Clinical Results of a Single Central Interbody Fusion Cage and Transpedicle Screws Fixation for Recurrent Herniated Lumbar Disc and Low-Grade Spondylolisthesis

Kuo-Feng Huang, MD; Tzu-Yung Chen, MD

Background: The posterior lumbar interbody fusion (PLIF) procedure allows restoration of the weight-bearing capacity to a more physiological ventral position and maintenance of disc space height. However, the procedure can be technically difficult and may cause complications. It has always been performed bilaterally with paired cages; a single central cage has not been commonly used.

Methods: Twenty-eight patients who met the interbody fusion criteria from March 1999 through November 2001 were included in the study. Surgery was performed from the posterior with a single central cage supplemented with transpedicle screws. The follow-up period ranged from 8 to 39 months with a mean of 14.4 months. Clinical outcomes were assessed. Dynamic radiography for fusion mass was interpreted by an independent radiologist.

Results: Overall, 92.86% of the patients were satisfied with their conditions after surgery. Radiography study showed the rate of bony fusion being 82.14%. Fibrous union was noted in five patients. No migration of the cage was observed. One patient experienced laceration of the dura without clinical sequelae. One patient had transient paresthesia and recovered within 2 weeks. One patient had transient bladder atony and recovered within 3 days. Overall, the complications were negligible and none of the patients sustained a motor deficit and permanent complication.

Conclusions: The PLIF procedure using a single, central cage combined with bilateral pedicle screws fixation obtained satisfactory outcome within a short-term or long-term follow-up period. Since the implant-related complications have seldom been observed, it may be used as an alternative option for recurrent lumbar disc herniation or low grade spondylolisthesis with apparent degenerative disc disease.

(Chang Gung Med J 2003;26:170-7)

Key words: **posterior lumbar interbody fusion, cage.**

Interbody fusion is the most reliable fusion technique currently available for the lumbar spine. These constructs are biomechanically stronger, provide axial support with less graft subsidence or collapse comparing to those with posterolateral arthrodesis, and produce a better biologic fusion in

From the Department of Neurosurgery, Chang Gung Memorial Hospital, Taipei.
Received: Jul. 23, 2002; Accepted: Dec. 7, 2002
Address for reprints: Dr.Tzu-Yung Chen, Department of Neurosurgery, Chang Gung Memorial Hospital. 5, Fushing Street, Gueishan Shiang, Taoyuan, Taiwan 333, R.O.C. Tel.: 886-3-3281200 ext. 2119; Fax: 886-3-3285818; E-mail: tychen@doctor.com

lordotic alignment.[1,2] A successful interbody construct reduces the postoperative segmental mobility and permits better graft incorporation.[3] The bilateral posterior lumbar interbody fusion (PLIF) procedure was first introduced by Cloward for lumbar interbody fusion and neural decompression.[4] Since then, many variations of the procedure have been implemented, including morsalized autogenous onlay graft, disc replacement, bone dowels, and unilateral procedure (but not a single central procedure).[5-8] The PLIF procedure can be technically difficult, and complications may include graft migration, implant subsidence, epidural hemorrhage, inadvertent laceration of the dura, and bone graft donor-site morbidity, which was performed bilaterally before.[5,9] Theoretically, the procedure that was performed using single central cage implantation appears to reduce the risk to neural and bony structures in comparison with bilateral cage implantation. However, the clinical outcome and fusion rate of single central cage with pedicle screws has not been studied. The purpose of this retrospective study was to demonstrate the feasibility and clinical option of single cage posterior lumbar interbody fusion supplemented with pedicle screws in patients with recurrent sequestrated lumbar disc herniation or in patients with low-grade degenerative spondylolisthesis.

METHODS

The study included 28 patients in whom PLIF with one single central cage with transpedical screws were performed at Linkou Chang Gung Memorial Hospital from March 1999 through November 2001. Among the 28 patients, eight had recurrent herniated lumbar discs (3 patients had previous operations for 3 times, 2 patients had previous operation for 2 times and 3 patients had previous operation for 1 time) and 20 had low-grade spondylolisthesis with degenerative discs (no disc space higher than 9 mm and all MR imaging showed apparent end-plate changes). The PLIF indications were strictly limited to those patients with severe discogenic disease. The standard hospital chart, outpatient notes, and preoperative and postoperative imaging studies were reviewed.

