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A CLOSER LOOK AT TOTAL POSTERIOR SPINE SYSTEM

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Abstract

Debilitating pain or neurologic abnormalities can result from lumbar spine degenerative disease, which typically occurs with aging. Traditional therapy has involved decompression surgery followed by the potential need for lumbar fusion when minimally invasive therapies and pain management strategies are unable to relieve the patient's symptoms. A mechanical implant system called the Total Posterior Spine (TOPS) System has been presented as a dynamic substitute for fusion surgery after decompression. By offering multiaxial, three-column stabilization, the device-a dynamic posterior arthroplasty with pedicle screw insertion—maintains range of motion, flexibility, and mobility. Percutaneous endoscopic discectomy was the original form of endoscopic spine surgery (ESS), which has since developed over 20 years ago.

Introduction

The Total Posterior Spine (TOPS) System first developed in 2003, provides an alternative. It aims to avoid spinal fusion drawbacks while achieving adequate decompression, preserving multiaxial stability, and restoring near-anatomic mobility. The TOPS System is an active single level prosthesis wedged between two pedicle screw-fixated titanium plates. It allows for side bending, axial rotation, and flexion/extension range of motion while limiting sagittal translation[1]. It is currently indicated for LSS, spondylolisthesis, and facet arthrosis and has been increasingly proven safe and effective for these conditions. Despite this encouraging evidence, it continues to be an experimental device and thus, further high-quality studies are warranted.

Nevertheless, the absolute values cannot be directly compared with in vivo conditions because no known preload could be simulated. Additionally, the hydrostatic pressure can only be determined accurately in a nondegenerated disc[2].

1. Implant Characteristics

As part of the overall development program on early designs of the TOPS system, a finite element analysis was performed on the implant by using ANSYS computational software. The original model developed for this theoretical stress analysis was a half-section representation of the device[3]. The model was chosen because the device itself and the loading conditions on it were found to be symmetrical around the central plane. This hemi model analysis allowed for faster computation without loss of precision.

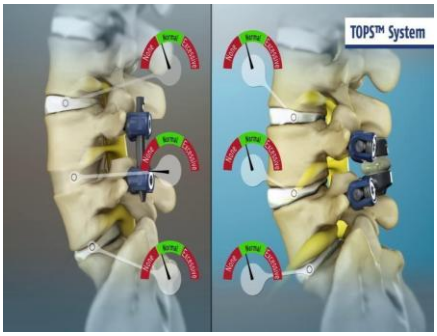


Fig1. Implant parts of total posterior device

The total posterior arthroplasty system called TOPS Implant is a dynamic facet arthroplasty prosthesis that is designed specifically for the purpose of restoring segmental stability while preserving near anatomical motion characteristics after surgical decompression of a diseased, stenotic lumbar spinal segment[4]. By using the TOPS prosthesis in lieu of arthrodesis and or rigid pedicle screw instrumentation after decompression, our goal was to gain experience with this novel means of treating patients suffering from spondylolisthesis and to achieve validated clinical low-back pain and neurological outcome scores that were at least equivalent to those of traditional posterior lumbar decompressive and fusion procedures.

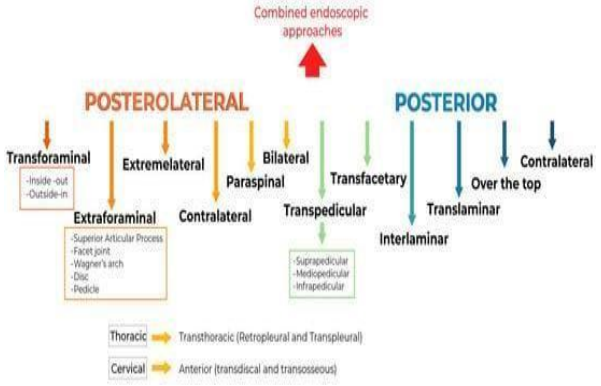


Fig 2. Types of Endoscopic Approaches

2. Methods

The Total Posterior Spine System

The TOPS System includes the TOPS device and the pedicle screws used for its fixation. The device is designed to allow axial rotation, lateral bending, extension and flexion, and block sagittal translation. The device is implanted using a posterior surgical approach to replace the skeletal elements such as the lamina and the facet joints that are diseased and or removed during the decompression[5]. The implant is available in various sizes, allowing a 1- level implantation at either the L2-3, L3-4, or L4-5 vertebral level. The indication for use of the TOPS implant is a grade I degenerative spondylolisthesis with facet degeneration and or moderate-to-severe spinal stenosis, with a 4-mm minimum intervertebral disk height and without Modic 1 signs of the neighboring vertebral bodies[6]. Serious symptomatic facet arthrosis with vertebral misalignment and without pronounced instability is also an appropriate indication.

