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Adding posterolateral fusion to interbody cage fusion improves the fusion rate through fusion of the three columns of the motion segment which is called circumferential or global fusion through posterior approach alone without another anterior approach (Wheatherley, C.R. et al., 1986).

All patients with combined interbody cage fusion and posterolateral fusion had no back pain or back catch. Moreover, patients with posterior circumferenitial fusion had grade-5 fusion and had no cage complications (Weatherley, C.R. et al., 1986).

Reduction of grade I spondylolisthesis was not our goal in this study and the results proved that there was no need for reduction.

Intraoperative difficulties were more in patients, with failed previous back surgery. However, patients with failed back surgery gained benefit from circumferential fusion more than interbody fusion alone.

Pedicular fracture intraoperatively were attributed to technical difficulties of the K2 rod screw system, that was used in our study. The two patients with temporary foot drop had postlaminectomy spondlylolisthesis and stenosis, and the other one had isthmic spondlylolisthesis and stenosis. This happened because of the decompression which was undertaken for neural tissues. We found that ample spinal decompression was needed to avoid injury to neural structures and to facilitate cage insertion.

Steffe and Sitkowski in 1988 performed PLIF with posterior plates and screws in 36 patients and obtained 92% satisfactory clinical results. Yashiro, et al. (1991), managed 30 patient with the same technique and obtained 93% radiological fusion. In our series, we have 83.3% excellent clinical results and 16.6% good clinical results. Also, our radiological results regarding fusion were 100% (83.3% grade 5, 8.3% grade 4 and 8.3% grade 3).

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Interbody cage made of Poly-Ether-Ether Ketone (PEEK) has the following features; radiolucency permits with x-ray a precise follow-up of bony fusion and a metal marker provides the exact location on the x-ray pictures. PEEK cages have an elastic modulus close to that of bone, so the graft of is under optimal fusion conditions (Tencer, A.F. et al., 1995) (Fig. 11).

PEEK cage has a unique bullet shape which facilitates the intracanal navigation, limiting neural injuries and dural tears. It also has a wide and stable supporting surface with optimal surface contact between the graft (inside the cage) and the subchondral bone, which assures bony fusion. A wide serrated weight bearing surface provides immediate stability and prevents. implant migration. A range of lordotic cages are available in 0o, 4o and 8o version, inducing perfect adaptation to the lumbar lordosis which can be preserved or restored (Oxland, T.R. et al., 1996).

Adding posterior interpedicular screws fixation balances the cage, prevents failure of cage in extension and prevents dislodgment of the cage. It also correct the lumbar deformity, restores disc height and physiological posterior column support (Brore, D.S. et al., 1997).

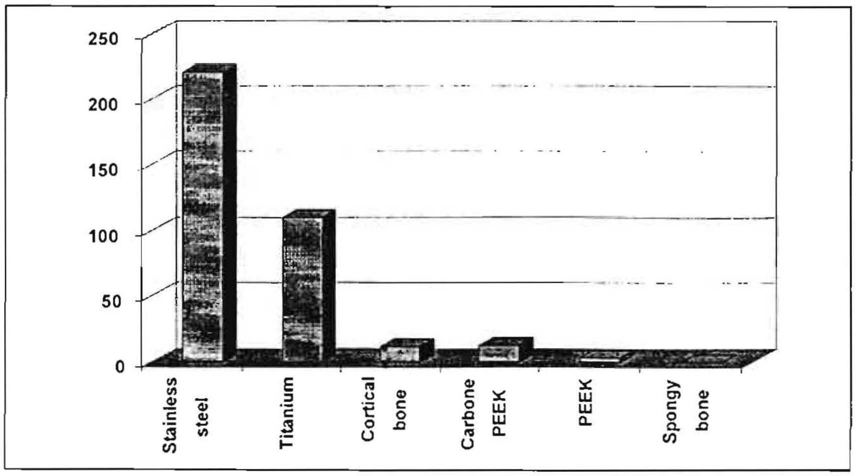


Fig. 11 : Different types of materials and their modulus of elasticity (Ray, C.D., 1997).

