The use of a hybrid dynamic stabilization and fusion system in the lumbar spine: preliminary experience

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Object. The authors report the use and preliminary results of a novel hybrid dynamic stabilization and fusion construct for the surgical treatment of degenerative lumbar spine pathology.

Methods. The authors performed a retrospective chart review of all patients who underwent posterior lumbar instrumentation with the Dynsys-to-Optima (DTO) hybrid dynamic stabilization and fusion system. Preoperative symptoms, visual analog scale (VAS) pain scores, perioperative complications, and the need for subsequent revision surgery were recorded. Each patient was then contacted via telephone to determine current symptoms and VAS score. Follow-up was available for 22 of 24 patients, and the follow-up period ranged from 1 to 22 months. Clinical outcome was gauged by comparing VAS scores prior to surgery and at the time of telephone interview.

Results. A total of 24 consecutive patients underwent lumbar arthrodesis surgery in which the hybrid system was used for adjacent-level dynamic stabilization. The mean preoperative VAS score was 8.8, whereas the mean postoperative VAS score was 5.3. There were five perioperative complications that included 2 durotomies and 2 wound infections. In addition, 1 patient had a symptomatic medially placed pedicle screw that required revision. These complications were not thought to be specific to the DTO system itself. In 3 patients treatment failed, with treatment failure being defined as persistent preoperative symptoms requiring reoperation.

Conclusions. The DTO system represents a novel hybrid dynamic stabilization and fusion construct. The technique holds promise as an alternative to multilevel lumbar arthrodesis while potentially decreasing the risk of adjacent-segment disease following lumbar arthrodesis. The technology is still in its infancy and therefore follow-up, when available, remains short. The authors report their preliminary experience using a hybrid system in 24 patients, along with short-interval clinical and radiographic follow-up. (DOI: 10.3171/2010.3.FOCUS1055)

Key Words • dynamic stabilization • motion preservation • lumbar spine • degenerative disc disease

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Abbreviations used in this paper: DTO = Dynesys-to-Optima; VAS = visual analog scale.
and immediate elimination of motion and, ultimately, arthrodesis. While both strategies seek to address the underlying pathology of microinstability, the dynamic stabilization approach promises to do so in a more physiological manner. By “restoring” normal motion, mobility is theoretically preserved rather than eliminated, and the forces acting above and below the construct are altered to a lesser extent, reducing the potential undesirable effects of fusion.

Nearly a dozen such systems are currently available, and all employ a variety of motion-preserving technologies ranging from semirigid rods to ball-and-socket joints. Of note, due in large part to the exigencies of the medical device approval process, FDA approval of these systems has thus far been for their use as an adjunct to fusion in the lumbar spine, a decision based on the demonstration of noninferiority of the approved systems compared with traditional pedicle screw/rod-based fusion. Nevertheless, “off-label” use for motion-preservation surgery is widespread, and several investigational device exemption studies for nonfusion applications are ongoing.

At our institution, we have been using one of these systems—the Dynesys Dynamic Stabilization System (Zimmer Spine)—for motion-preservation surgery for nearly 5 years. Recently available is a hybrid system (DTO, Zimmer Spine; Fig. 1) in which dynamic stabilization may be performed immediately above (or less commonly, below) a fusion. The system is intended for use in patients in whom fusion is desired—whether to treat gross instability or severe, advanced degeneration—at one or more levels, and in whom one or more adjacent segments exhibit degenerative changes that are thought to be contributing to the patient’s symptoms but are not of a severe-enough degree to warrant arthrodesis. This study was performed to evaluate the preliminary experience with the DTO hybrid construct.

Methods

We performed a retrospective review of all DTO posterior lumbar hybrid dynamic stabilization and fusion procedures at the University of Pittsburgh Medical Center, Presbyterian Hospital. Patients with degenerative lumbar disc disease were chosen to undergo the procedure if they were candidates for fusion and had symptomatic adjacent-level pathology in which dynamic stabilization was thought to be more appropriate than arthrodesis. The DTO procedure involves placement of standard transpedicular instrumentation and fusion utilizing the Zimmer Optima system at segments deemed to require rigid fixation and fusion. A unique Dynesys screw is then placed in the superior pedicle of the segment believed to be at risk for subsequent degeneration adjacent to the fusion. A transitional screw is placed in the intervening pedicle that allows the 2 systems to be connected. An intertransverse process fusion is then performed at the levels to be fused and is typically supplemented with interbody fusion via a transfemoral approach. Autograft bone, obtained from the same incision in the course of the bony decompression, is supplemented with demineralized bone matrix and laid down between the decorticated transverse processes.

Medical records were reviewed to determine preoperative VAS pain scores (with 1 being very little pain and 10 being very severe pain) obtained at the time of surgical consent, to assess clinical outcomes at follow-up (including the need for reoperation), and to record complications. Postoperative imaging studies, including radiographs, CT scans, and MR images, were reviewed when available. Patients were contacted via telephone at the time of chart review to assess their current level of back and leg pain. In all cases, patient permission was obtained for this review.

Results

A total of 24 patients underwent the DTO procedure between March 2008 and December 2009. The mean patient age was 49 years (range 29–66 years). There were 12 men and 12 women. Fifteen patients had undergone previous lumbar surgery at one or more of the surgically treated levels. Patient demographics are summarized in Table 1. Figure 2 shows a representative case, including a preoperative provocative discogram and postoperative lateral radiograph.