Fig 3. Premia spine announces FDA breakthrough device designation

The TOPS implant is based on a unique design comprising titanium plates with extending rods attached to pedicle screws. The plate's orientation transverses the spinal column, above and below the resected facet joint, in contrast to typical fixation systems that connect pedicle screws with rods or fixation components oriented longitudinally, or in parallel, to the spinal column[6]. The titanium plates are anchored to one another by an interlocking articulating core sealed within a polycarbonate urethane boot that resists motion in a way mimicking the elastic properties of the native facet capsule and posterior ligaments[9].

Functional mobility and intradiscal pressures of the L4–5 functional spinal unit motion segment in flexion, extension, lateral bending, and rotation was assessed sequentially at the initial intact state after bilateral laminectomy and functional total facetectomy after dynamic stabilization with the facet prosthesis. Additionally, the hydrostatic pressure can only be determined accurately in a nondegenerated disc[11].

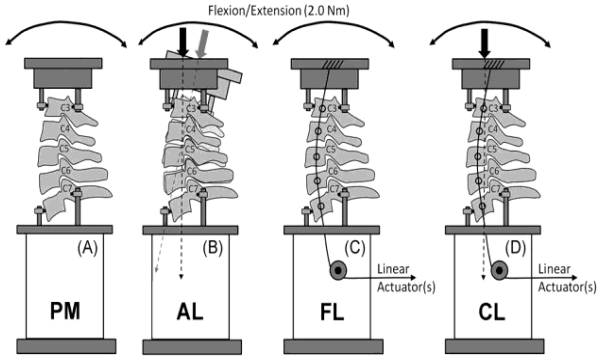


Fig 4. Assessing the bio fidelity of in vitro biomechanical testing of the human cervical spine

3. TOPS Technique

To achieve proper device alignment and optimal postimplant ROM, the surgery is performed with patients lying prone to maintain their neutral standing lordosis. Pedicle screws are placed parallel to the craniocaudal axis and symmetrical to the median plane of the spine, ensuring that the vertical distance between pedicle screws is the same on both sides[11]. For TOPS placement need only be extended to the lateral aspect of the facet complex. Depending on the exact pathological features of the individual case, the degree of bone, synovium, and ligamentum flavum resection varied accordingly. Because the TOPS system serves functionally to replace the motion restraint of the native facet complex, a functional decoupling of both facet complexes was required. This was achieved by aggressive resection through the joint itself and or by removing the inferior articulating processes from the superior vertebrae[12].

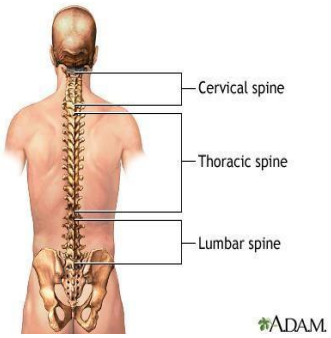


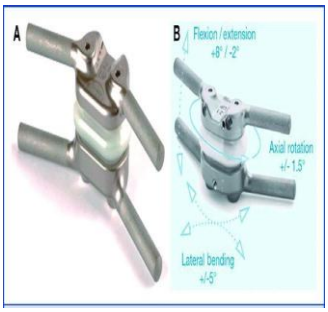
Fig 5. Hyoid bone u-shaped bone located just above the larynx

4. Model Design

Patient informed consent and Institutional Review Board authorization were not required for this study since the patient cohort was extracted from an ongoing, multicenter RCT.12 Included patients were randomized preoperatively to receive either the experimental TOPS system or TLIF as the control arm[14]. The conventional time horizon used to estimate cost and health utility is 2 years. Additional postoperative periods examined in this analysis included 90 days, 1 year, 6 years, and 10 years.

5. Load on the Pedicle Screw

To evaluate the potential length of time that the TOPS prosthesis could maintain its pedicular fixation to the lumbar spinal segment, an assessment of the stress at the screw–bone interface was conducted[16]. Because there is no established standard torque or strain value for lumbar pedicle screw pullout in the published literature, it was



decided to compare the TOPS device with the Dynesys system (Zimmer Spine), which has a low incidence of fixation failure in long-term clinical series.26

6. Advanced Techniques of TOPS

The TOPS device is a unitary implant consisting of two titanium plates with an interlocking flexible articulating core. It has metal arms that connect horizontally to pedicles with four polyaxial pedicle screws[17]. This device can be implanted after a standard decompression via removal of the lamina and medial facets. It is unnecessary to expose the transverse processes in this procedure fully. The operator can preserve the capsule and muscular attachments proximate to the superior facet complex. After adequate exposure, the spinal canal's decompression is achieved with the removal of lamina and facet joints[15].