Fig.10 : X-ray A.P view showing fracture of the right pedicle of L4 with displacement of the right rod.

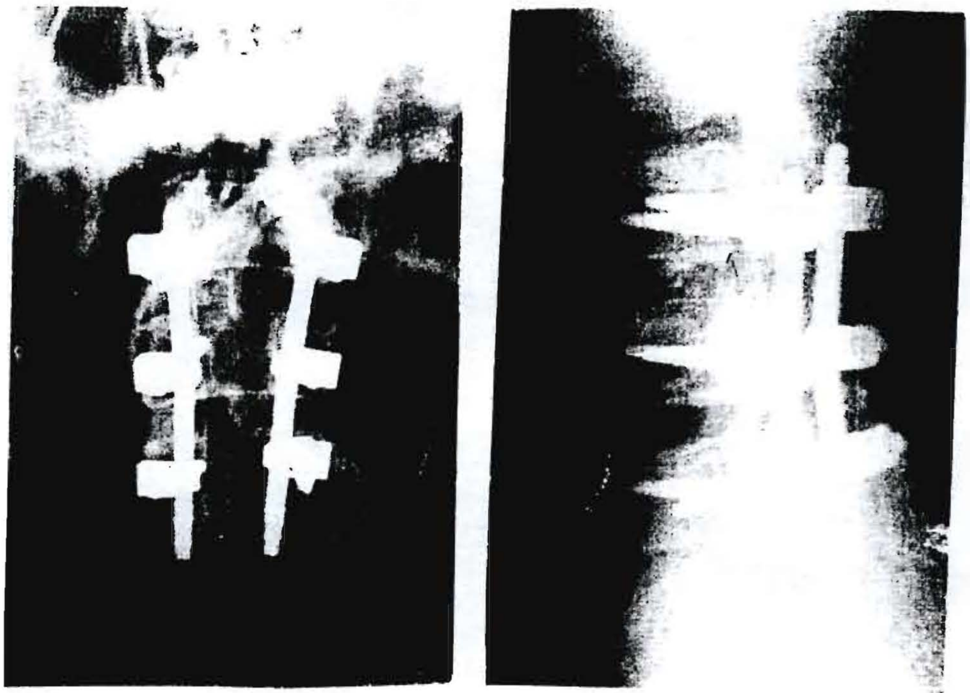
Discussion

Posterior lumbar interbody fusion (PLIF) has a successful rate ranging from 90-100% with posterior fixation (Oxland, T.R., 1996).

However, inadequate mortise construction and bone graft fitting are perhaps the most common preventable errors leading to PLIF failure and complications. Moreover, PLIF is a technically demanding operation and depends on a great part on the surgeon to construct and to fit the graft accurately (Enker, P. et al., 1996).

