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Original Article

Stand-alone anterior lumbar interbody fusion – complications and perioperative results☆

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ABSTRACT

Objectives: Historically, anterior lumbar interbody fusion (ALIF) was related to high rates of intraoperative complications and adverse events related to interbody devices. In recent decades, there have been technical adjustments, and cages that are more suitable have emerged. The aim of this study is to evaluate the efficacy and complication rate of the use of stand-alone mini-ALIF using a self-locking cage.

Methods: Retrospective single center study. Inclusion criteria: retroperitoneal mini-ALIF for single-level fusion (L5S1); self-locking cage; DDD/stenosis and grade I spondylolisthesis. Exclusion criteria: posterior supplementation, previous fusion/arthroplasty. Endpoints: surgery data, intraoperative and perioperative adverse events related both to surgical access and to the intersomatic device.

Results: Eighty-seven cases were enrolled. Median surgical time was 90 min; median blood loss was 100 mL. The median length of stay in the ICU was zero days; median hospital stay was one day. Ten cases had an adverse event (11.5%): four major adverse events (4.6%; 3 L bleeding; DVT; retroperitoneal haematoma; incisional hernia), and seven minor events (8%; peritoneum injury; minor vascular injury; events related to the cage). No cases of retrograde ejaculation were observed. There was improvement in pain, physical restriction, and quality of life ($p < 0.001$).

Conclusions: The mini-ALIF procedure performed for single-level fusion at the distal lumbar level demonstrated low adverse event rates related to both the surgical approach and to the intersomatic device, with reduced hospital stay and satisfactory perioperative clinical results.

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Artrodese lombar intersomática anterior por via única – Complicações e resultados perioperatórios

Palavras-chave:
Coluna vertebral
Fusão espinal
Artrodese
Vértebras lombares

RESUMO

Objetivos: Historicamente, a fusão intersomática lombar anterior (ALIF) esteve relacionada a altas taxas de complicações intraoperatórias e eventos adversos relacionados aos dispositivos intercorporais. Nas últimas décadas, ocorreram ajustes técnicos que propiciaram o surgimento de *cages* mais adequadas. Este estudo teve como objetivo avaliar as complicações e eficácia do uso de via única por mini-ALIF com uso de *cage* autobloqueante.

Métodos: Estudo retrospectivo de centro único. Critérios de inclusão: mini-ALIF retroperitoneal para a fusão de nível único (L5S1); *cage* autobloqueante; DDD/estenose e espondilolistese de baixo grau (grau I). Critérios de exclusão: suplementação posterior; fusão/artroplastia prévia. Foram analisados dados de cirurgia, complicações intra e perioperatórias relacionadas ao acesso cirúrgico e ao dispositivo intersomático.

Resultados: Foram incluídos 87 casos, todos no nível lombar distal. Mediana de tempo cirúrgico: 90 min; mediana de perda sanguínea: 100 mL. A mediana do tempo de internação na UTI foi zero dia; a mediana de internação hospitalar foi de um dia. Dez casos (11,5%) apresentaram eventos adversos, quatro maiores (4,6%; sangramento de 3 L; TVP; haematoma retroperitoneal; hérnia incisional) e sete menores (8%; lesão de peritônio; lesão vascular menor; ocorrências relacionadas ao implante). Nenhum caso de ejaculação retrógrada foi observado. Houve melhoria em dor, restrição física e qualidade de vida ($p < 0{,}001$).

Conclusões: O procedimento mini-ALIF feito em um único nível distal lombar apresentou baixas taxas de eventos adversos intra e perioperatórios, tanto quanto à abordagem e ao dispositivo, reduzida estada hospitalar e bons resultados clínicos perioperatórios.

Introduction

Lumbar interbody fusion can be performed through different accesses (anterior, anterolateral, lateral, transforaminal and posterior). The advantages of the anterior approach (anterior lumbar interbody fusion, ALIF) include the possibility of disc space re-expansion, lumbar lordosis recovery, indirect decompression, prevention of damage to posterior structures (paravertebral and osteoligamentous muscle) and morbidity and immediate perioperative pain reduction.[1–5]

The anterior interbody lumbar fusion technique was initially used by Burns[6] and Capener,[7] developed as one of the predominant techniques for the treatment of discogenic lumbar pain. Historically, ALIF has been linked to high rates of intraoperative complications, because of the transperitoneal pathway and adverse events related to fusion devices due to lack of adequate cages.[8–10]

Recently, with the adaptation of surgical access techniques and better interbody devices, it has been possible to obtain satisfactory rates of complications and high fusion rates.[11] Thus, it may be advantageous to perform arthrodesis with adequate cages by a less traumatic anterior approach.