All PLIF procedures were performed by the same surgeon using the open box cage (Stryker implants, Cestas. France). The patients were in the prone position during surgery. The operating table was not flexed, helping to increase lumbar lordosis. For cases with stenotic canals, decompressive laminectomy and foraminotomy were performed. The inferior facectectomy was performed unilaterally on the same side as the single cage implantation. Then, annulus was cut with a large square plug. Radical discectomy was achieved to the boundary of the anterior limiting membrane as to avoid anterior vascular injury. Partial decortication of the cartilaginous end-plate was also accomplished using sharp straight curettage, and with slight finger-touch rotational force. Posterior elements (lamina and spinal process) were used as the autogenous bone graft. Before the cage was impacted, the important part was to put some autogenous bone chip into the central and contralateral area of the disc space. Then, the cage device was packed with the autogenous bone graft and was placed and confirmed as being properly positioned 0.5 cm below posterior vertebral surface using fluoroscopic guidance. All patients who underwent single and central cage implantation received bilateral transpedical screws fixation. The wound then was closed after meticulous hemostasis.

Each patient returned to a regular hospital ward postoperatively and became mobilized after being fitted with a thoracolumbar or lumbar orthosis (rigid molded plastic orthosis, or Tailor's brace).

All patients underwent preoperative anteroposterior, lateral flexion-extension radiographs and MR imaging. Postoperative radiographic evaluations (antero-posterior and lateral radiographs) were conducted after the patients became mobile and all patients underwent dynamic radiographic evaluation at 1, 3, 9, and 12 months after the operation. From a radiology perspective, a successful fusion was defined as the absence of lucency around the graft, evidence of bridging bone between the endplate and the graft, and the absence of movement on dynamic imaging studies. Postoperative CT scans were obtained for five patients to evaluate the cross-sectional bone area at the fusion level after 6 months.

The results were assessed according to the economic and function rating scale system developed by Prolo et al.[10] The economic grade of the patient indicated his or her capacity for gainful employment or alternative comparable pursuits (housework, retirement activities). For the functional grade, the patients ranked his or her pain responses and the

Table 1. Anatomic-Economic-Functional (AEF) Rating System by Prolo et al(10)

Economic status	Functional status
E1 Complete invalid	F1 Total incapacity (or worse than before operation
E2 No gainful occupation (including ability to do housework or continue retirement activity)	F2 Mild to moderate level of low-back pain and/or sciatica (or pain same as before operation but able to perform all daily tasks of living)
E3 Able to work but not at previous occupation	F3 Low level of pain and able to perform all activities except sports
E4 Working at previous occupation on part-time or limited status	F4 No pain, but patient has had one or more recurrences of low back pain or sciatica
E5 Able to work at previous occupation with no restrictions of any kind.	F5 Complete recovery, no recurrent episodes of low-back pain, able to perform all previous sport activity.

effects of the pain on the activities of living. Each grading scale consisted of five reproducible criteria that were assessed before and after treatment (Table 1). The sum of the responses from these two scales ranged between a perfect result of 10 to an incapacitated state of 2. According to this scale, the results of treatment were divided into categories including: excellent (10,9), good (8,7), fair (6,5), and poor (4-2).[10]

RESULTS

This small series consisted of 28 patients who were followed for more than 8 months after PLIF (Table 2). The ages of the patients ranged from 30 to 80 years with an average of 56.6 years. There were 10 men and 18 women. A total of 30 levels were surgically treated. Twenty-six patients underwent one-level fusions (Level L3-L4: 3 patients, Level L4-L5: 16 patients, Level L5-S1: 7 patients), and two patients underwent 2-level fusions (both were L3-L4-L5). The levels fused were mostly at L4-5.