Fig 6. Total posterior spine system implant and B, permitted range of motion.

7. Out Comes

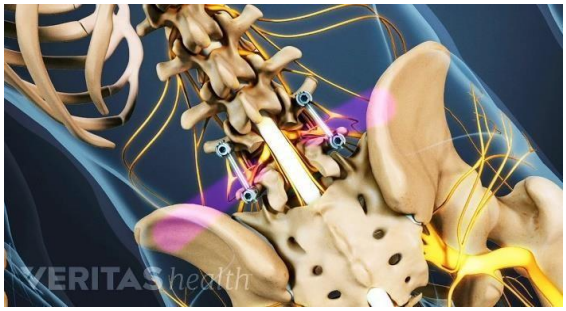
TOPS has been shown in clinical studies to improve pain levels and maintain spinal range of motion. Simultaneously, the TOPS system preserves the natural biomechanics of the spine when assessing intervertebral disc strain and bulge[18]. The Visual Analog Scale (VAS), Oswestry Disability Index (ODI), and Short Form 36 (SF-36) were all utilised to quantitatively measures changes in pain and quality of life as a result of the implant. X-rays, CTs, and MRIs were additionally utilised to evaluate adverse events or unintended changes to the implant.

Advantages of Using TOPS Alternative

Primarily, the TOPS implant allows the spine to move in all directions – axial rotation, lateral bending, extension, and flexion. However, while it is doing that, the system blocks sheer forces that are naturally and continually exerted onto the low spine. These can be highly detrimental and damaging, especially when the patient is recovering from surgery[20]. Clinical studies prove that this system offers immediate pain relief, which is sustained throughout the weeks, months, and years after the TOPS surgery. Spine improvement continues over time, and the patient sees an enhancement of their quality of life [11].

Fig 7. Posterior lumbar interbody fusion.

It takes more time to recover from the procedure, but the



patient may never move fully as they did before the pain. Most importantly, patients have immediate pain relief that continues as they improve. For people with severe or moderate spinal stenosis with or without facet arthrosis (a bone spur) or spondylolisthesis (slipped discs), they can alleviate the persistent low back and leg aches [6].

8. Risks Associated with posterior spinal implants, including the TOPS System

- Removal, revision, reoperation or additional fixation after procedure.
- Additional surgery due to loosening, breaking, or wearing.
- Bone formation or fusion.
- Difficulty placing the pedicle screws or TOPS device properly in the spine[25].

9. Conclusion

These early findings demonstrate that, for patients with moderate to severe lumbar spinal stenosis, the TOPS total posterior arthroplasty device is a safe and useful substitute for fusion, even though longer-term, comparative data are required. Significant progress has been observed in ODI, VAS, and ZCQ scores at all intervals, including the preliminary follow-up after a year, according to clinical outcomes. There were no reported adverse events linked to the device, and all advertisement events unrelated to the device were in line with rates that had been published. With the recently started prospective, multicenter, randomized TOPS trial, sponsored by the Food and Drug Administration, these encouraging preliminary results call for additional research. The TOPS system has the ability to reduce back discomfort, preserve a range of motion that is nearly normal for extended periods of time, and prevent neighboring segment degeneration, according to data from this single-site experience of installing the system following a laminectomy.

Author contributions

All authors are contributed equally.

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Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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Reference

