of this injury after the initial ten days of immobilization, physiotherapy and cryotherapy. Because this was not a case of clinical instability and the injury was a stable one with no fracture, dislocation or neurologic deficit, light manipulation was employed. Closed reduction manipulation under anesthesia has been shown in the literature to be efficacious in cases of clinical instability with unilateral facet and subluxation (7-9, 11, 26, 27). Manipulation of the cervical spine has been shown to be effective in cervical pain syndromes as well (28-40).

In a study by Thabe, cervical spine manipulation reduced abnormal electromyographic findings as measured by postmanipulative electromyography (28). Another study by Capria found that abnormal somatosensory evoked potentials reverted to normal after cervical manipulation (33). Other studies using range of motion and pressure algometry as outcome tools found manipulation effective in reducing cervical spine dysfunction (32, 34, 35, 37-39). In this case, manipulative techniques were not used in the acute stage; only immobilization and physiotherapy was delivered. Manipulation was added in the subacute stage; at 3 wk, the repeat radiographs revealed a reversal in the loss of lordosis and anterior sagittal displace-
ment. Prolonged immobilization may have detrimental effects and prolong a disability, so there is an increased trend toward early mobilization to enhance recovery (42). A double blind study revealed that patients mobilized early without the prolonged use of a collar had greater reduction in pain and increased cervical ranges of motion (36, 42).

Although speculative, it is hypothetically possible that the mechanical stimulation of the ligaments during a manipulative adjustment to the cervical spine causes a histological change with fibroblastic hyperplasia. This has been seen in a technique called prolotherapy, ligament injections that cause hypertrophy of the ligament (41). Greenman suggests that cervical manipulation influences mechanoreceptors, causing an afferent reflex arc to reduce hypertonicity in segmentally associated paraspinous muscles (43). This would then enhance articular mobility. He suggests that manipulation may possibly release a C-fiber, innervated, intra-articular meniscoid, enhancing mobility and reducing pain (43). With enhanced mobility and joint function it is possible for adequate nutritional diffusion to reach the articular cartilage; with enhanced biomechanics comes enhanced joint articular neurology. Although it is possible that the results seen in this case may have occurred spontaneously with rest only, the case reports of Webb et al., Scher and Torg & Sennett suggest otherwise; X-ray follow-up of their cases showed poor healing (1, 2, 12). Scher specifically reported on cases of anterior subluxation that resulted in delayed instability despite initial immobilization (2). Manipulative therapy may help to increase ligament strength, reduce cervical pathomechanics and inhibit plastic and elastic deformation of the cervical ligaments, resulting in rapid clinical and radiographic results. Fibroblasts can align in a controlled matrix after injury with the introduction of motion (40). This allows optimal healing of soft tissue. I did not feel that the radiographic findings at C2/C3 and C3/C4 were that of “pseudosubluxation” as suggested by Cattell & Filtzer and Swischuk, because of the age of this patient and the rapid resolution of the translational displacement and vertebral angulation seen on neutral and stress cervical X-rays in both short- and long-term follow-ups.

This case report demonstrates that chiropractic management and judicious use of manipulative therapy in conjunction with immobilization, physotherapy and exercise were successful in reducing a case of anterior subluxation, loss of cervical lordosis and intersegmental hypermobility (Figure 5). One must exercise caution in drawing broad conclusions from this paper because it is a case report and each patient must be carefully assessed for clinical stability vs. instability. Perhaps a larger, case-controlled series could be launched to determine short- and long-term effects and benefits of manipulative therapy for this type of injury. Cases that are deemed stable should not preclude the use of cervical manipulation; however, in cases of clinical instability as defined earlier, manipulation would be contraindicated (20).

CONCLUSION

This case reveals that cervical manipulation, in conjunction with conservative methods of immobilization, physotherapy and cervical isometric and tubing exercises, can be beneficial in reducing anterior subluxation, intersegmental ligamentous hypermobility and loss of cervical lordosis. In the absence of neurologic deficits, fracture, facet dislocation or cervical spine clinical instability, manipulative therapy was not contraindicated. Conservative chiropractic care, including manipulation in the subacute/chronic stages, may enhance healing, rate of return to athletic competition and inhibition of late complications such as progressive delayed clinical instability with degenerative changes.

ACKNOWLEDGMENTS

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REFERENCES

OPTOELECTRIC MEASUREMENT OF CHANGES OF LEG LENGTH INEQUALITY RESULTING FROM ISOLATION TESTS

To the Editor:

Authors DeWitt et al. (DeWitt JK, Osterbauer PJ, Stelmach GE, Fuhr AW. Optoelectric measurement of changes of leg length inequality resulting from isolation tests. J Manipulative Physiol Ther 1994;17:530–8.) should be congratulated for the painstaking detail obvious in the performance of their study and its subsequent write-up. However, I fail to see the clinical relevance that such a study, or most of the other studies funded by Activator Methods, has regarding either the reliability of their actual clinical application or the validity of their leg length inequality (LLI) assessment.

Although these studies have established the reliability of assessing LLI in the prone position (1) and the ability of an optoelectric device to accurately measure the phenomenon (2), this current study, as well as others, fails to address the fact that the procedures under study are not applied as described in the clinical setting by Activator Methods clinicians. Furthermore, these studies do not even attempt to address the reliability of the “Position No. 2” prone LLI assessment procedure that is promoted as an integral part of the decision making process for identification and adjustment of subluxated vertebral segments (3).

Additionally, validity can be defined as the extent to which a test measurement measures what it is intended to measure and face validity as “a subjective judgment of whether a measurement makes sense intuitively, whether it seems to be a reasonable approach” (4). Activator Methods’ written materials indicate that they perceive the LLI phenomenon to be a sign of neurological facilitation. To assess neurological facilitation the appropriate unit of measure would have to be volts or amps—not inches or millimeters of leg length inequality—because nervous system activity is an electrical phenomenon. The preoccupation of these researchers with an invalid measure of the nervous system component of vertebral lesions seems curious at best.

Finally, the conclusions of the current study add nothing to the body of knowledge regarding either the reliability, validity or clinical utility of this procedure. With research resources in scarce supply in the chiropractic profession, one must question the motivation and use of such precious resources.

REFERENCES


To the Editor:

In their article, De Witt et al. (De Witt JK, Osterbauer PJ, Stelmach GE, Fuhr AW. Optoelectric measurement of changes in leg length inequality resulting from isolation tests. J Manipulative Physiol Ther 1994;17:530–8.) evaluated leg alignment alterations associated with neck flexion and extension isolation tests using an objective procedure that eliminated bias that could be introduced by examiner handling of the patient’s feet. Two groups were examined: patients believed to have pretest/posttest leg alignment alterations on manual screening and asymptomatic patients believed not to have pretest/posttest leg alignment changes on manual screening. Diagnostic suspicion bias in the screening leg alignment tests and low statistical power aside, it was interesting to see documentation of RMS motion and range of motion during the isolation tests, posttest change in foot positioning (albeit small in average magnitude) and relatively large differences between the comparison groups. Unfortunately, in clinical practice, pretest/posttest change in side-by-side leg alignment discrepancy is the outcome of interest. These data are not provided. It would be valuable to all physicians who use leg alignment to know the means and SDs of discrepancy changes (before/after) in the two subject groups and the clinical implications of the magnitudes of these changes.

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In Reply:

Drs. Troyanovich and Haas raise an important point that all clinical measures have to ultimately face: clinical utility. It

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