Dynamic radiography for fusion mass was interpreted by an independent radiologist. Radiography study showed that the bony fusion rate was 82.14% (Fig. 1). Fibrous union was noted in five patients during follow-up. Postoperative CT scans confirmed an average of 46.3% (18.3 to 63.5) cross section area of bony fusion per level (Fig. 2). The preoperative and postoperative economic and functional status of the 28 patients is shown in Table 3. Most patients (27) had no gainful occupation and experienced mechanical axial low-back pain and/or sciatica. It was also noted that none of the patients achieved an

Table 2. Description of Patient Population with Respect to Gender, Age, Levels Fused

	No.
Gender	
Male	10
Female	18
Age (years)	
30-39	1
40-49	6
50-59	11
60-69	7
>70	3
Levels fused	
L3-4	3
L4-5	16
L5-S1	7
L3-4-5	2

Table 3. Preoperative and Postoperative Economic and Functional Scores for 28 patients

Preoperative			Postoperative		
Status	Score	NO.	Status	Score	NO.
E1F1	2	13	E5F5	10	10
E2F1	3	3	E5F4	9	4
E2F2	4	11	E4F4	8	8
E3F2	5	1	E5F3	8	1
			E3F5	8	1
			E4F3	7	1
			E3F4	7	1
			E3F3	6	2

*Categories are described in Table 1.

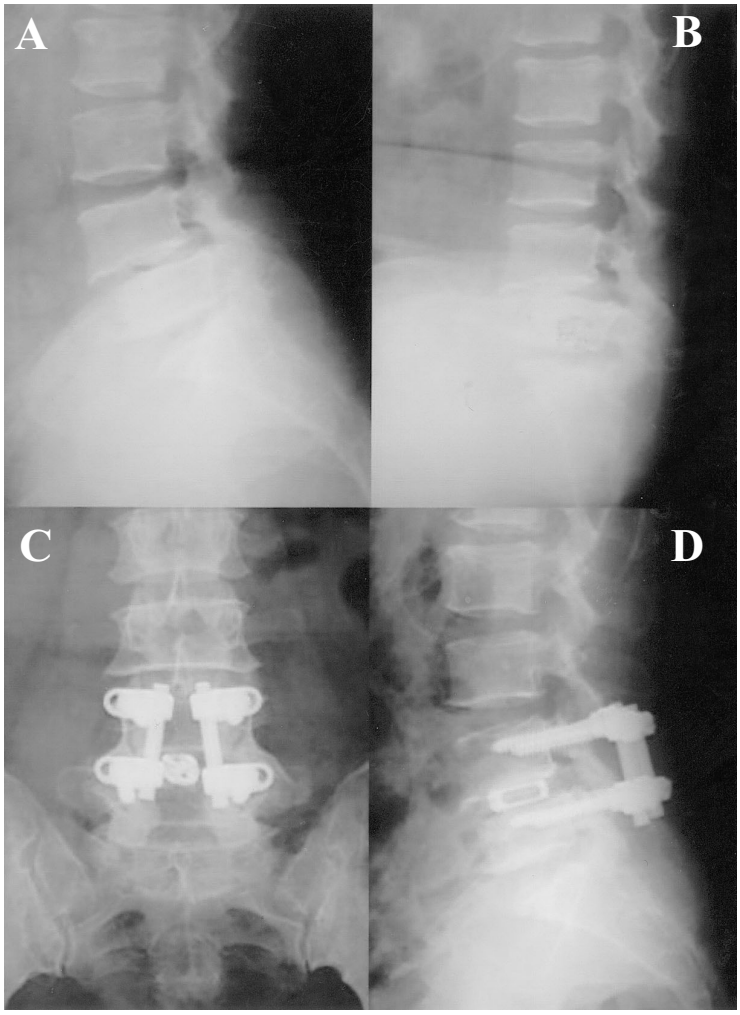

Fig. 1 Pre-operative plain film of L-S spine, (A) flexion view; (B) extension view. Post-operative plain film of L-S spine; (C) antero-posterior view; (D) lateral view.

