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Review

Review of early clinical results and complications associated with oblique lumbar interbody fusion (OLIF)

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ABSTRACT

Lumbar interbody fusion represents an effective surgical intervention for patients with lumbar degenerative diseases, spondylolisthesis, disc herniation, pseudoarthrosis and spinal deformities. Traditionally, conventional open anterior lumbar interbody fusion and posterior/transforaminal lumbar interbody fusion techniques have been employed with excellent results, but each with their own advantages and caveats. Most recently, the antero-oblique trajectory has been introduced, providing yet another corridor to access the lumbar spine. Termed the oblique lumbar interbody fusion, this approach accesses the spine between the anterior vessels and psoas muscles, avoiding both sets of structures to allow efficient clearance of the disc space and application of a large interbody device to afford distraction for foraminal decompression and endplate preparation for rapid and thorough fusion. This review aims to summarize the early clinical results and complications of this new technique and discusses potential future directions of research.

1. Introduction

Lumbar interbody fusion represents an effective surgical intervention for patients with lumbar degenerative diseases, spondylolisthesis, disc herniation, pseudoarthrosis and spinal deformities [1,2]. There have been great strides in the development of surgical techniques and implant technologies over the past decades. Traditionally, conventional open anterior lumbar interbody fusion (ALIF) [3] and posterior/transforaminal lumbar interbody fusion (PLIF/TLIF) [4–7] techniques have been employed with excellent results, but each with their own advantages and caveats. More recently, minimally invasive (MI) techniques have been developed and introduced in order to minimize surgical trauma, reduce bleeding and infection rates, while shortening hospitalization. Other advances in access approaches include the introduction of the lateral lumbar interbody fusion (LLIF) [8,9], which allows access to the lumbar spine via a lateral approach that passes through the retroperitoneal space and psoas muscle.

Most recently, the antero-oblique trajectory has been introduced, providing yet another corridor to access the lumbar spine. Termed the oblique lumbar interbody fusion (OLIF) [10], this approach accesses the spine between the anterior vessels and psoas muscles, avoiding both sets of structures to allow efficient clearance of disc space and application of a large interbody device to afford distraction for foraminal decompression and endplate preparation for rapid and thorough fusion. The OLIF approach is considered the solution to the caveats of both ALIF and LLIF techniques, the anterior approach being associated with iliac vessel and peritoneal injury [11–13], whilst the lateral approach is associated with psoas muscle splitting and limited lower lumbar spine access [14,15].

Whilst there is great interest currently in the antero-oblique approach, there have been few robust clinical studies investigating the efficacy, advantages and disadvantages of the OLIF approach. This review aims to summarize the early clinical results and complications of this new technique and discusses potential future directions of research.

2. Methods

The present systematic review was performed according to recommended Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [16,17]. A literature search was performed from six electronic databases, including Ovid Medline, PubMed, Cochrane Central Register of Controlled Trials (CCTR), Cochrane Database of Systematic Reviews (CDSR),

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American College of Physicians (ACP) Journal Club, and Database of Abstracts of Review of Effectiveness (DARE). Biomechanical, morphometric or clinical studies which reported complications, technique, efficacy, anatomy or animal or cadaveric studies on OLIF for lumbar degenerative disease were included. The level of evidence of search studies were appraised according to recommendations of the National Health and Medical Research Council guidelines (Supplementary Table 1). Example search strategies for Pubmed Central and Medline are demonstrated in Supplementary Table 2. The bibliographies of these papers were further searched for relevant references.

3. Results

A PRISMA flow-chart for the search strategy is presented in Fig. 1. A total of 224 studies were identified through six electronic database searches and from other sources such as reference lists. After exclusion of duplicate or irrelevant studies, 22 potentially relevant articles were retrieved. After detailed evaluation of these articles, 16 articles [3,10,18–31] remained for inclusion. Of these articles, two studies were cadaveric investigations [30,31], and three studies were published as abstracts [26–28]. There are a total of 712 patients included in this present systematic review, with the largest series of 186 patients from Hynes et al. and 179 patients from Silvestre et al. Study characteristics and outcomes were extracted and summarized in Table 1 and Fig. 2. The proportion of patients with degenerative disc disease (DDD) as an indication for OLIF ranged from 0%–92.6%. The proportion of patients receiving OLIF at the L5/S1 level ranged from 0%–100%. Operative duration ranged from 55–145.1 minutes, whilst blood loss ranged from 67.8–260 mL. Fusion rates ranged from 84%–100%.

