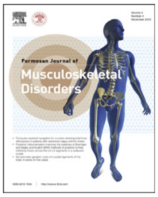
Formosan Journal of Musculoskeletal Disorders 4 (2013) 105–108

Contents lists available at ScienceDirect

Formosan Journal of Musculoskeletal Disorders

journal homepage: www.e-fjmd.com



Original Article

Posterior instrumentation improves the stabilities of Brantigan and Bagby and Kuslich (BAK) methods of posterior lumbar interbody fusion across the L4–L5 segments in a cadaveric model

Shih-Tien Wang [a,b,*], Vijay K. Goel [c], Chong-Yau Fu [d], Shinichiro Kubo [e], Woosung Choi [f], Justin K. Coppes [g], Chien-Lin Liu [b]

[a] *Department of Orthopedics, School of Medicine, National Yang Ming University, Taipei, Taiwan, ROC*
[b] *Department of Orthopedics and Traumatology, Taipei Veterans General Hospital, Taipei, Taiwan, ROC*
[c] *Spine Research Center, University of Toledo and Medical College of Ohio, Toledo, OH, USA*
[d] *Institute of Public Health, National Yang Ming University, Taipei, Taiwan, ROC*
[e] *Department of Orthopedic Surgery, Miyazaki Medical College, Miyazaki, Japan*
[f] *Department of Orthopaedics, Tae Jeon St. Mary's Hospital, The Catholic University of Korea, Seoul, South Korea*
[g] *Department of Biomedical Engineering, University of Iowa, Iowa City, IA, USA*

ARTICLE INFO

Article history:
Received 16 May 2013
Received in revised form
31 May 2013
Accepted 5 June 2013
Available online 11 November 2013

Keywords:
biomechanics
cadaveric model
intervertebral fusion cage
lumbar spine
posterior instrumentation
posterior lumbar interbody fusion

ABSTRACT

Background: The Brantigan and Bagby and Kuslich (BAK) cages for posterior lumbar interbody fusion have different geometric characteristics. However, both cage designs have been demonstrated to be helpful in restoring disc space across spinal motion segments in clinical observations. This study was designed to compare the biomechanical performance of these devices at one-motion segments and to determine the effects of posterior instrumentation on their stabilities.

Methods: Eight intact fresh human cadaver spines (L2-S1) were affixed within a testing frame for *in vitro* biomechanical testing: four randomly assigned spines for the BAK cage group and four for the Brantigan cage group. For each spine, the three-dimensional load-displacement behavior of each vertebra was quantified using the Selspot II Motion measurement system during the following steps: (1) intact state; (2) destabilization after laminectomy and discectomy across L4-L5; (3) stabilization using a pair of BAK cages or Brantigan cages; and (4) additional stabilization using variable screw plates (VSP) across L4-L5.

Results: The Brantigan cage alone did not show satisfactory results in improving the stability of one-motion segment destabilized spines in left and right axial rotation. However, the BAK cages appeared to provide significant stability in extension, flexion, left and right lateral bending, and left axial rotation. After implanting the additional posterior instrumentation, both cages provided similar and significantly improved stabilities.

Conclusion: Although the results indicate that the Brantigan cage did not provide satisfactory improvement in the stabilities as the BAK cage in the one-motion segment model, implantation with additional posterior instrumentation may significantly improve the stabilities and reduce the differences between the two cage designs.

Copyright © 2013, Taiwan Orthopaedic Association. Published by Elsevier Taiwan LLC. All rights reserved.