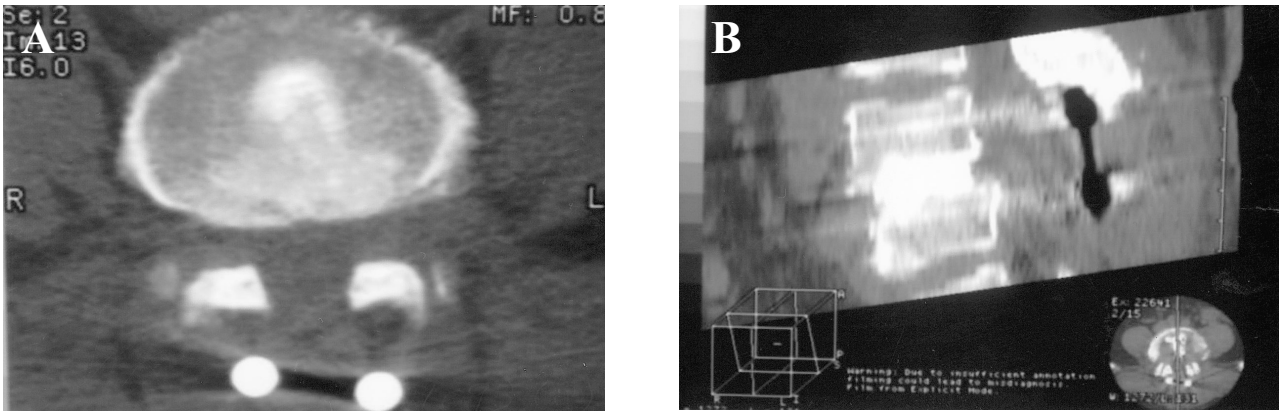

Fig. 2 (A) Postoperative computed tomography confirmed 57.3% cross section area of bony fusion per level. (B) Postoperative computed tomography, sagittal view.

economic/functional score greater than 5. The results demonstrated that 92.86% of the patients had an excellent (9,10) or good (7,8) outcomes (Table 4). Among the eight patients of recurrent herniated lumbar disc, six patients had excellent or good outcomes and two patients had fair outcomes. Among the 20 patients of low-grade spondylolisthesis, nearly all of the patients had excellent or good outcomes.

No patient sustained permanent motor deficit. One patient (recurrent herniated disc, had previous operation for 3 times) experienced a dural tear with no associated clinical sequelae. Transient and non-disabling neurological deficits related to the cages occurred in two patients: one patient had transient paresthesias and recovered within 2 weeks; one patient had transient bladder atony and recovered within 3 days. Overall, there were no permanent neurological complications in our study. There was not any cage migration either.

Table 4. Summary of Postoperative Economic and Functional Scores for 28 patients

Results	Score	NO.	Percentage
Excellent	(9,10)	14	50%
Good	(7,8)	12	42.86%
Fair	(5,6)	2	7.14%
Poor	(2,3,4)	0	0%

DISCUSSION

In theory, interbody fusion provides several advantages when compared with other fusion techniques.[4-15] It immobilizes the painful degenerated spinal segments, decompresses the nerve roots, and restores disc height and root canal dimensions, as well as load bearing ability of the anterior structures. Overall, acceptable results were achieved. According to previous reports, PLIF with bilateral cage and autologous bone can be used as a stand-alone procedure, and even with posterolateral fusion in some situations, may achieve very similar results. The fusion rates ranged from 88 to 94 %, and clinical success rates ranged from 82 to 92%.[5-11] However, problems such as graft collapse, slippage, cage migration, dura and nerve root manipulations have also been observed in 4 to10 % of the cases in which PLIF was performed.[5,7,16] With techniques improving, however, the risks decrease. Because of the sufficient disc space exposure required for inserting the cages, difficulties are often experienced in preserving the facet joints. Kettler et al reported that although the shear force resulted in translation motion across the disc space that may be resisted by threaded cages, reduced stability during cyclic loading was observed in various cage designs.[17] It makes the case for supplemental instrumentation of the motion segment to reconstruct the posterior tension bend and preserve the best possible stability in extension and rotation.[18-20] The patients in our study who underwent surgery using the single central cage with placement of pedical screw had acceptable clinical outcomes, with satisfactory rate up to 92.86%. Among the eight patients with recurrent herniated lumbar disc, six patients had excellent or good outcomes and two patients had fair outcomes. Among the 20 patients with low grade spondylolisthesis, nearly all patients had excellent or good outcomes. This suggested that the procedure had more favorable outcome in the patients with low-grade spondylolisthesis than those with recurrent herniated discs. The results also suggested that there was an equivalent or even better outcome than for the patients who received bilateral cages supplemented with transpedicle screws.

The use of posterior fusion and posterolateral fusion have been the predominant surgical modalities in the treatment of degenerative spinal conditions. According to the report by Zdeblick, the fusion rate in patients with posterolateral fusion was about 80%.[22] In comparison with the posterolateral fusion , interbody fusion techniques have apparent mechanical and surgical advantages, such as restricted motion by placing the graft bone in the center of segmental movement, giving the method the greatest theoretically possible restriction of motion. In addition, it requires a small volume of bone to obtain the fusion. However, further studies with a larger population are necessary to clarify the indications for the use of interbody cages in lumbar surgery. In our study, the PLIF indications were strictly limited to those patients with severe discogenic diseases such as recurrent herniated disc disease and low-grade spondylolisthesis with apparent degenerative disc disease.