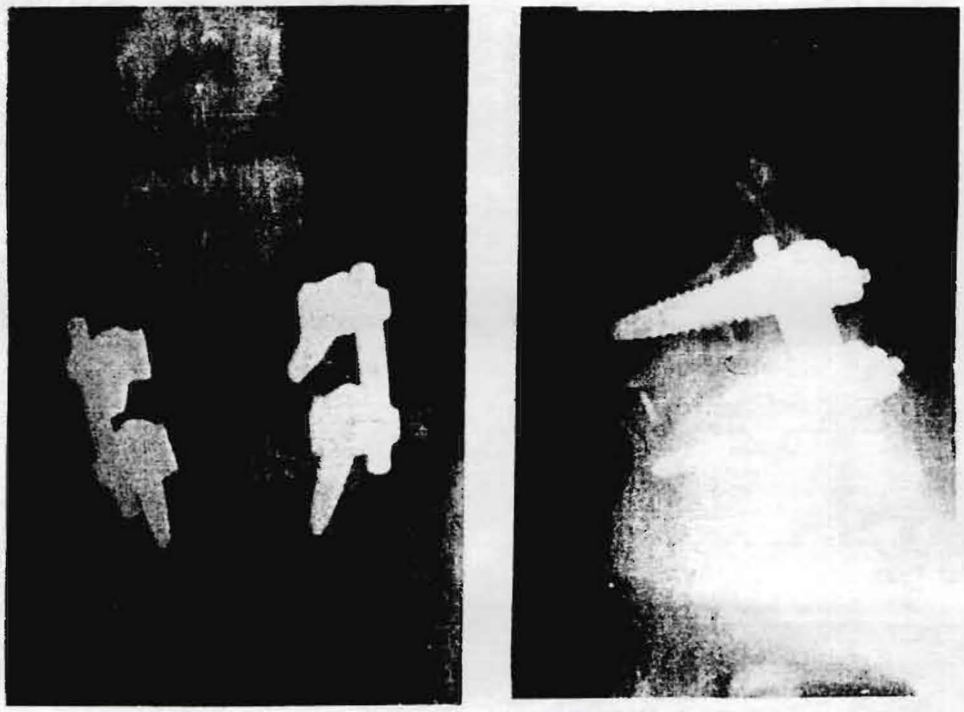
Interbody cage adds to the advantages of PLIF and avoid its disadvantages such as graft retropulsion, settling or late collapse (Lund, T. et al., 1998).

No significant differences in the three-dimensional stabilization provided by the different cage designs. All cages significantly stabilise the spine in flexion and lateral bending. Also, all cages provides the greatest stabilization in flexion-extension and lateral bending when used together with posterior instrumentation (Lund, T. et al., 1998).



A B

Fig. 9 A & B : (A) A.P view. (B) lateral view x-rays showing two segmental level fixation L3. 4 and L4. 5 and one segmental level fusion L3. 4 with cages. Note the metal marker and the maintained disc height of L3. 4.



A B

Fig. 8 A & B : (A) AP view, (B) lateral view x-rays showing one segmental level fusion of L4, 5 with cages and fixation with K2 system. The metal marker, provides exact location on the x-ray picture. Note the maintained height of the disc space.

Table 3 : Grading of the radiological fusion according to Brantigan and Steffee system (1993)

Grade	No. of patients	%
Grade 5	10	83.3%
Grade 4	1	8.3%
Grade 3	1	8.3%
Grade 2	0	0
Grade 1	0	0

Table 4 : The relation between the etiology of instability and both clinical and radiological results.

	Clinical results		Radiological results of fusion	
	Preop. cases	Postop. grade	Preop. cases	Postop. grade
Degenerative spondylolisthesis	1	Excellent	1	Grade 5
Isthmic spondylolisthesis	7	6 excellent 1 Good	7	6 grade 5 1 grade 4
Post-laminectomy spondylolisthesis	1	Excellent	1	Grade 5
Primary spondylolysis	2	Excellent	2	Grade 5
Post-laminectomy spondylolysis	1	Excellent	1	Grade 3

two patients had temporary weakness of ankle dorsiflexion which improved completely within three weeks. All radiographs showed satisfactory cage position without cage retropulsion or deformation. Only one patient had one cage displaced laterally and the other cage was in the proper position.

Pedicular fracture occurred during the application of two screws. from 28 screws used in this study which had no interference with the final out-come (Fig. 10). No patient had pseudoarthrosis. No patient had arachnoiditis or dural scars.

Table 1 : Clinical results according to Henderson evaluation system (1966).

Grade	No. of patients	%
Excellent	10	83.3%
Good	2	16.6%
Fair	0	0
Poor	0	0

Table 2 : Preoperative and postoperative disc height in twelve patients treated by PEEK cage and P.L.I.F.

Disc height	X ± SD
Preoperative	9.20 ± 0.32
Postoperative	12.06 ± 0.63
t	4.5
P	<0.05*

* Statistically significant

Results

Clinical results :

Back symptoms as pain disappeared in all patients except two. had occasional pain. Movement and flexion improved in all patients.

No patient had leg pain postoperatively.

No patients had catching back or giving way.

