A RANDOMIZED PROSPECTIVE STUDY OF FUSION RATE BETWEEN BONE MARROW ASPIRATE MIXED LOCAL BONE VS. AUTOLOGOUS ILIAC CREST BONE GRAFT FOR INSTRUMENTED POSTEROLATERAL FUSION OF LUMBAR SPINE

Nipon Pantarote, M.D.
Narat Prasopchoke, M.D.
Orthopaedic department, Lampang Hospital

ABSTRACT

A randomized controlled trial in posterolateral fusion in forty spondylolisthetic patients was performed to compare fusion rate between bone marrow aspirate mixed local bone and autologous iliac crest bone graft. All patients were operated by single orthopaedic surgeon with the same technique and instrument. Fusion rates were evaluated by an independent doctor at 12th month post operation by plain radiographs. Devided all patients to be two groups continuously. The first group (20 patients) used bone marrow aspirate mixed local bone but the second group (20 patients) used autologous iliac crest bone graft in posterolateral fusion procedure. Fusion rate in the first group was 85% (17 in 20 patients) and 90% (18 in 20 patients) in the second group but no statistically significant difference ($p > 0.05$). The first group had no complication but three patients in the second group had donor harvest site morbidities (1 pain and 2 fractures) but no statistically significant difference ($p > 0.05$). Donor site pain was disappeared after 3 months later and iliac crest fractures in two patients did not affect activities daily living. Finally, posterolateral fusion in spondylolisthetic patients could achieved by bone marrow aspirate mixed local bone comparable to autologous iliac crest bone graft.

Key words : posterolateral fusion, bone marrow aspirate.

INTRODUCTION

The gold standard in bone grafting for instrumented posterolateral lumbar fusion is autologous bone harvested from the iliac crest. Autologous bone provides an osteoconductive matrix, osteoinductive factors, and is rich in bone marrow which contains the osteoprogenitor cells necessary for bone formation. However, harvestion of iliac crest bone is associated with varying rates of postoperative pain and morbidity (4 – 33%).[1-4] High rates of solid fusion have been reported in the literature for instrumented posterolateral lumbar fusion with iliac crest bone graft. With recent advances in biologic technologies, spine surgeons are considering the necessity of donor graft site morbidity (pain and fracture).

Heary et al.[1] reported 34% incidence of persistent iliac crest donor site pain (31% was mild degree and 3% was unacceptable pain) as same as Fernyhough et al.[2] reported 29% incidence of posterior iliac crest pain. Sawin et al.[5] documented an incidence of 17% for patients who required narcotics as a result of iliac graft procurement. Hu et al.[3] reported 7% incidence of fracture at iliac crest graft harvest site.

To reduce donor site morbidity, bone graft substitutes were used for spinal fusion. Kurica et al.[6] reported good result of fusion by used resorbable porous ceramic mixed autologous growth factor but Tay et al.[7] used collagen hydroxyapatide matrix combined with bone marrow, it produced fusion rates that were comparable with autologous bone graft. Allograft, the primary alternative to autograft, is a poor choice as an onlay graft in posterolateral lumber fusion due to its limited inductive properties and infective risk.

In generally, decompressive laminectomy procedure could had local autologous bone, derived from spinous process and lamina but it has not shown to contain the same osteogenic potential as iliac crest bone. So in author study, bone marrow was aspirated from iliac crest to increase osteogenic potential and mixed local bone compare to standard technique which used autologous iliac crest bone graft in posterolateral fusion in spondylolisthetic patients.

PATIENTS AND METHODS

This study was approved by the Lampang Hospital Research Committee. Forty consecutive patients indicated for two levels instrumented posterolateral fusion were enrolled in this study. Primary diagnosis was spondylolisthesis and spinal stenosis. All patients were operated by single orthopaedic surgeon with the same technique and same brand of pedicular screw system. Devided all patients into two groups by 1:1 ratio (simple random). The first group (20 patients), bone marrow was aspirated from iliac crest for 15 ml and mixed local bone 20 – 25 cm^3 (figure 1, 2 and 3) and the second group (20 patients), autologous iliac crest bone graft was harvested for posterolateral fusion. The surgeon has evaluated about donor site fracture in the second group. All patients were assessed for donor site pain on the day of discharge from the hospital and followed up at, 3^{rd}, 6^{th}, and 12^{th} month after operation to continuous assessment of morbidities by clinical. Solid fusion assessment was done by an independent doctor at 12^{th} month post operation by plain radiographs (anteroposterior and lateral flexion – extension views).