To obtain a solid interbody spinal fusion, over 30% cross-sectional bone area was required.[22-24] In

our patients, postoperative CT scans confirmed that over 45% cross-sectional bone area may be achieved using the unilateral approach. Ray reported that of the 236 patients who underwent PLIF, solid fusion occurred in 47% of cases within 6 months and in 65% of cases within 2 years after operation.[11] In the series by Kuslich et al, 85% of the 356 patients with PLIF reported experiencing less pain at 2 years postoperatively, and 91% had improved functionally.[16] In our clinical review, interbody fusion using one central cage and peri-cage bony chip without postero-lateral arthrodesis achieved similar excellent results. Radiography studies showed the bony fusion rate as 82.14%.

Complications associated with PLIF can be serious. They are often related to excessive retraction of the nerve roots or the dura sac. Theoretically, the procedure that was performed using single central cage implantation appears to reduce the risk to neural and bony structure in comparison with bilateral cage implantation with only unilateral dura and nerve root manipulations. According to various reports, these serious complications occurred in 4 to 10% of the patients who underwent the procedures with or without supplemental pedicle screw placement.[16,25,26] In our study, only one patient had the complication of laceration of the dura with no associated permanent clinical sequelae. There were few negligible complications directly associated with the procedure using single central cage supplemented with pedicle screw fixation, and no patient experienced any permanent complications.

In conclusion, the outcomes of PLIF with single central cage supplemented with pedicle screws were encouraging. The fusion rate of 82.14% and the overall satisfaction rate of 92.86% demonstrated that this is an acceptable procedure. There were very few negligible transient complications directly related to the procedure. The procedure was relatively safe. It may be used as an alternative option for recurrent herniated discs and low-grade spondylolisthesis with kyphotic spine or apparent degenerative disc disease. Larger studies may be needed to further clarify the indications for the use of single central interbody cages in more advanced lumbar surgery.

REFERENCES

1. Enker P, Steffee AD. Interbody fusion and instrumentation. Clin Orthop 1994;300:90-101.
2. Evans JH. Biomechanics of lumbar fusion. Clin Orthop 1985;193:38-46.
3. Panjabi MM. Biomechanical evaluation of spinal fixation devices: I. A conceptual framework. Spine 1988;13:1129-34.
4. Cloward R. The treatment of ruptured intervertebral discs by vertebral body fusion. Indications, operation technique after care. J Neurosurg 1953;10:154-68.
5. Lin PM, Cautilli RA, Joyce MF. Posterior lumbar interbody fusion. Clin Orthop 1983;180:154-68.
6. Blume HG. Unilateral posteral lumbar interbody fusion: simplified dowel technique. Clin Orthop 1985;193:75-84.
7. Collis JS. Total disc replacement: a modified posterior lumbar interbody fusion. Report of 750 cases. Clin Orthop 1985;193:64-67.
8. Simmons JW. Posterior Lumbar interbody fusion with posterior elements as chip grafts. Clin Orthop 1985;193: 85-9.
9. Branch CL Jr. The case for posterior lumbar interbody fusion. Clin Neurosurg 1996;43:252-267.
10. Prolo DJ, Oklund SA, Butcher M. Toward uniformity in evaluating results of lumbar spine operations. A paradigm applied to posterior lumbar interbody fusions. Spine 1986;11:601-6.
11. Ray CD. Threaded titanium cages for lumbar interbody fusions. Spine 1997;22:667-80.
12. Hutter CG. Posterior intervertebral body fusion. A 25-year study. Clin Orthop 1983;179:86-96.
13. Fraser RD. Interbody, posterior, and combined lumbar fusions. Spine 1995;20:167S-77S.
14. Goel VK, Pope MH. Biomechanics of fusion and stabilization. Spine 1995;20:85S-99S.
15. Onesti ST, Ashkenazi E. The Ray Threaded Fusion Cage for posterior lumbar interbody fusion. Neurosurgery 1998;42:200-5.
16. Kuslich SD, Ulstrom CL, Griffith SL, Ahern JW, Dowdle JD. The Bagby and Kuslich method of lumbar interbody fusion. History, techniques, and 2-year follow-up results of a United States prospective multicenter trial. Spine 1998;23:1267-79.
17. Kettler A, Wilke HJ, Kietl R, Krammer M, Lumenta C, Claes L. Stabilizing effect of posterior lumbar interbody fusion cages before and after cyclic loading. J Neurosurg (Spine 1) 2000;92:87-92,
18. Masferrer R, Gomez CH, Karahalios DG, Sonntag VK. Efficacy of pedicle screw fixation in the treatment of spinal instability and failed back surgery: a 5-year review. J Neurosurg 1998;89:371-7.
19. Schlegel KF, Pon A. The biomechanics of posterior lumbar interbody fusion (PLIF) in spondylolisthesis. Clin Orthop 1985;193:115-9.
20. Vaccaro AR, Garfin SR. Internal fixation (pedical screw fixation) for fusion of the lumbar spine. Spine 1995;20: 157S-65S.

