The use of autogenous laminar graft in lateral transforaminal lumbar interbody fusion for the treatment of low-grade isthmic spondylolisthesis

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Introduction
Low-grade spondylolisthesis often presents with low back pain and radicular symptoms and often requires surgical intervention in the form of decompression and instrumented fusion.
Objective
The aim of this study was to evaluate the safety and efficacy of transforaminal lumbar interbody fusion using autologous laminar strut grafts in low-grade isthmic spondylolisthesis.
Patients and methods
A total of 15 patients in a prospective cohort study have been clinically evaluated between January 2014 and August 2017 after performing transforaminal lumbar interbody fusion using autologous laminar strut grafts.
Results
Mean operative (OR) time was 156 min, and mean estimated blood loss was 377 ml. Three patients required packed red blood cells transfusion. The mean length of stay at the hospitals was 4 days. One patient had an accidental durotomy and one patient developed low-grade fever. One patient developed superficial infection. None of the patients developed any neurologic deficits. All patients showed evidence of fusion and bony bridging between the vertebral bodies within 6 months after the surgeries.
Conclusion
The technique of using laminar strut grafts in the treatment of patients with low-grade isthmic spondylolisthesis is safe and with low complications rate.

Keywords:
disc space, isthmic spondylolisthesis, lumbar spine

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Introduction

Isthmic spondylolisthesis is forward slippage of vertebrae over the caudal vertebrae owing to a defect in the pars interarticularis. The incidence of isthmic spondylolisthesis is 6% in the general population [1]. It commonly affects the L5 vertebra, and then L4 vertebra. In the presence of bilateral pars defects, a loose laminar fragment is developed (Gill fragment) owing to the presence of pseudoarthrosis, and subsequently, fibrocartilaginous tissue proliferates at the site of the pars defect leading to irritation of the nerve roots [2]. The initial treatment usually involves anti-inflammatory medications and steroid injections, combined with physical therapy in the form of back strengthening, hamstring stretching, and avoiding hyperlordosis of the spine.

The surgical treatment involves vertebral fusion, which can be performed with or without instrumentation, but the addition of pedicle screws in the posterolateral spinal fusions offers great immediate stability to the fusion process as compared with noninstrumented fusion [3–5]. Furthermore, adding anterior column support in the form of interbody grafting offers great 360° form of fusion. The advantages of interbody fusion include removal of the degenerated disc material, and replacing it with a graft that spans most of the surface between the vertebrae, improving segmental lordosis and indirect decompression of neural foramina by increasing the height of the disc space.

Surgical decompression is indicated in the presence of neural compression and the presence of sphincteric dysfunction [6]. Decompression usually involves removal of the Gill fragment, hypertrophic tissues, and any compressive bony or ligamentous tissue compressing the thecal sac and the nerve roots, but decompression alone may lead to progression of the

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slippage; hence, fusion is done in conjunction with decompression [7,8].

Posterior Lumbar Interbody Fusion (PLIF) was first popularized by Briggs and Milligan in the 1940s, when the excised part of the spinous process is impacted it in the disc space for the sake of achieving Interbody fusion [9]. PLIF involves some degree of medial retraction of the dural sac to gain access to the disc space, without the need of doing complete facetectomy.

Transforaminal lumbar interbody fusion (TLIF) was popularized by Harms and Rolinger [10], and it involves the removal of the facet joint, to gain access to the disc space from a further lateral entry as compared with PLIF. Placement of the TLIF cages at the front of the disc space in front of the instantaneous axis of rotation with compression at the screws leads to improvement of the segmental lumbar lordosis [11]. Both TLIF and PLIF could be performed through a standard open midline approach, or a minimally invasive paramedian small incisions.

Anterior lumbar interbody fusion involves gaining access to the disc space from the front, via a retroperitoneal or transperitoneal approach. Anterior lumbar interbody fusion and oblique lateral interbody fusion approaches provide great exposure of the disc space and more ability to improve the lumbar lordosis, but there is an additional risk of injury to the surrounding neurovascular and visceral structures. Various structures and fusion materials have been often extensively used for TLIF: morcelized bone graft, peak cages, carbon fiber cages and titanium cages, and allografts [12,13]. The purpose of this study was to evaluate the effectiveness and complications of the use of local struts from the Gill fragment as a structural graft between the vertebral bodies without the use synthetic cage in cases of low-grade isthmic spondylolisthesis.