1. Introduction

In the treatment of spinal instability, successful fusion is one of the most important goals for spinal surgery.[1] Although bone graft alone may lead to a high failure rate and complications, stand-alone anterior fusion cages with autogenous bone graft has been reported to have high rates of success.[2] Recently, a number of interbody fusion cages have been developed with different rationales.[3,4] These cages may be implemented through the anterior or posterior approach and have been evaluated to be helpful in achieving successful interbody fusions.[3,5,6]

The implantation of Bagby and Kuslich (BAK) cages (Sulzer Spine-Tech, Minneapolis, MN, USA) has been evaluated to be safe and effective for interbody fusion through the anterior or posterior approach.[3,6] As a posterior lumbar interbody fusion (PLIF) technique, this cage design has a high overall fusion rate of 86% at month 12 after surgery. This fusion rate was then increased to 91%

---

[*] Corresponding author. Department of Orthopedics, School of Medicine, National Yang Ming University, Taipei 112, Taiwan, ROC. Tel.: +886 2 28757557.
E-mail address: stwang@vghtpe.gov.tw (S.-T. Wang).

2210-7940/$ – see front matter Copyright © 2013, Taiwan Orthopaedic Association. Published by Elsevier Taiwan LLC. All rights reserved.
http://dx.doi.org/10.1016/j.fjmd.2013.06.002

at month 24 and 98% at month 36. The rates were 87%, 94%, and 100% in one-level cases and 75%, 71%, and 90% in the two-level cases. Moreover, no device-related deaths or complications have been observed.[5] The Brantigan cage (DePuy-AcroMed, Raynham, MA, USA) is a carbon fiber rectangular cage.[7] In addition to possessing better mechanical strength than allografts,[8] the implantation of the Brantigan cage showed a 100% fusion rate among 26 patients in a 2-year follow-up investigation, whereas a fusion rate of 54.5% was observed after the application of an allograft fusion.[9] Moreover, no statistically significant differences were found among the stabilities among the Stratec, Ray, and Brantigan cages using a cadaveric spine model.[10]

Although the clinical observations and biomechanical studies have demonstrated the effectiveness of these two cage designs, there is no information concerning with the comparison of the stabilities between the Brantigan and BAK cages. Moreover, the necessity of implantation of posterior instrumentation to these cages remained undetermined. In this study, we employed a human cadaveric spinal model to compare the stabilities between the two types of cages implanted across the L4–L5 segments through a posterior approach. The effects of using supplementary posterior instrumentation on the stability were also investigated.

2. Materials and methods

2.1. Specimen preparation

Eight intact fresh human cadaveric spines (L2–S1) were used for the *in vitro* biomechanical testing. These spines were divided randomly into two groups: one implanted with Brantigan cages and the other with BAK cages. The bone mineral density of these specimens was determined using DEXA (dual energy x-ray absorptiometry) scanning. The bone density information and the interpretations of the radiographs enabled us to exclude highly degenerative, severe osteoporotic, malformation, metastatic, or fractured ones from the study. After stripping off the soft tissues and leaving the ligamentous structures intact, the superior half of the proximal vertebral body (L2) and inferior half of the distal body (S1) of each specimen were affixed in a polyester resin. To ensure a secure fixation between the vertebral bodies and resin, metallic screws were inserted into the vertebral bodies before pouring the polyester resin. The disc spaces between L2 and L3, L3 and L4, L4 and L5, and L5 and S1 were left unhindered.

2.2. Testing procedures

Mechanical testing on the spine specimens was performed according to the protocol in our previous study.[11–15] Each specimen was tested in the following states: (1) intact state; (2) destabilization by partial laminectomy, facetectomy, and discectomy across L4–L5; (3) stabilization using a pair of BAK cages or Brantigan cages; (4) additional stabilization using variable screw plates (VSP) system (DePuy-AcroMed, Raynham, Massachusetts) across the L4-L5 segments in both groups. All implements were inserted according to the instructions of the manufacturer.