The objective of the present study was to evaluate the complications and perioperative results of mini-ALIF anterior stand-alone interbody fusion surgery with the use of self-locking cage at L5S1 level.

Materials and methods

This is a retrospective study with data collected prospectively from a single medical center. It was submitted to and approved by the Research Ethics Committee (52909516.3.0000.5551). Patients selected had undergone ALIF technique by the same spine surgery team from 2009 to 2016. Inclusion: retroperitoneal mini-ALIF for single-level fusion; self-locking ALIF cage; degenerative disc disease (DDD, with or without stenosis), or low grade spondylolisthesis (grade I). Exclusion: posterior or anterior additional supplementation; fusion/prior arthroplasty; cages with angulation greater than 15 degrees of lordosis.

A retroperitoneal access was performed by senior spine surgeons trained in general surgery, with no mandatory participation of an access surgeon. Data related to the surgery and the review rate were analyzed. General and device-related complications with up to 3 months of the procedure were also evaluated: end-plate fracture, device migration or displacement. Secondary outcomes were the clinical results assessed through questionnaires: VAS (visual analogue scale) for back and leg pain and ODI (Oswestry Disability Index)

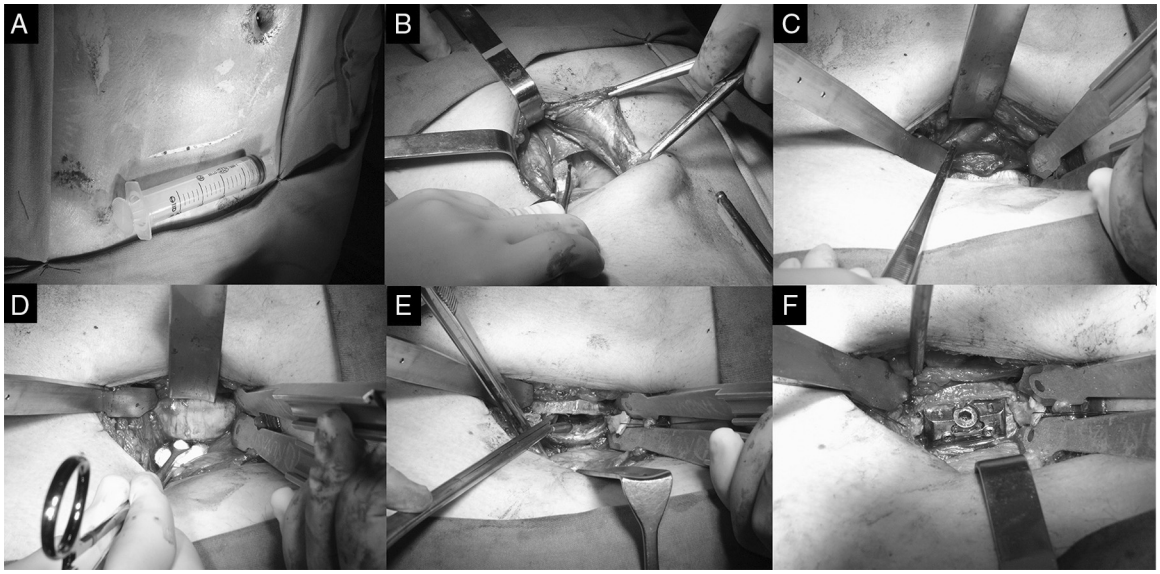

Fig. 1 – Images representing anterior retroperitoneal access to the L5-S1 disc space. (A) Abdominal incision; (B) passage through the abdominal muscles; (C) identification of the bifurcation of the great vessels in front of the disc space of L5S1; (D) exposure of the anterior face of the intervertebral disc; (E) discectomy and preparation of the disc space for arthrodesis and (F) interbody implant secured with locking screws into the disc space.

analyzed in the perioperative period and up to three months of follow-up.