According to Henderson evaluation system (1966), ten cases were excellent clinically (83.3%) and two good cases (16.6%) table (1).

Radiological results :

All patients had immediate postoperative x-ray and then at two, four, six and twelve months follow-up, to detect the disc height and to assess the degree of fusion as well as any complications.

Disc height increased and was maintained (Figs. 8 & 9) in all patients over the follow-up period without late decrease. There is statistically significant increase in the postoperative disc height (mean 12.6±63) compared with the preoperative disc height (mean 9.2±32). P<0.05 (table 2).

Fusion occurred in all cases and was evaluated according to Brantigan and Steffee system (1993) 10 cases were grade 5 (83.3%) one case was grade 4 (8.3%) and one case was grade 3 (8.3%) (table 3).

The excellent clinical results occurred in ten patients, while good clinical results occurred in one patient with isthmic spondylolisthesis and the other with postlaminectomy spondlyolisthesis.

The radiological results of the fusion were grade 5 in patients with degenerative and postlaminectomy spondylolisthesis, while patients with isthmic spondlyolisthesis were grade 4. The radiological results of fusion in patients with primary sponylolysis were grade 5. while the patient with postlaminectomy spondylolysis was grade 3 (table 4).

Complications :

No patient had an early or late infection. No patient had permanent neurological injury and only

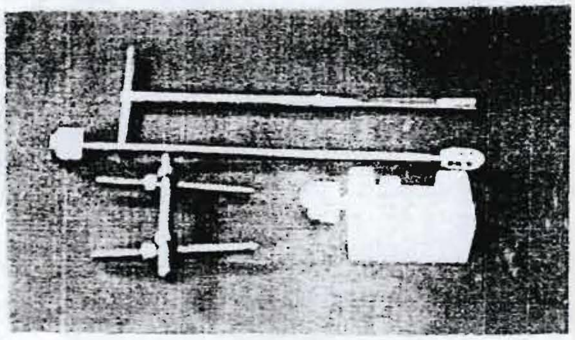
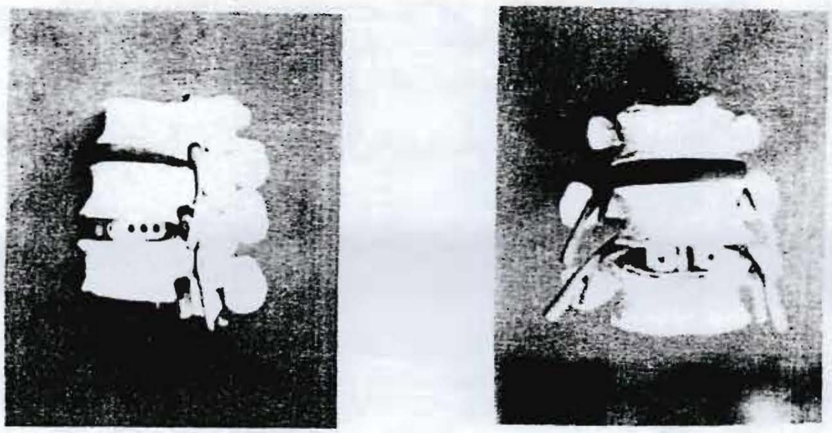


Fig. 6 B : Showing K2 pedicular rod-screw system, cage support for graft, the cage impactor and the reamer-distractor.



A B

Fig. 7 A & B : A lumbar spinal model showing two cages in the intervertebral disc space; (A) Profile view, (B) Front view.

Postoperative regimen :

All patients were ambulated once pain was tolerated and the general condition allowed. Lumbosacral brace was applied for all patients for 6 months postoperatively.

Statistical analysis :

Comparison was done between the preoperative and postoperative disc height in patients using t-test, p-value of < 0.05 was considered statistically significant (Compbell and Machin, 1993).

of the interbody spaces for cage insertion. We used the interbody reamer and distractor, or reamer-distractor instrument to prepare the space for cage insertion according to the degree and level of segmental instability. We prepared the cage for insertion after putting a cancellous bone graft or remnants of bone from the decompressed level (Fig. 6 B). The cages were put 3 to 5 mm anterior to the posterior vertebral body wall (Fig. 7 A & B).