Patients and methods

After institutional ethics committee approval, a prospective analysis was performed at Beni Suef University hospitals on 15 patients diagnosed with isthmic spondylolisthesis between January 2014 and August 2017. Data collected included age, sex, occupation, workload, smoking status, and analgesic administration.

Inclusion criteria included patients with grades 1 and 2 isthmic spondylolisthesis who underwent conservative management for 3–6 months. Exclusion criteria included patients who had previous spinal surgeries, neoplastic, traumatic, and degenerative etiology for spondylolisthesis. All comorbidities were documented in the cohort. All surgeries were performed by the author, A.A. We collected the visual analog scale (VAS) parameters from the patient files before and after the surgery (6 and 12 months postoperatively) [14].

Demographically, there were five males and 10 females. Average age was 42 years old (29–55 years). All patients had significant low back pain and radicular symptoms. Conservative management was tried first in the form of physical therapy and steroid injections. All patients were evaluated by plain radiographs (anteroposterior and lateral views), computed tomography scans, and MRI scans. Eleven patients had grade one slippage, according to Myerding classification [15], three had grade 2 slippage, and one had grade 3 slippage. Moreover, 10 patients had the slip at the L5-S1 level, four at the L4-5 level, and one at L3-4 level. Data collected included the operative (OR) time, amount of blood loss, packed red blood cells transfusion, hospital stay, and the presence of any intraoperative or postoperative medical or surgical adverse events.

Operative technique

Patients were given intravenous antibiotic prophylaxis (first generation cephalosporin). After induction of general anesthesia, patients were carefully prone positioned on the operating table. Adequate padding of the chest and iliac crests was done, and all bony prominences were adequately protected. Abdomen was hanging free. The skin of the back was properly prepared and draped. Then the incision was marked using fluoroscopy.

A small 3–5 cm midline longitudinal incision was done centered on the targeted levels. Dissection then was carried out in layers in a subperiosteal fashion with meticulous attention to hemostasis. The targeted level is then identified, and a loose laminar fragment is identified comprising the non-united lamina (Gill fragment). Pedicle screws are then inserted after carefully localizing, drilling, palpating, tapping, and then re-palpating the pedicle screws tracts. After confirmation of adequate positioning of the screws with the aid of fluoroscopy, we then started the decompression of the neural elements by removing the loose laminar fragment in one piece as it will later serve as the source of strut graft material for interbody fusion. Then we started removing the ligamentum flavum, and any hypertrophied cartilage at the pars defect site and exposed the dural sac and nerve roots.

Careful hemostasis and control of epidural venous bleeding was performed using bipolar electrocautery. Then, unilateral excision of the inferior and the superior articular processes to enter the intervertebral foramen was done. A contralateral temporary rod was usually inserted and then a gentle distraction was performed on the contralateral pedicle screws to distract the disc space and facilitate the disc preparation process (Fig. 1).

After exposing the disc space, we used size eleven blade to cut the annulus fibrosus, and then, we started removing the disc material using pituitary rongeurs, and microcurettes. We then used a trial instrument to determine the size of the graft. We impacted small pieces of morcelized bone graft at the front of the disc space. Then, we started preparing the excised laminar fragment and cut it into three pieces and used them as strut grafts between the vertebral bodies. We used cutting rongeurs to make the size of the strut grafts as close to the sizing template as possible. We then checked the position of the strut grafts using fluoroscopy. The temporary contralateral rod was then removed, and two small contoured rods were then cut and secured to the pedicle screws on both sides. Gentle compression is then done across the screws to compress the strut grafts and then final tightening was performed. Any remaining morcelized graft was then inserted in the intertransverse space. Irrigation and then suction drain was then inserted under the fascia. The wound was then closed in layers (Figs 2 and 3).