Surgical technique

The modern surgical technique of an anterior access with the use of a blunt passage through the abdominal musculature, retroperitoneal surgical approach, and direct view to access the L5S1 disc space has been called mini-ALIF. The patient is placed in a supine position on a standard radiolucent surgical table. The degree of lumbar lordosis should be observed, and a pad placed under the patient at the level of the lumbar spine to raise it, which not only opens the anterior space to facilitate discectomy but also allows easier placement of the implant with some degree of angulation (lordosis). All patients underwent the anterior approach to the lumbosacral spine. A mini-Pfannenstiel incision was used to access L5-S1 level.

Blunt dissection is used to mobilize the anterior sheath of the rectus abdominis muscle to access the retroperitoneal space. Palpation of large vessels helps prevent vascular lesions. The ureter should be identified to avoid its inadvertent damage, and this is typically found on the peritoneal side of the exposure.

Autostatic retractors are deeply placed, and attached to a device assembled on the surgical table to keep the view of the spine in midline. The use of curare-like drugs facilitates exposure and ensures correct positioning of the retractors. For the exposure of L5-S1 space, the disc can be normally accessed below the bifurcation of the large vessels. The transverse segmental arteries to the disc space or the arterial branches of the aorta need to be securely ligated. Iliolumbar veins can also be the cause of problems related to bleeding. The median sacral artery and its vein need to be ligated to allow access below the bifurcation.

The excessive use of electrocautery along the anterior longitudinal ligament must be avoided to prevent sympathetic hypogastric plexus injury, which may result in retrograde ejaculation. The anterior longitudinal ligament is then opened with a scalpel, and the complete removal of the intervertebral disc with curettes is performed. The posterior longitudinal ligament is maintained and the lateral ring portions are opened to the level that allows insertion of the interbody spacer implants. Following extensive discectomy and removal of the end plate, the intervertebral implants are impacted and locking screws are passed through the cages towards the adjacent vertebral bodies. Illustrative images of the surgical procedure are shown in Figs. 1 and 2.

Results

We analyzed 87 cases (50 female individuals, mean age 44 years, mean BMI 26.6 kg/m^2). All cases were at the most distal lumbar level (L5S1 or between L5/L4 and transitional vertebra). The data of the studied group are shown in Table 1. Average case follow-up was 46 months after surgery (minimum 3 and maximum 84 months).

Information regarding the surgical procedure and hospital admission are shown in Table 2. Mean surgical time was 98 min (SD 24; 40–150); median blood loss 100 mL (SD 455; 50–3000); mean time of admission in an ICU was zero day (SD 0.3; 0–1); median hospital stay of one day (SD 0.6; 1–3).

The occurrences of adverse events are shown in Table 3. There were 10 (11.5%) events, four (4.6%) major and seven (7%) minor events. Eight cases (9.2%) were adverse events related to surgery, four of them (4.6%) were intraoperative. These consisted of two (2.3%) minor peritoneal violations (intraoperative repair); one (1.1%) minor vascular damage (intraoperative repair); one (1.1%) major vascular damage (3 L, intraoperative

