

The History of Lumbar Arthroplasty

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INTRODUCTION: While laminectomies, discectomies, and spinal fusion procedures were considered the standard surgical treatment throughout the 20th century, the development of artificial disc technologies has introduced an alternative surgical intervention in the form of total disc replacement. Initially, the novel devices and treatment approaches attracted much attention causing a spike in the rates of disc replacement procedures performed, however, several years after the FDA approval of the first device, the prevalence of procedures steadily decreased and eventually plateaued. This trend is thought to be due to several factors such as the growing financial burden of hospitalization, inclusion criteria for procedure, and surgeons' overall familiarity of the procedure.

Although the popularity of total disc replacements has fluctuated, there are several benefits that indicate potential for future growth of the procedure and establish it as an appropriate alternative.

METHODS: A comprehensive review of the relevant data concerning lumbar arthroplasty was performed using the PubMed database. Inclusion criteria consisted of review articles that detailed the history of lumbar disc arthroplasty. The key words used in the search included "lumbar arthroplasty future", "lumbar arthroplasty trends", "lumbar arthroplasty review", and "lumbar arthroplasty". 354 articles were identified using these search terms and 45 articles were used in our review. Statistical analysis was not performed for this narrative review.

RESULTS SECTION: The referenced literature confirms fluctuating trends in both popularity and outcomes of patients who had undergone lumbar arthroplasty procedures in recent decades. In the United States, surgical treatment for degenerative disc disease (DDD) increased 2.4-fold in the United States while rate of fusions increased, and the rate of L-TDR did not increase significantly from 2000 to 2009. Additionally, there was a 10% increase in lumbar fusion procedures but a 28% decrease in lumbar arthroplasty between 2005 and 2008. Rates after 2008 also displayed a decrease in L-TDR (Figure 1). In a study conducted in 2022 and utilizing the NIS dataset, Mills et al. discovered a steep decline in L-TDR after 2009 until 2013 where rates then plateaued. This trend continued from 2013 through 2017 where only about 600 cases of TDR were performed per year. The opposite trend was found in fusion procedures which exponentially increased during the same time period. Overall, there was an 82% decrease in L-TDR from 2005-2017. The authors also found that although lumbar disc arthroplasty (LDA) was approved by the FDA prior to cervical disc arthroplasty (CDA), there was a 795% net increase of CDA usage from 2005 to 2017, which again contrasts with rates of LDA during the same time period.

DISCUSSION: The modern prosthetic discs seen today were perhaps first crudely modeled in the 1980s with the development of the SB Charité intervertebral disk prosthesis by Dr Karin Buettner-Janz and Dr. Kurt Schellnack at Charité Hospital in 1982. The initial European clinical experience involving a cohort of 93 patients featured some positive results, including noted pain relief and improvements in pain intensity, walking distance, and lumbar mobility. However, the limited follow up period (average follow up = 11.9 +/- 8.3 (n= 90) months) ultimately highlighted the need for further detailed studies with longer follow up periods to assess long-term efficacy and feasibility of disc replacement procedures. In 2001, a decade after the first ProDisc I implantation had occurred in Europe, the Prodisc-L began its FDA Investigational Device Exemption (IDE) trial and was later approved in 2006. Multiple other lumbar arthroplasty devices were developed during this period, as shown in Table 1. Overall, the reasons for the declining popularity of L- 2000s and early 2010s are likely due to inconsistent clinical results, difficulties with insurance authorization, concerning complications, advancements made in alternative procedures, and narrow inclusion criteria without recent studies attempting to expand the indications for this procedure. Though multiple long-term studies of LDRs have showed improved clinical and safety benefits with LDR at five years and beyond as well as demonstrate significant differences in reoperation rates and patients' satisfaction favoring arthroplasty to arthrodesis, more recent long-term, high-quality studies are necessary to evaluate new emerging designs and technologies that support the use of L-TDR. Most recent designs provide a substantial improvement over previous versions with safer and more effective motion preservation to prevent adjacent segmental disc disease (ASDD). With more studies evaluating these new designs to demonstrate more favorable outcomes along with slowly increasing coverage from insurance agencies, the future of lumbar disc replacement may be brighter than its previous trends as more surgeons become more aware of its benefits and educated in this procedure.

SIGNIFICANCE/CLINICAL RELEVANCE: This study sought to explore the history, current trends, and future of lumbar arthroplasty to provide a better idea on how this procedure can help thousands of patients with degenerative disc disease.

IMAGES AND TABLES:

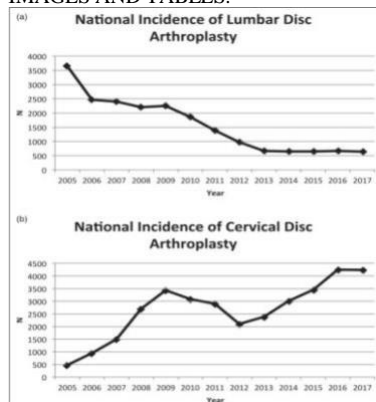


Figure 1. National incidence trends in lumbar and cervical disc arthroplasty.

Table 1. Lumbar disc arthroplasty implantation designs from 1987-2010.

device	design	year	current company	Status
Charité	Unconstrained	1987	Depuy	Discontinued
ProDisc-L	Semiconstrained	1999	Centinel Spine	FDA approved
activL	Semiconstrained	2005	Aesculap	FDA approved
Flexicore	Constrained, metal-on-metal	2005	Stryker	Withdrawn
Kinflex-L	Semiconstrained, metal-on-metal	2004	SpinalMotion	Withdrawn
Acroflex	Elastic core, Constrained	1998	Acromed Depuy	Discontinued
Maverick	Semiconstrained, metal-on-metal	2002	Medtronic	IDE trial complete, OUS only
Triumph	Semiconstrained, metal-on-metal	2008	Globus	IDE incomplete
XL TDR	One piece, laterally placed	2009	NuVasive	OUS only
Physio-L	One piece, elastomeric	2007	K2M	No IDE trial, OUS only
M6-L	One piece, elastomeric	2010	Orthofix	No IDE trial, OUS only
Freedom Disc	One piece, elastomeric	2010	AxioMed	IDE trial incomplete
LP-ESP	One piece, elastomeric	2005	FH Orthopedics	No IDE trial, OUS only