2.3. Testing steps

After affixing the spine to an immobile base plate within a testing frame, infrared light emitting diodes (LEDs) were attached to the anterior part of vertebral bodies of L3, L4, and L5. A special set of LEDs was also attached to the immobile base for reference. Loads of 1.5, 3.0, 4.5, and 6.0 Nm in the form of pure moments to L2 were applied to the spine through a system of arms, pulleys, and weights. The loads were applied in six degrees of freedom: extension (EXT), flexion (FLEX), right and left lateral bending (RLB, LLB), and right and left axial rotation (RAR, LAR). The three-dimensional (3-D) load-displacement in each vertebra was quantified using the Selspot II Motion measurement system (Innovision Systems, Inc., Warren, MI, USA). The maximum load was achieved in five equal steps and spatial location of the specimen was recorded after each load step. In response to the loads, cameras tracked the LEDs in an XYZ Cartesian axis system and transformed the 3-D motions into degrees of angular rotation. Mean changes in motion were calculated for different loading modes. To prevent dehydration during preparation and testing, specimens were sprayed with 0.9% NaCl solution.

2.4. Statistical analysis

The angular data collected from the in vitro tests at different stages within each group were converted into percentage changes with reference to the intact stage. The percentage changes were calculated as 100 × (Angular rotation - Angular rotation at intact stage) / Angular rotation at intact stage. Difference between the intact stage and the remaining ones in each group were compared using the Wilcoxon sign test (matched pair). The Wilcoxon rank sum test (two independent samples) was used to compare the differences between Brantigan and BAK cages at different stages. A p-value <0.05 was considered statistically significant.

3. Results

In this study, the specimens were obtained from three females and five males aged between 46 and 78 years (62.8 ± 13.1 years). Averages and S.D. of the bone mineral densities were, respectively, 0.9 ± 0.3 g/cm^2, 0.9 ± 0.3 g/cm^2, 0.9 ± 0.3 g/cm^2, 0.8 ± 0.3 g/cm^2 at L2, L3, L4, and L5. There were no significant differences in these parameters for the specimens implanted with the Brantigan cages (0.8 ± 0.4 g/cm^2 at L2, 0.8 ± 0.4 g/cm^2 at L3, 0.8 ± 0.4 g/cm^2 at L4, and 0.7 ± 0.4 g/cm^2 at L5) and those with the BAK cages (1.0 ± 0.1 g/cm^2 at L2, 1.1 ± 0.1 g/cm^2 at L3, 1.0 ± 0.1 g/cm^2 at L4, and 0.9 ± 0.1 g/cm^2 at L5) groups ($p > 0.05$).

Figs. 1–3 show percentage changes with reference to the intact stage at the destabilization, cage only, and cage with posterior instrumentation stages. The intra-group variations became extremely higher at the destabilization stage. In the Brantigan group, there were no significant percentage changes in extension,

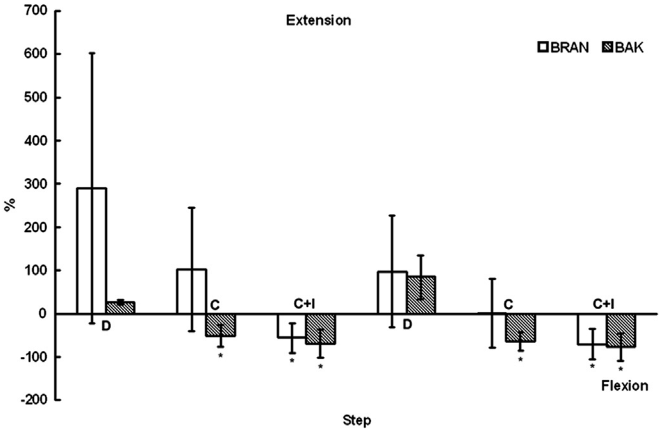


Fig. 1. Percentage changes (mean ± SE) in extension and flexion rotations for the Brantigan (BRAN) and Bagby and Kuslich (BAK) cages across the L4–L5 segments. Graphs are for a 6 Nm load step. (*Intact vs. remaining stages: $p < 0.05$.) C = cage only; C+I = cage plus instrumentation; D = destruction.

Download English Version:

https://daneshyari.com/en/article/4055322

Download Persian Version:

https://daneshyari.com/article/4055322

Daneshyari.com