The pedicular rods were applied with addition of posterolateral fusion then closure of the wound after insertion of a ready vac.

Decompression was performed for ten cases before cage insertion. Central decompression was performed for eight cases which had spinal canal stenosis. Lateral decompression (facetectomy) was done for two cases which had root compression. Posterolateral fusion was done for ten cases.

Intraoperative difficulties :

Simple dural tear occurred in three cases and end plate bleeding occurred in four cases (Fig. 6A, B & 7A, B).

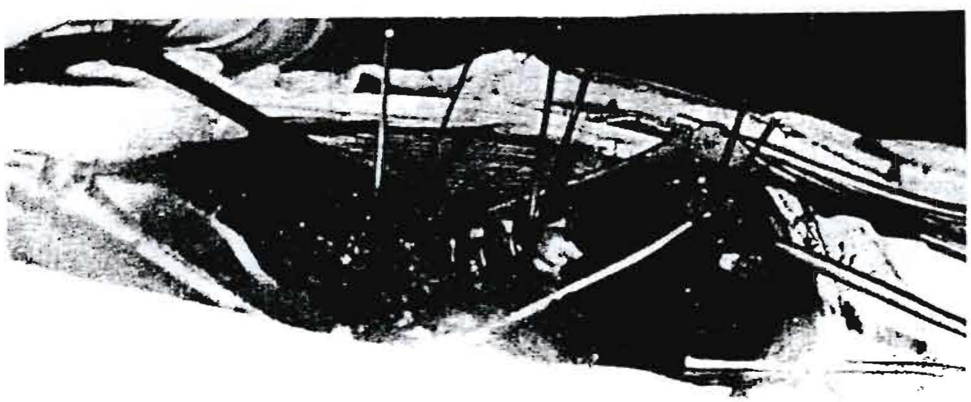


Fig. 6 A : Posterior exposure with guide pins in the pedicles and wide decompression laminectomy.

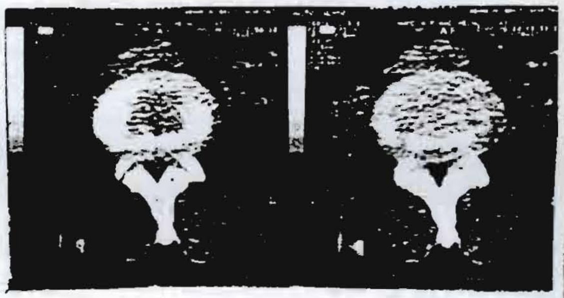


Fig. 4 : C.T. showing disc prolapse in a level above the lytic defect.

Fig. 5 : MRI showing L4 spondylolisthesis and L5, S, disc degeneration.

Surgical technique

After the usual preparation and preliminary soft tissue dissection exposing the posterior elements, an osteotome was used to remove the inferior border of superior lamina of the involved segment, the medial portion of medial facet was removed with the exostosis. The medial border of the lateral facet out to the pedicle gave excellent visualization of segmental nerve root. Wide decompression lamminectomy was under taken in most of cases for good visualization of the interbody space and for global decompression of neural tissues. Discectomy was done and segmental fixation by any system of pedicular screw fixation was undertaken and we put here K2 system (Fig. 6 A). Before putting rods we used the pedicular screw distractor to facilitate preparation

Pre-operative evaluation

Clinical evaluation :