21. Axelsson P, Johnsson R, Stromqvist B, Arvidsson M, Herrlin K. Posterolateral lumbar fusion. Outcome of 71 consecutive operations after 4 (2-7) years. Acta Orthop Scand 1994;65:309-14.
22. Zdeblick TA. A prospective, randomized study of lumbar fusion. Preliminary results. Spine 1993;18:983-91.
23. Turner JA, Ersek M, Herron L, Haselkorn J, Kent D, Ciol MA, Deyo R. Patient outcomes after lumbar spinal fusions. JAMA 1992;268:907-11.
24. Lee CK, Vessa P, Lee JK. Chronic disabling low-back pain syndrome cased by internal disc derangements: the results of disc excision and posterior lumbar interbody fusion. Spine 1995;20:356-61.
25. Lin PM. Posterior lumbar interbody fusion technique: complications and pitfalls. Clin Orthop 1985;193:90-102.
26. Mardjetko SM, Connolly PJ, Shott S. Degenerative lumbar spondylolisthesis. A meta-analysis of literature 1970-1993. Spine 1994;19:2256S-65S.

以單一椎體護架於腰椎椎體間之中央配合兩側椎莖螺釘固定在復發性椎間盤突出與低度脊椎滑脫症的臨床結果

黃國烽 陳子勇

背 景： 後側腰椎椎間體融合術(PLIF)可以回復支撐重量的能力而可以有更多的生理活動，並且可以維持椎間盤的高度。但是這個手術在技術上是困難的也可能有併發症。以往都是雙側手術植入兩個椎體護架，使用單一中央的椎體護架沒有被探討過。

方 法： 在1999年3月到2001年11月總共有28個病患符合腰椎椎間體融合術的條件進入本研究。手術的方式是採用由後背手術以單一中央的椎體護架，加上椎莖螺釘固定，術後追蹤的時間在8個月到39個月之間，平均在14.4月。我們評估臨床的結果，並由動態放射線攝影來評估融合的情況。

結 果： 有92.86%的病患術後對於他們的狀況滿意，放射學檢查也顯示有82.14%的骨融合率有五個病患爲纖維性融合。沒有任何的椎體護架移行的情況發生。有一個病患併發硬膜的撕裂但沒有臨床後遺症發生。一個病患術後有暫時性的神經感覺麻木現象在兩週之內就恢復。有一病患也發生暫時性膀胱無力在三天之內就恢復。這些術後的不適都是很輕微可以忽略的。沒有運動缺陷與永久性的併發症發生。

結 論： 後側腰椎椎間體融合術手術如果只使用單一中央的椎體護架加上兩側的椎莖螺釘固定，在長期與短期的追蹤方面，可以有令人滿意的結果。而且與植入物有關的併發症也很少發生，所以這種手術方式可以作爲治療復發性椎間盤突出、低度的脊椎滑脫且有明顯的退化性椎間盤疾病的一種替代的治療選擇。

(長庚醫誌 2003;26:170-7)

關鍵字： 後側腰椎椎間體融合術，椎體護架。

長庚紀念醫院 台北院區 神經外二科
受文日期：民國91年7月23日；接受刊載：民國91年12月7日。
索取抽印本處：陳子勇醫師，長庚紀念醫院 神經外二科。桃園縣333龜山鄉復興街5號。Tel.: (03)3281200轉2119; Fax: (03)3285818; E-mail: tychen@doctor.com