SURGICAL TECHNIQUES

A midline incision was made and decompressive laminectomy was performed after two levels transpedicular screws fixation (6 screws and 2 rods). Bilateral hemifacetectomies and decortical transverse processes were done for two levels fusion. The first group, 15 ml of bone marrow was aspirated from right iliac crest and mixed with 20 – 25 $cm.^3$ of local bone (from spinous processes and laminas) and placed at bilateral of the facet joints for two levels posterolateral fusion (figure 1, 2 and 3). The second group, autologous iliac crest bone graft was harvested from right iliac crest and placed at the same position. Radivac drainage tube was placed but no connected to continuous suction machine until completely wound closure to prevent bone marrow was sucked out.

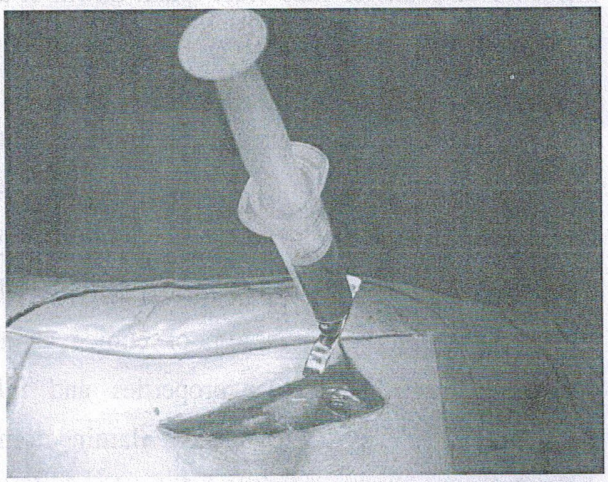

Figure 1 : The bone marrow was aspirated from right iliac crest.

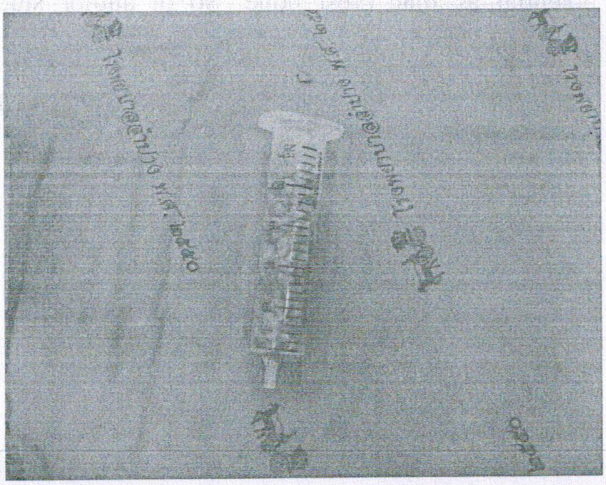

Figure 2 : The local bone graft from spinous processes and laminas was measured in the syringe.

DATA COLLECTION

1. Age and operative position.

2. Solid fusion at 12th month postoperation was assessed by plain radiographs in anteroposterior and lateral flexion - extension views by an independent doctor.

3. Donor site pain was evaluated by surgeon on discharge's day, 3rd, 6th, and 12th month after operation.

4. Iliac crest fracture was evaluated intraoperatively by surgeon.

5. Statistic analysis was performed by using X^2 test. Statistically significant difference was defined as $p < 0.05$.

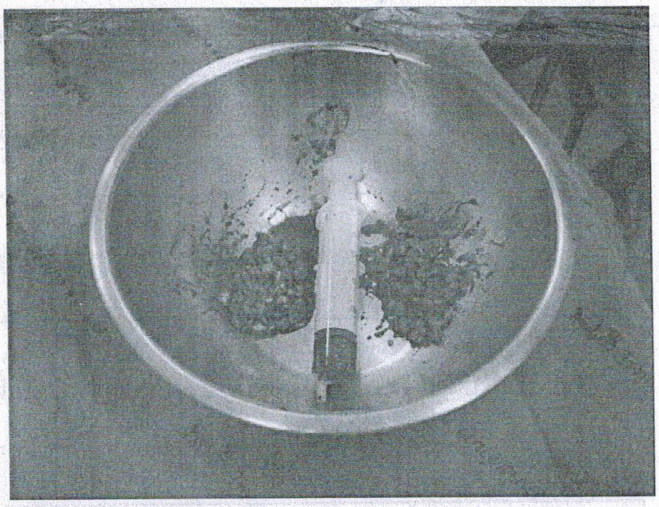

Figure 3 : The local bone was mixed with bone marrow and prepared for posterolateral fusion.