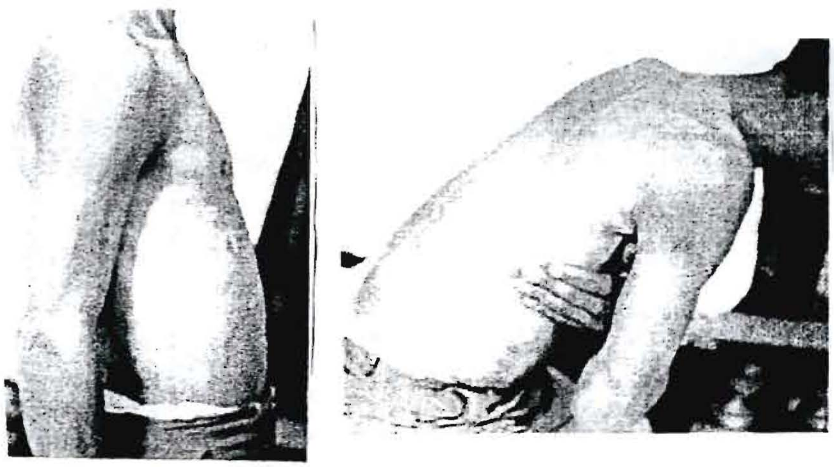
All patients were evaluated preoperatively and at follow up according to Henderson s evaluation system. This scoring system is graded according to presence of back pain, back catch, back disconnection and to leg symptoms as claudication pain or spastic thigh pain (Henderson E.D., 1966).

Radiological evaluation :

Plain x-ray views were done for all patients in the form of simple standing, lateral views, oblique views, stress views and Knuttson s views in the form of flexion in standing position and extension in sitting positions (Fig. 3A & B) (Kirkddy-Willis W.H., 1982).

Also C.T scans were done for patients who had leg symptoms to diagnose presence of disc prolapse, spinal stenosis or disc degeneration (Fig. 4) M.R.I. were also done for patients who had failed back surgery to differentiate between postoperative arachnoiditis, dural adhesions and discitis or to diagnose degenerative disc disease in other levels near by the unstable level for determination of fusion level extent (Fig. 5).

A



B

Extension in sitting position. Flexion in standing position.

Fig. 3 A&B : The patient positions in the Knuttson s views (Flexion and extension views). **Fig. 2 B :** Spondylolysis of L3 with mild spondylolisthesis.

(b) segmental instability defined by excessive motion of dynamic x-ray views in a patient with intractable posturally related back pain, leg pain, or both, (c) recurrent disc herniation with posturally related back pain, sciatica or both. Nine patients had Grade I spondylolisthesis (75%) one case was degenerative, seven were isthmic and one case was post-laminectomy. Three patients suffered from spondylolysis (25%), two cases had primary spondylolysis and one had post laminectomy spondylolysis.

Interbody cage fusion was contraindicated if the degree of spondylolisthes was more than grade I, and if the bone was osteoporotic. The presence of discitis was considered to be a contraindication for cage insertion (Fig. 2A, B).

Fig. 2 A : Spondylolisthesis of L4 (grade I) with diminished disc space of L4, 5.

Fig. 2 B : Spondylolysis of L3 with mild spondylolisthesis.

pathological conditions in the spine other than instability caused by spondylolysis or spondylolisthesis, such as, chronic low back pain or what is called intrinsic disc diseases, degenerative spinal disorders and spine revision surgery (Oxland, T.R. et al., 2000) (Fig. 1).

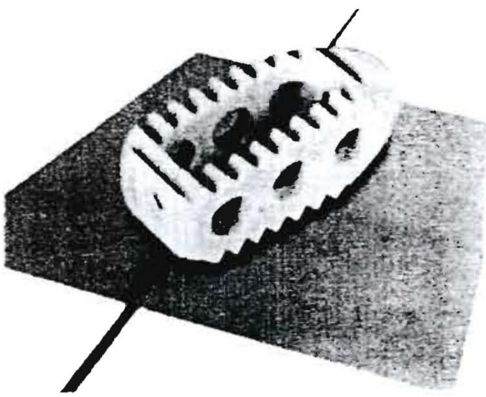


Fig. 1 : The intervertebral body cage made of PEEK (Poly- Ether- Ether- Ketone).

Aim of the Work

The puropose of this study is to evaluate prospectively, the functional, and radiological results of PEEK interbody cage in lumbar spinal fusion and to detect the effect of additional posterolateral fusion on functional results of the interbody PEEK cage.