4. Discussion

4.1. Rationale for new spinal access approaches

The current main approaches for accessing the lumbar spine include direct ALIF and LLIF [11,32] (Fig. 3a). The anterior approach is an excellent historical approach for the L5–S1 level, but with poorer access for levels above L3–L4. ALIF provides direct access to the intervertebral disc and allows easy removal and implant insertion without laminectomy or trauma to spinous ligaments, nerve roots and paraspinal musculature [13]. Improved correction of collapse disc height can also be achieved. However, given that ALIF requires the retraction of retroperitoneal vessels and tissue structures, there are potential risks of vessel injury [33]. Furthermore, in a small proportion of patients, retrograde ejaculation is also an unwanted complication of ALIF surgery due to trauma to the superior hypogastric plexus near the aortic bifurcation [33].

The lateral approach (Fig. 3b) LLIF offers several unique advantages. The lateral approach allows relatively easy access to multiple levels from T11–L4, with a trans-psoas approach which preserves the longitudinal ligaments of the spine, as well as posterior musculature. In contrast to ALIF, there is no direct trauma to the abdominal viscera, and can avoid injury to the peritoneum, great iliac vessels and sympathetic chain. However, given that the psoas is directly penetrated in this lateral technique, there have been reports of 10–20% of patients experiencing postoperative hip flexion weakness [34,35]. Precise surgical expertize is necessary so as not to injure local nerve plexuses, and with optimal technique, long term follow up data demonstrates similar fusion rates (clinical and radiological) in comparison to anterior and posterior approaches [36]. Thigh and groin pain may be other postoperative complications following LLIF if the genitofemoral nerve is stretched or injured. As outlined by Ozgur et al. [8] in 2006, there may be limited exposure throughout the lumbosacral region due to obstruction from the inferior margin of the 12th rib and the superior edge of the iliac crest. Given that the iliac crest obstructs the true lateral trajectory, LLIF is not possible at the L5/S1 level. As such, LLIF is often limited to lower thoracic and higher lumbar levels.

The "oblique corridor" or space between the anterior great vessels and the more lateral psoas muscles provides another new opportunity to access the lumbar spine. The following section describes early and recent clinical results of the antero-lumbar fusion approach or OLIF.

4.2. Early modifications leading up to OLIF

Anterior access corridors for lumbar fusion have been used and developed since they were introduced by Carpenter in 1932 [37]. During its initial introduction into clinical practice, indications for ALIF included spinal deformities, instability, tumours, infection, low back pain and pseudoarthrosis [38,39]. Uptake of this approach was not universal, with varied success rates achieved and considerable complication rates reported by some studies due to surgical trauma to the peritoneum and iliac vessels.

One of the very first modifications of the ALIF procedure was the use of multiple-splitting for less surgically traumatic anterior exposure. Fraser et al. in 1992 [40] reported an extensive retroperitoneal approach to the mid-lumbar and lumbosacral spine, which involved muscle splitting of the external oblique in the direction of the fibres but sparing of the internal oblique and transversus abdominus muscles. The peritoneus is then swept medially. Once retroperitoneal space access was obtained, the authors used three Steinman pins with two criss-crossed pins to retract the right and left common iliac veins laterally and superiorly, thus providing adequate exposure for disc and end-plate excision. Any median sacral vessels were coagulated with diathermy. From outcomes of 50 patients, no complications were reported in ALIF procedures.

As a further extension to the lateral approach by Fraser et al., Mayer [3] proposed several modifications in 1997, which is now considered by several groups to be the prelude to the modern day OLIF approach. Mayer described a MI anterior retroperitoneal

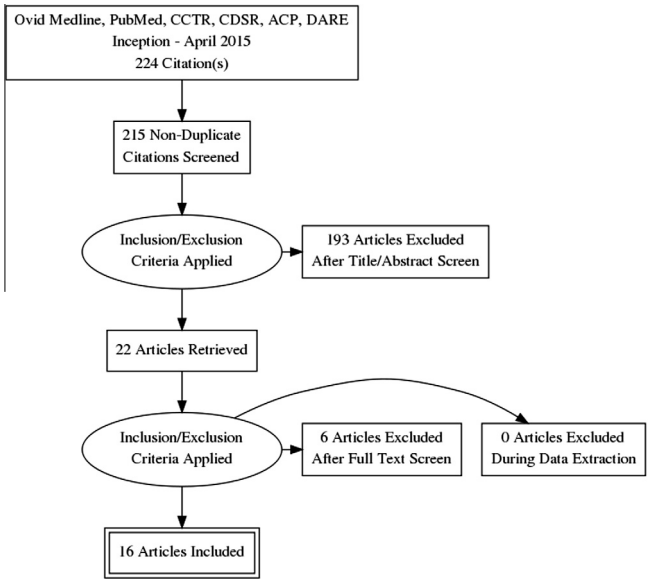

Fig. 1. PRISMA flow-chart for systematic review search strategy. CCTR = Cochrane Central Register of Controlled Trials; CDSR = Cochrane Database of Systematic Reviews, ACP = American College of Physicians Journal club, DARE = Database of Abstracts of Review of Effectiveness.