RESULTS (Table 1 and 2)

A total of 40 patients who underwent two levels decompressive laminectomy and posterior instrumentation, of whom 27 were approached at $L_{3,4,5}$ and 13 at $L_{4,5}$, S_1 position. All patients were devided into two groups (20 patients each group). The mean age was 55.1 years (range, 38 – 71 yr) in first group and 57.5 years (range, 40 – 68 yr) in second group. Twelve months period follow up for solid fusion was assessed by an independent doctor by plain radiographs (anteroposterior and lateral flexion – extension views). A "solid fusion" necessitated no motion on lateral flexion and extension radiographs and no loss of fixation. In first group "solid fusion" was indentified in 17/20 patients (85%) and 18/20 patients (90%) in second group but no statistically significant difference between two groups ($p > 0.05$). No iliac crest pain and fracture were occured in first group but one iliac crest pain and two iliac crest fractures were occurred in second group. Donor site pain was disappeared after 3 months later and iliac crest fractures in two patients did not affect activities daily living. There was no statistically significant difference in morbidities (pain and fracture) between two groups ($p > 0.05$).

TABLE 1. Demographic data of patients in both groups.

	1st group (n = 20)	2nd group (n = 20)	p value
Age (mean ± SD) year	55.1 ± 10.4	57.5 ± 9.2	0.898
Position $L_{3,4,5}$	14	13	1.000
Position $L_{4,5,}S_{1}$	6	7	1.000

TABLE 2. Incidence of solid fusion and morbidities among two groups.

	1st Group N (%)	2nd Group N (%)	p value
Solid fusion	17 (85)	18 (90)	1.000
Iliac crest pain (on discharge's day)	0	1 (5)	1.000
Iliac crest fracture	0	2 (10)	0.487
Total morbidities	0	3 (15)	0.231

DISCUSSION

The iliac crest is the most frequently selected site for procurement of autologous bone for the purpose of promoting spinal fusions[2]. Fusion rates obtained with autologous bone are superior and has become standard, compared with alternative graft materials[3,7]. The higher fusion rates achieved with the use of autologous bone are the result of its osteoinductive and osteoconductive properties.[2] The histocompatible and nonimmunogenic features of autologous bone provide additional advantages over allografts for application in spinal surgery. Potential disadvantages of autologous bone graft use include increased operative time, increased blood loss and donor site morbidities.[2] Major complications of iliac bone grafting are uncommon and include superior gluteal artery injury, deep wound infections, donor site visceral herniation, meralgia paresthetica and pelvic instability or fracture.[3, 6]

The incidence of iliac crest donor site pain varies widely in the literature and despite the common practice of iliac bone graft harvestion, the true incidence of persistent iliac crest donor site pain remains unknown. Schnee et al.[8] and Younger and Chapman[9] determined iliac crest donor site pain to be present in 2.8% and 2.5% of cases, respectively. Sawin et al.[5] documented an incidence of 17 % for patients who required narcotics as a result of iliac graft procurement. Fernyhough et al.[2] reported a 29% incidence of posterior iliac crest pain. Goulet et al.[10] documented overall incidences of donor site pain of 37% at 6 months and 18% at 2 years.

This study described a randomized controlled trial of 40 patients with decompressive laminectomy and posterior instrumentation and posterolateral fusion in spodylolisthesis with spinal stenosis patients to compare solid fusion between bone marrow aspirate mixed local bone (studied group) and autologous iliac crest bone graft (controlled group). Studied group had two broken rods and one no solid fusion patients. Controlled group had one broken rod and one no solid fusion patients. But there was no statistically significant difference in solid fusion between two groups utilizing plain radiographs (anteroposterior and lateral flexion – extension views) at 12th month postoperation. This study shows the potential use of bone marrow aspirate mixed local bone graft that is comparable to autologous iliac crest bone graft for instrumented posterolateral fusion at two levels. Local bone is mainly osteoconductive and bone marrow is osteoinductive agent when mixed together can produced high fusion rates comparable with those produced by autologous iliac crest bone graft. In controlled group, a patient still had donor site pain on discharge's day from the hospital but disappeared within 3 months later and two patients had intraoperative iliac crest fractures but did not affect activities daily living. Preliminary results may indicate less pain and fracture at the aspiration site compared to the iliac crest harvest site but no statistically significant difference.

CONCLUSIONS

Bone marrow aspirate mixed local bone could produced high fusion rates that is comparable to autologous iliac crest bone graft for instrumented posterolateral fusion two levels in spondylolisthesis and spinal canal stenosis patients .