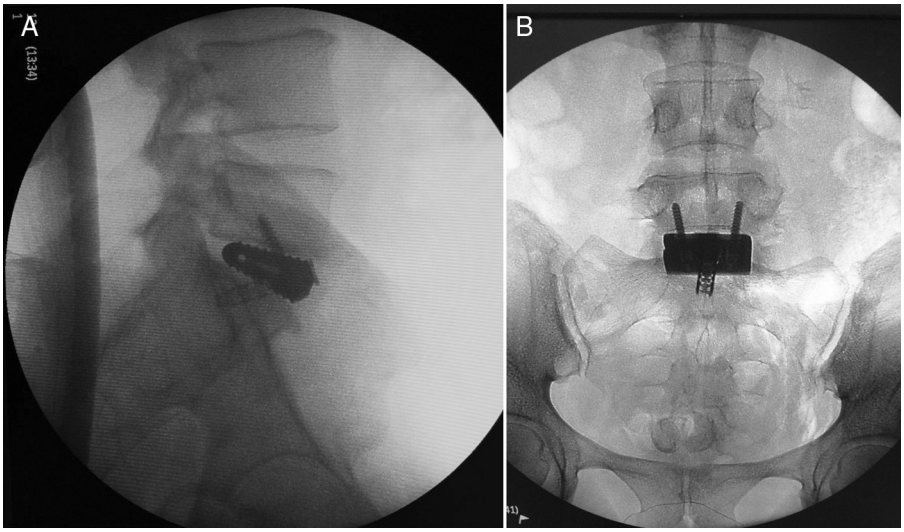

Fig. 2 – Images of intraoperative fluoroscopy showing final positioning of the interbody spacer. (A) Lateral view and (B) anteroposterior view evidencing the titanium spacer and the locking screws towards the adjacent vertebral bodies.

Table 1 – Demographic and preoperative data.

Total (*n*)	87
Age (years)	44 ± 11
Gender (female)	50 (64%)
BMI (kg/m^2)	26.6 ± 4.1
Levels treated	87
Disc degenerative disease	45 (51%)
DDD + stenosis	19 (22%)
Spondylolisthesis	16 (18%)
Post discectomy	8 (9%)
L5S1	81 (93%)
L4TV	2 (2%)
L5TV	4 (4%)

BMI, body mass index; DDD, disc degenerative disease.
Values shown in median ± standard deviation or in absolute number (and percentage).

Table 2 – Surgical and perioperative data.

Duration	90 (98) ± 24 min
Blood loss	100 (171) ± 455 mL
ICU admission	0 (0.2) ± 0.2 dia
Hospital admission	1.5 (1.6) ± 0.6 dia

Values shown in median (mean) ± standard deviation.

Table 3 – Adverse events.

INTRAOP		
Vascular		
Venous damage (1[a])	2 (1[a])	2%
Arterial damage	0	0%
Accidental opening of the peritoneum	2	2%
Visceral lesion	0	0%
PERIOP		
Infection		
Superficial	1	1%
Deep	0	0%
DVT[a]	1[a]	1%
Retroperitoneal hematoma[a]	1[a]	1%
Incisional hernia[a]	1[a]	1%
Retrograde ejaculation	0	0%
Implant	2	2%
TOTAL	**10**	**11%**
Major adverse events	4	5%
Minor adverse events	7	8%

Values shown in absolute numbers and percentage.
[a] Major adverse events.

Table 4 – Short-term clinical results.

	Preop	1 week	6 weeks	3 months
Back VAS	7.4	4.0[a]	3.7[a]	4.2[a]
Lower limbs VAS	5.1	3[a]	2.9[a]	2.8[a]
ODI	44	39	34[a]	31[a]
EQ-5D	0.59	0.65	0.70[a]	0.76[a]

Values shown in mean.
[a] Statistically lower than the preoperative value.

controlled lesion). Postoperative events were one (1.1%) deep vein thrombosis, one (1.1%) retroperitoneal haematoma (additional surgery required for drainage), one (1.1%) incisional hernia (required surgical repair), and one (1.1%) superficial intraoperative wound infection. There was no case of retrograde ejaculation in this series. Regarding the two cases (2.3%) of postoperative events related to the implant, we report one case of sinking and one of poor positioning. No cases of expulsion or migration of the implant were observed. There were no cases of death.

Short-term clinical results showed a statistically significant clinical improvement in the cases treated. Pain symptoms showed a decrease at just one week of follow-up after surgery ($p < 0.001$). Physical restraint and quality of life improved after six weeks of follow-up ($p < 0.006$). The results are shown in Table 4. At three months, the pain scale showed a 43% improvement in lumbar axial symptoms, and a 45%

improvement in symptoms irradiated to the lower limbs. The ODI scale showed a 30% improvement in physical restraint, and a 29% improvement in quality of life.