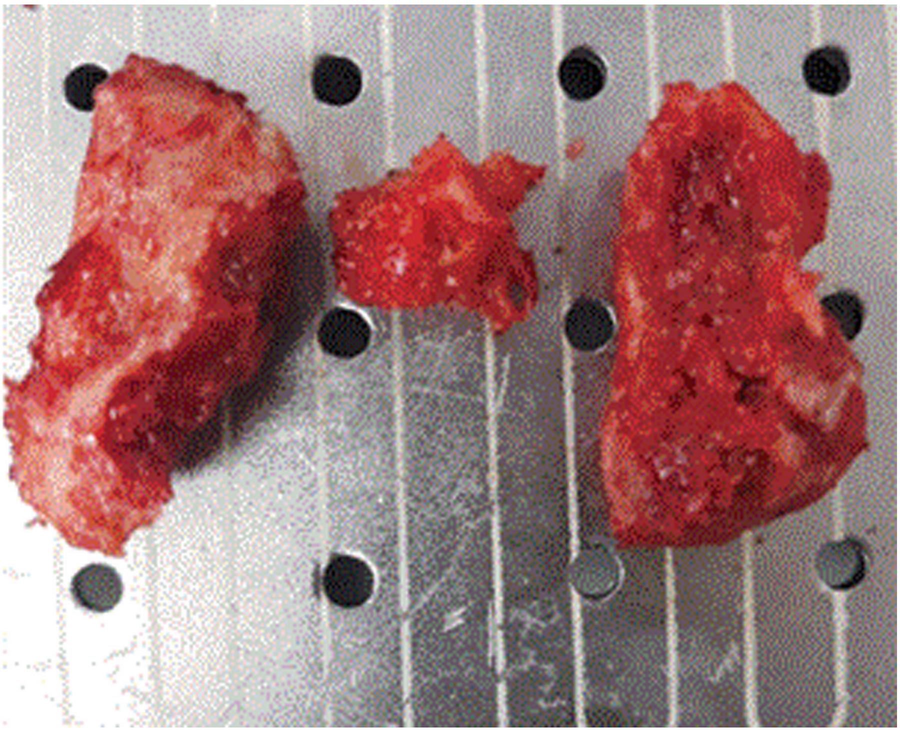
Results

After performing prospective analysis, the mean operative (OR) time was 156 min (range: 120–180 min), and mean estimated blood loss was 377 ml (range: 200–500 ml). Of the 15 patients, three (20%) required postoperative packed red blood cells transfusion (500 ml) owing to low hemoglobin level. The mean length of stay at the hospitals was 4 days (range: 3–5 days). During the surgery, one patient encountered an accidental durotomy (6.6%), which was repaired with a 4/0 proline suture with no further leakage.

In the postoperative period, one (6.6%) patient developed low-grade fever, which was resolved uneventfully. One (6.6%) patient developed mild superficial infection, which resolved with repeated dry dressings and oral antibiotic therapy. None of the patients developed any neurologic deficits. One (6.6%) patient developed urinary tract infection, and it was treated uneventfully.

Follow-up ranged between 6 months and 2 years. During that period, 14 (93%) of the 15 patients reported improvement of back and leg pain, and none of them

Figure 1



Gill fragment, removed and cut into strut grafts.

Figure 2

Preoperative T2 Sagittal MRI.

Figure 3

Postoperative radiography at 1-year follow-up.

required any opioid medications. One (6.6%) patient had persistent mild leg discomfort after the surgery and was treated by pain medications. All patients had improved functional outcomes and all were able to carry out normal activities of daily living. The average preoperative VAS was 6.73. At 6 and 12 months of follow-up, the average VAS was 3.81 and 2.98, respectively.

Radiologically, radiographs and computed tomography scans showed well-positioned hardware, and all patients showed evidence of fusion and bony bridging between the vertebral bodies (based on Brantigan criteria) within 6 months after the surgeries [16]. Reduction of the slip was obtained in 13 (87%) of the 15 patients, and the remaining two patients had near-full reduction (Tables 1–4).