1. Kalff R, Ewald C, Waschke A, Gobisch L, Hopf C. Degenerative lumbar spinal stenosis in older people: current treatment options. Deutsches Ärzteblatt international. 2013 Sep;110(37):613.
2. Abbas J, Peled N, Hershkovitz I, Hamoud K. Facet tropism and orientation: risk factors for degenerative lumbar spinal stenosis. BioMed Research International. 2020;2020(1):2453503.
3. Bagley C, MacAllister M, Dosselman L, Moreno J, Aoun SG, El Ahmadieh TY. Current concepts and recent advances in understanding and managing lumbar spine stenosis. F1000Research. 2019;8.
4. McGregor AH, Probyn K, Cro S, Doré CJ, Burton AK, Balagué F, Pincus T, Fairbank J. Rehabilitation following surgery for lumbar spinal stenosis. Cochrane Database of Systematic Reviews. 2013(12).
5. Floman Y. Progression of lumbosacral isthmic spondylolisthesis in adults. Spine. 2000 Feb 1;25(3):342-7.
6. Dey B, Hwisa NT, Khalf AM, Mitra A, Katakam P, Rao CB. Pharmaco-epidemiological Studies on Self Medication and Drug Utilization Pattern in Chronic Diseases via Prescription Auditing. International Journal of Scientific Research in Knowledge. 2013 Nov 1;1(11):464.
7. Guha D, Heary RF, Shamji MF. Iatrogenic spondylolisthesis following laminectomy for degenerative lumbar stenosis: systematic review and current concepts. Neurosurgical focus. 2015 Oct 1;39(4):E9.
8. JA A. Lumbar spine stenosis: a common cause of back and leg pain. Am Fam Physician. 1998;57:1825-40.
9. Buchiraju, Ravi; Nama, Sreekanth; Sakala, Bhargavi; Chandu, Babu Rao; Kommu, Arun; Chebrolu, Jaya Kishore Babu; Yedulapurapu, Narasimhamurthy
10. Dhillon KS. Spinal fusion for chronic low back pain: a 'Magic Bullet'or Wishful Thinking?. Malaysian orthopaedic journal. 2016 Mar;10(1):61.
11. Buchiraju R, Nama S, Sakala B, Chandu BR, Kommu A, Chebrolu JK, Narasimhamurthy Y. Vesicular drug delivery system-an over view. Res J Pharm Biol Chem Sci. 2013 Jul;4(3):462-74.
12. Kim M, Kim HS, Oh SW, Adsul NM, Singh R, Kashlan ON, Noh JH, Jang IT, Oh SH. Evolution of spinal endoscopic surgery. Neurospine. 2019 Mar;16(1):6.
13. Kwon H, Park JY. The role and future of endoscopic spine surgery: a narrative review. Neurospine. 2023 Mar;20(1):43.
14. Kambin P, Bracer MD. Percutaneous posterolateral discectomy: anatomy and mechanism. Clinical Orthopaedics and Related Research®. 1987 Oct 1;223:145-54.
15. Kambin PA, Sampson ST. Posterolateral Percutaneous Suction-Excision of Herniated Lumbar Intervertebral Discs: Report of Interim Results. Clinical Orthopaedics and Related Research (1976-2007). 1986 Jun 1;207:37-43.
16. Hausmann B, Forst R. Nucleoscope: Instrumentarium for endoscopy of the intervertebral disc space. Archives of orthopaedic and traumatic surgery. 1983 Sep;102:57-9.
17. Schreiber A, SUEZAWA Y, LEU H. Does percutaneous nucleotomy with discoscopy replace conventional discectomy?: Eight years of experience and results in treatment of herniated lumbar disc. Clinical Orthopaedics and Related Research®. 1989 Jan 1;238:35-42.
18. Suezawa Y, Jacob HA. Percutaneous nucleotomy: An alternative to spinal surgery. Archives of orthopaedic and traumatic surgery. 1986 Sep;105:287-95.
19. Kambin P. Arthroscopic microdiscectomy. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 1992 Sep 1;8(3):287-95.
20. Yeung AT. Minimally Invasive Disc Surgery with the Yeung Endoscopic Spine System (YESS). Surgical technology international. 1999 Jan 1;8:267-77.
21. Manini DR, Shega FD, Guo C, Wang Y. Role of Platelet-Rich Plasma in Spinal Fusion Surgery: Systematic Review and Meta-Analysis. Advances in Orthopedics. 2020;2020(1):8361798.

22. Campos LB, Dietrich L, de Sousa PC, de Oliveira Andrade CM, de Assis Costa MD, da Mota Martins V. Fibrina Rica em Plaquetas (PRF) como auxiliar na Implantodontia Oral: relato de caso. Research, Society and Development. 2021 Dec 9;10(16):e132101623503-.
23. Tuan TL, Song A, Chang S, Younai S, Nimni ME. In vitrofibroplasia: Matrix contraction, cell growth, and collagen production of fibroblasts cultured in fibrin gels. Experimental cell research. 1996 Feb 25;223(1):127-34.
24. Creaney L, Hamilton B. Growth factor delivery methods in the management of sports injuries: the state of play. British journal of sports medicine. 2008 May 1;42(5):314-20.
25. Cavallo C, Roffi A, Grigolo B, Mariani E, Pratelli L, Merli G, Kon E, Marcacci M, Filardo G. Platelet-rich plasma: the choice of activation method affects the release of bioactive molecules. BioMed research international. 2016;2016(1):6591717.