Also, to evaluate the effect of supplementary posterior segmental fixation on the functional results of the interbody PEEK cage.

Material And Methods

This work was conducted in Benha university hospital and Tanta university hospital between January 1997 and June 1999 and consisted of 12 patients. Ten patients were female (83.4%), and two patients were male (16.6%), with a mean age 50 years (range 38 62 years). Two patients had failed previous back surgery (16.6%). The presenting symptoms were back pain, giving way and catching back in all patients and ten of them had caudal claudication (83.4%). The prime surgical indications in our study were persistence of clinical symptoms and signs of instability in addition to radiological signs of mechanical instability. Associated spinal stenosis and or disc prolapse were another indications for surgery. So, we adopted the strong indications of PLIF according to (Branch, Jr. 1993) which are; (a) degenerative or lytic spondylolisthesis (Fig. 2 a & b) associated with herniated disc or facet removal at that level, or lumbar interbody fusion, posterior, posterolateral or posterior lumbar interbody fusion (PLIF) should be undertaken to avoid segmental instability (Simmon, J.W., 1997).

It was demonstrated that significant intervertebral disc motion occurs with posterolateral fusion technique, even after the fusion mass has developed (Oxland, T.R. et al., 1996).

The interbody fusion operations including (PLIF), can use the phenomenon of parallelogram distraction or ligamentotaxis, that takes the advantage of inherent strength of the fibroligamentous complex surrounding the vertebral body and connecting the motion segments (Enker, P. et al., 1996).

The theoretical basis is that mechanical stability is provided by the intervertebral fusion, the original disc height is restored, the intervertebral foramina are distracted and excision of the nucleus pulposus eliminate many of the possible biomechanical causes of chronic pain (Enker, P. et al., 1996).

There has been, however, a lack of enthusiasm for PLIF, mainly due to the technical difficulty of the mortise construction, inadequate bone graft fitting and because of the complications, especially the risk of neural damage and graft retropulsion into the spinal canal (Lund, T. et al., 1998).

Moreover, clinical studies have shown that the postoperative increase in the disc height tends to return to the preoperative level either, with or without the additional posterior fixation, and regardless of the type of bone graft. Whether this occurs because of the graft subsidence into the adjacent vertebral body or graft collapse is unknown (Lund, T. et al., 1998).

In the last few years, several interbody cages of different designs and materials such as titanium, carbon fibre, stainless steal and poly-ether-ether-ketone (PEEK), Fig. (1) have been developed for use through an anterior or posterior approaches (Oxland, T.R. et al., 2000).

Cages are indicated for other

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POSTERIOR LUMBAR INTERBODY FUSION WITH PEEK CAGE IN SPONDYLOLYSIS AND SPONDYLOLISTHESIS

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Abstract

Posterior lumbar interbody fusion (PLIF) is now considered to be the golden standard for lumbar instability caused by spondylolysis or spondylolisthesis. PLIF has many limitations because of the technical difficulties, complications and the gained postoperative increase of the disc height tends to return to preoperative level. The use of poly-ether-ether ketone cage for posterior lumbar interbody fusion is technically less difficult with minimal complications. Twelve patients; ten were female and two male; with spondylolysis and spondylolisthesis of different causes were treated by PEEK interbody cage and interpedicular fixation with or without posterolateral fusion. Age of the patients ranged from 38 to 62 years (mean 50 years). The patients were followed for a mean 1 year duration and were evaluated both clinically and radiologically. All twelve patients were improved clinically except two patients had partial improvement with occasional and temporary back pain due to causes other than cage complications.

Introduction

Lumbar instability could be caused by degenerative, isthmic, or post-decompression spondylolisthesis. Neurological affections associated with spondylolisthesis are caused by foraminal stenosis, vertebral displacement, disc prolapse or by fibrocartilagenous mass at the site of isthmic defect (Branch, Jr., C.L., 1993).

Posterior decompression alone for the treatment of radicular affection will exagerate the lumbar instability. Therefore, surgical fusion through one or more of the following four approaches; anteri-