Discussion

The most common procedure for the surgical treatment of isthmic spondylolisthesis is instrumented lumbar fusion and decompression, which gives better results

Table 1 Preoperative demographic data

Demographic data	
Number of patients	15
Age (mean)	42
Sex (%)	
Male	33.3
Female	66.6
Slip level [*n* (%)]	
L5-S1	10 (66.6)
L4-5	4 (26.6)
L3-4	1 (6)

Table 2 Preoperative data/slip level/grade

Patients	Age	Gender	Level	Grade
1	33	Male	4-5	2
2	42	Female	5-1	1
3	44	Female	5-1	1
4	50	Male	3-4	1
5	48	Male	4-5	1
6	39	Female	5-1	2
7	45	Male	5-1	1
8	41	Female	5-1	3
9	53	Female	5-1	1
10	55	Female	4-5	2
11	38	Female	5-1	1
12	41	Female	5-1	1
13	40	Female	5-1	1
14	29	Male	5-1	1
15	37	Female	4-5	2

Table 3 Operative data

	EBL	PRBCs	OR time	AE	LOS
1	400	0	180		5
2	300	0	180		3
3	400	0	150		4
4	500	0	180		4
5	400	0	150		3
6	350	0	120		4
7	300	0	150	Urinary infection	5
8	200	0	180		4
9	300	500	150	Dural tear	4
10	350	0	150		3
11	400	500	180	Pneumonia	7
12	500	0	120		4
13	500	500	150		5
14	400	0	150	Fever	4
15	350	0	150		3

AE, adverse events; EBL, estimated blood loss in ml; LOS, length of stay in the hospital in days; OR, operative time in minutes; PRBCs, packed red blood cells transfusion in ml.

Table 4 Visual analog scale

Visual analog scale	
Preoperative VAS for low back pain	6.73
6 months postoperative	3.81
12 months postoperative	2.98

VAS, visual analog scale.

when compared with decompression alone [17]. This study describes the use of autogenous laminar strut grafts for TLIF in patients with low-grade spondylolisthesis. In 1984, a similar technique to what we used in this study was described, where corticocancellous chips where used for noninstrumented lumbar interbody fusion [18,19]. Decades later, interbody fusion has been proven to show many advantages such as circumferential fusion, anterior column support and load sharing, and better lordosis. Graft material is under compression on a large surface area

PLIF involves excessive medial retraction of the thecal sac and dural scarring with possible development of postoperative neurological deficits. TLIF has the advantage of accessing the disc space without overzealous neural retraction. Moreover, only single side is needed to access and fuse the vertebral bodies as opposed to standard PLIF. In our study, we had 0% neurologic injuries, which is similar to previous reports [20,21].

Many disc spacers have been used for interbody fusion, for example polyetheretherketone (PEEK) cages, Titanium cages, and Allografts. Titanium has the highest rigidity among interbody devices, which has been reported to be related to the occurrence of subsidence and disc space height loss [10]. Femoral head allografts have the advantages of serving as a scaffolding material for bone growth, but also, subsidence and disc space collapse have been reported [9]. The PEEK cages were popularized owing to its radiolucency, low rigidity, and less subsidence as compared with the titanium and allografts spacers. PEEK cages have a modulus of elasticity close to that of cortical bones [22].

For the fusion process to happen between the vertebral bodies, the interbody spacers have to possess both osteoinductive and osteoconductive properties. Iliac crest strut grafts have these properties, but graft site morbidity, including persistent pain, infection, sensory loss, and wound dehiscence, has diverted many surgeons to look for alternative [23,24].

Allografts have good osteoconductive properties but lack the osteoinductive ones, although reports denote that there is no difference in the rate of fusion between them and iliac crest grafts when used for interbody fusion [25]. The use of local autograft has been used as an alternative to iliac crest grafts, although it is less osteoinductive but eliminate the morbidity of harvesting bone from the iliac crest. Fusion rates of 93% have been reported with the use of local bone from the lamina and facet joints when combined with synthetic cages [26].

In our study, we evaluated the efficacy and complications of using laminar strut graft in between the vertebral bodies instead of using synthetic cages. There were no serious complications in our cohort of patients, the mean OR time was 156 min and mean blood loss was 377 ml. the mean hospital stay was 4 days. Follow-up radiographies showed 100% fusion rates, and all patients showed very good recovery of activities of daily living. We believe that this technique is efficient, and potentially can save the cost of interbody devices. The average cost of interbody cage is 2500 LE. So, by adopting this technique in the context of low budget in the developing countries like Egypt, we can save a significant amount of the cost of the hardware.

Conclusion

We conclude that the use of TLIF utilizing autogenous laminar strut grafts in patients with low-grade isthmic spondylolisthesis is a safe and cost-effective technique of treatment with low complications rate.

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Conflicts of interest

There are no conflicts of interest.

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