Discussion

This study evaluated the use of the mini-ALIF stand-alone approach regarding its complications and its intra and perioperative results. An 11% rate of adverse events (minor and major) with only 4% of major adverse events was found, which resulted in reduced hospital stay (average 1.6 days) and improvement of pain after a week of surgery. It is worth mentioning that the present study analyzed only cases without previous arthrodesis or interbody surgery, and only in the last mobile level of the spine (L5S1); this is the technically less challenging level, with faster access (about 20 min) and that potentially leads to fewer complications.[12]

The overload of segments adjacent to a fusion is due to poor alignment in the sagittal plane,[13] procedures that cause posterior destabilization (damage to the paravertebral muscles and osteoligamentary structures),[14] and violation of the upper articular facets by the shaft and screws (kicking spine).[15] The stand-alone option (with no further supplementation) with only impacted or threaded cages in the disc space has shown many flaws in the history of spinal surgery.[8,16] Currently, the traditional options for instrumentation in ALIF short fusions are cage and transpedicular screws or cage and anterior plate.

The most modern form of instrumentation in ALIF is the stand-alone option with self-locking cages. The great advantage of this option would be the possibility to perform the procedure through an anterior approach, in a stand-alone procedure, without injury or iatrogenesis of the posterior elements of the spine. Thus, the procedure becomes less invasive and allows the patient the opportunity of low perioperative morbidity and rapid postoperative mobilization.[1,17]

Unlike the old stand-alone option, self-locking spacers now provide very satisfactory biomechanical stability, with characteristics that are similar to construction with transpedicular screws[15,18,19] and different from only impacted cages.[20] Obviously, the use of the stand-alone option should be recommended for less unstable lumbar levels, it may even include spondylolisthesis,[21–24] but in cases with bone failures (such as pars lysis), they may generate an abnormal movement, and result in arthrodesis failure.[25]

The disadvantages of ALIF are related to possible adverse events related to peritoneal and retroperitoneal structures. In Brazil and in other countries the access to the intervertebral disc in an ALIF is usually obtained by an access surgeon (general or vascular surgeon)[26] in order to reduce the possibility of intra and perioperative complications. However, this practice is not mandatory and depends on whether the surgeon has the training and the ability to do so. Historically, the European school of spine surgery has a basic training for anterior access surgeries,[27] and the American school is beginning to embark on this practice. This fact is evidenced by Jarret et al.[28] in an article that evaluates the incidence of complications in the presence or absence of access surgeons in spine surgeries. No differences were observed. This shows that it depends a lot on the spine surgeon's experience and training.

The vascular lesions are potentially among the most severe intraoperative complications. They are considered to be the most devastating complications with an injury rate reported in the literature of 1–40%,[12,26,27,29] depending on the experience of the group and the type of case treated; occurrences at L4L5 level are more frequent.[30] In this study, with access only to L5S1, we noted 2.3% of vascular lesions observed during surgery, and probably one more event not observed during the procedure (total 3.4%), but that led to a retroperitoneal haematoma noticed some days after surgery. Arterial lesions occur less frequently than venous lesions, and the most common types of vascular injury are laceration of the iliac vein, inferior vena cava and ileolumbar vein. Not all vascular lesions are severe, and some of them can be simply solved during the procedure, as we observed with minor lesions in our study. In the article by Quraishi et al.,[27] in which there were 24/304 (7.8%) vascular problems of different magnitudes, 9/304 (3% of the total or 38% of the lesions) the presence of a vascular surgeon was required.

Some attitudes can help avoiding injuries, such as the use of a curved haemostatic forceps with a small piece of gauze or cotton wool on its tip. This forceps is used at the time of dissection of the anterior longitudinal ligament and disc, for better visualization of the disc space. The median sacral artery and vein are divided with vascular clips, or ligated.[12] One of the possible adverse events is that of retrograde ejaculation if there is upper hypogastric plexus injury. Although being feared, the reported incidence is low, as observed in this study and in the literature, 0.1–8% of the cases, depending on the technique used.[12] With a more refined exposure technique, and currently less use of electrocautery, the rate of retrograde ejaculation is the lowest observed in the history of spinal surgery. Although possible, incisional hernias are rare complications if a meticulous closure in planes is performed after the mini-ALIF.[12]

Conclusion

The procedure of lumbar interbody arthrodesis at a single lumbar distal level via an anterior mini-open access demonstrated low rates of adverse events, both regarding the surgical approach and the interbody device. The perioperative data showed a shorter hospitalization, rare use of ICU, and good improvement of clinical parameters and quality of life. A surgical group with professionals with access experience is necessary to keep the reproducibility of the surgical procedure.

Conflicts of interest

The authors declare no conflicts of interest.

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