REFERENCES

1. Heary RF, Schlenk RP, Sacchierr TA, Barone D, Brotea C. Persistent Independent Outcome Assessment. *Neurosurgery* 2002 ; 50 (3) : 510 – 7
2. Ferneyhough JC, Schimandle JJ, Wiegel MC, Edwards CC, Levine AM. Chronic Donor Site Pain Complicating Bone Graft Harvesting from the Posterior Iliac Crest for Spinal Fusion. *Spine* 1992 ; 17: 1474 – 80.
3. Hu RW, Bohlman HH. Fracture at the Iliac Bone Graft Harvest Site After Fusion of the Spine. *Clin Orthop* 1994 ; 309 : 208 – 13.
4. Summers BN, Eisenstein SM. Donor Site Pain from the Ilium. A Complication of Lumbar Spinal Fusion. *J Bone Joint Surg* [Br] 1989 ; 71 : 777 – 80.
5. Sawin PD, Traynelis VC, Menezes AH. A comparative analysis of fusion rates and donor site morbidity for autogenic rib and iliac crest bone grafts in posterior cervical fusion. *J Neurosurg* 1998 ; 88 : 255 – 265
6. Kurica KL, Booton K, Giuffre JM. Autologous Growth Factors and Resorbable Porous Ceramic without Bone Graft for Instrumented Posterolateral Lumbar Fusion with or without Interbody Fusion. Presented at spine Across The Sea, Maui, Hawaii, July 28, 2003.
7. Tay BK, Le AX, Heilman MS, Lotz J, Bradford DS . Use of Collagen – hydroxyapatite Matrix in Spinal Fusion. *Spine* 1998 ; 23 (21) : 2276 – 81.
8. Schnee CL, Freese A, Weil RJ, Marcotte PJ. Analysis of harvest morbidity and radiographic outcome using autograft for anterior cervical fusion. *Spine* 1997 ; 22 : 2222 – 2227
9. Younger EM, Chapman MW. Morbidity at bone graft donor sites. *J Orthop Trauma* 1989 ; 3 : 192 – 195
10. Goulet JA, Senunas LE, DeSilva GK, Greenfield MLVH. Autogenous iliac crest bone graft: Complications and functional assessment. *Clin Orthop* 1997 ; 339 : 76 – 81

การศึกษาเปรียบเทียบอัตราการเชื่อมของปล้องกระดูกสันหลังโดยใช้ bone marrow aspirate ผสมกับ local bone กับการใช้ autologous iliac crest bone graft ในการผ่าตัดเชื่อมปล้องกระดูกสันหลังในผู้ป่วยกระดูกสันหลังเลื่อนที่ระดับ lumbar

นิพนธ์ ปันทะรส, พบ.
นรัตว์ ประสพโชค พบ.
กลุ่มงานศัลยกรรมออร์โธปิดิกส์ โรงพยาบาลลำปาง

บทคัดย่อ

การศึกษาแบบ randomized controlled trail ในการผ่าตัดเชื่อมปล้องกระดูกสันหลังในผู้ป่วยกระดูกสันหลังเลื่อนที่ระดับ lumbar จำนวน 40 ราย เพื่อเปรียบเทียบอัตราการเชื่อมของปล้องกระดูกสันหลังระหว่างการใช้ bone marrow aspirate ผสมกับ local bone กับการใช้ iliac crest bone graft ผู้ป่วยทุกรายได้รับการผ่าตัดโดยศัลยแพทย์ออร์โธปิดิกส์คนเดียวกัน วิธีการผ่าตัดและอุปกรณ์ดามกระดูกสันหลังชนิดเดียวกัน ส่วนการเชื่อมของปล้องกระดูกสันหลัง ดูจากฟิล์มเอกซเรย์ที่ 12 เดือนหลังผ่าตัด โดยแพทย์อีกท่านหนึ่งซึ่งไม่เกี่ยวข้องกับการผ่าตัด ได้แบ่งผู้ป่วยเป็น 2 กลุ่มๆ ละ 20 ราย กลุ่มที่ 1 ใช้ bone marrow aspirate ผสมกับ local bone ส่วนกลุ่มที่ 2 ใช้ autologous iliac crest bone graft ในการทำ posterolateral fusion ติดตามหลังผ่าตัด 12 เดือน พบว่า กลุ่มที่ 1 อัตราการเชื่อมปล้องกระดูกสันหลังพบ 85% (17 ใน 20 ราย) ส่วนกลุ่มที่ 2 พบ 90% (18 ใน 20 ราย) ซึ่งไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($p > 0.05$) ส่วนผลแทรกซ้อนบริเวณ iliac crest กลุ่มที่ 1 ไม่พบเลย กลุ่มที่ 2 พบ 3 ราย (ปวด 1 ราย, กระดูก iliac crest หัก 2 ราย) ซึ่งก็ไม่พบว่ามีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($p > 0.05$) และอาการปวดที่ iliac crest หายไปหลังการผ่าตัด 3 เดือน และกระดูก iliac crest ที่หักไม่มีผลต่อการดำรงชีวิตของผู้ป่วย การศึกษานี้ได้ข้อสรุปว่า การผ่าตัดเชื่อมปล้องกระดูกสันหลังในผู้ป่วยโรคกระดูกสันหลังเลื่อนที่ระดับ lumbar สามารถใช้ bone marrow aspirate ผสมกับ local bone ซึ่งได้ผลดีเช่นเดียวกับการตัดกระดูก iliac crest มาทำเป็น bone graft

คำสำคัญ : posterolateral fusion, bone marrow aspirate.