Clinical Outcomes

Postoperative VAS scores were available for 22 (92%) of the 24 patients. The mean follow-up duration was 8
Hybrid dynamic lumbar stabilization and fusion

months (range 1–22 months). For the entire group, the mean preoperative VAS score was 8.8, and the mean postoperative VAS score was 5.3. Pain in 3 patients improved by 7 points, in 2 patients by 6 points, in 3 patients by 5 points, in 3 patients by 4 points, in 3 patients by 3 points, in 4 patients by 2 points, and 4 patients rated their pain unchanged. Of the 4 patients who experienced no improvement in pain, one case was notable for the patient having a complicated postoperative course requiring reoperation after 8 months for a disc herniation at the stabilized level, which was further complicated by a wound infection requiring irrigation and debridement and long-term antibiotics. The other 3 patients had an uneventful postoperative course.

Complications

There were 5 perioperative complications. These included 2 dural tears for which primary repair was performed. In 1 of the patients with a dural tear, a persistent CSF leak developed and required wound revision. One patient awoke with new radicular pain that was attributable to a medially placed L–4 pedicle screw. This patient was taken back to the operating room and underwent revision of the screw. In 2 patients a postoperative wound infection developed, in both of whom the incisions healed following irrigation and debridement of the wound. All of these cases were believed to be unrelated to the DTO system itself and were thought to be rather typical for lumbar arthrodesis surgery with instrumentation. There were no cases of hardware failure.

**Treatment Failures**

Treatment failure was defined as persistent pain or the need for further surgery at either the surgically treated or adjacent levels. Three patients (12%) underwent extension of their fusion for adjacent-level disease during this follow-up period. In one patient, persistent pain attributed to the dynamically stabilized level prompted revision with interbody fusion at that level. In 2 other patients adjacent-level disease developed immediately rostral to the dynamically stabilized segment. Results are summarized in Table 2.

**Discussion**

The phenomenon of adjacent-segment disease, referring to accelerated degenerative changes occurring at the ends of the fused spine, has received increasing attention as ever more spinal fusions are performed and long-term follow-up data become available. While the time course and prevalence of adjacent-segment disease are not fully known, there is increasing evidence in the spine literature that its effects may be seen soon after fusion surgery and in as many as 30% of patients. In a recently published large retrospective analysis Cheh et al. reported a rate of clinical adjacent-segment disease of 30.3% and showed that patients in whom adjacent-level disease developed had significantly worse Oswestry Disability Index scores than those without adjacent-level disease. They further identified age > 50 years at time of surgery, increasing length of fusion, and extension of the fusion to L1–3 as significant risk factors for the development of adjacent-level disease. No significant difference was identified between posterior and circumferential fusion.

Over the past 20 years, an array of posterior pedicle fixation–based motion preservation systems have been introduced as many in the spine community have sought to

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**TABLE 2: Summary of pain scores, complications, and treatment failures**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean VAS score</td>
<td></td>
</tr>
<tr>
<td>preop</td>
<td>8.8</td>
</tr>
<tr>
<td>postop</td>
<td>5.3</td>
</tr>
<tr>
<td>no. of complications</td>
<td></td>
</tr>
<tr>
<td>dural tear</td>
<td>2†</td>
</tr>
<tr>
<td>symptomatic screw misplacement</td>
<td>1</td>
</tr>
<tr>
<td>wound infection</td>
<td>2</td>
</tr>
<tr>
<td>no. of treatment failures</td>
<td></td>
</tr>
<tr>
<td>symptomatic degeneration at the DSS‡</td>
<td>1</td>
</tr>
<tr>
<td>symptomatic degeneration above the DSS‡</td>
<td>2</td>
</tr>
</tbody>
</table>

* DSS = dynamically stabilized segment.
† One of the 2 patients required operative wound revision for a persistent CSF leak.
decrease the incidence of adjacent-level disease. One of these systems—the Dynesys Dynamic Stabilization System—has been in use at our institution for the past 5 years. More recently, we have begun to use a hybrid system in which Dynesys dynamic stabilization is performed above (or less commonly, below) a traditional pedicle screw–augmented fusion. The DTO hybrid construct has proven useful in the treatment of the patient in whom decompression and fusion are required at one or more levels, but in whom there is also the potential for symptomatic degenerative changes at one or more adjacent levels. In our series, clinical improvement, as measured by changes in VAS pain scores, was seen in 18 (82%) of 22 patients. Three (12%) of the original 24 patients developed symptomatic degenerative changes at or above the dynamically stabilized levels and subsequently underwent revision with fusion—a not insignificant rate of adjacent-segment degeneration whose cause is the subject of an ongoing investigation. Finally, 5 (21%) of 24 patients experienced a complication, including 2 dural tears, 2 wound infections, and a single screw misplacement requiring revision. However, these complications were not believed to have been related to the actual DTO system itself.

**Conclusions**

The DTO hybrid system represents a unique new technology that allows for the coupling of arthrodesis with dynamic stabilization at adjacent levels in the lumbar spine. Application of the technique is in the early stages, and long-term follow-up data are therefore scarce. However, based on preliminary results in 24 patients, the technique merits further investigation as an alternative to multilevel lumbar arthrodesis.

**Disclosure**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: PC Gerszten, MB Maserati, MJ Tormenti. Acquisition of data: MB Maserati, MJ Tormenti, CM Bonfield, DM Panczykowski. Analysis and interpretation of data: PC Gerszten, MB Maserati, MJ Tormenti. Drafting the article: MB Maserati, MJ Tormenti. Critically revising the article: PC Gerszten. Reviewed final version of the manuscript and approved it for submission: PC Gerszten. Statistical analysis: MB Maserati, MJ Tormenti, DM Panczykowski. Administrative/technical/material support: PC Gerszten. Study supervision: PC Gerszten.

**References**


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