

Iliac Crest Bone Graft in Lumbar Fusion: The Effectiveness and Safety Compared with Local Bone Graft, and Graft Site Morbidity Comparing a Single-Incision Midline Approach with a Two-Incision Traditional Approach

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Abstract

Study Design Systematic review.

Clinical Questions (1) Is autologous local bone (LB) graft as safe and effective as iliac crest bone graft (ICBG) in lumbar spine fusion? (2) In lumbar fusion using ICBG, does a single-incision midline approach reduce postoperative iliac crest pain compared with a two-incision traditional approach?

Methods Electronic databases and reference lists of key articles were searched up to October 2014 to identify studies reporting the comparative efficacy and safety of ICBG versus LB graft or comparing ICBG harvest site for use in lumbar spine surgery. Studies including allograft, synthetic bone, or growth factors in addition to ICBG and those with less than 80% of patients with degenerative disease in the lumbar spine were excluded. Two independent reviewers assessed the level of the evidence quality using the Grades of Recommendation Assessment, Development and Evaluation criteria, and disagreements were resolved by consensus.

Results Seven studies were identified as using ICBG fusion for degenerative disease in the lumbar spine. There were no differences in the fusion, leg pain, low back pain, or functional outcomes between patients receiving LB versus ICBG. There was a higher incidence of donor site pain and sensory loss in patients receiving ICBG, with no donor site complications attributed to LB. Compared with patients with the graft harvested through the two-incision traditional approach, patients with the graft harvested through the single-incision midline approach had lower mean pain scores over the iliac crest, with a higher proportion reporting no iliac crest tenderness. In patients with ICBG harvested through the single-incision midline approach on either the right or the left side of the ilium, only 36% of the patients were able to correctly identify the side when asked whether they knew which iliac crest was harvested. Only 19% of the patients with ICBG harvested through the single-incision midline approach on either the right or

Keywords

- ▶ Iliac crest bone graft (ICBG)
- ▶ local bone graft (LB)
- ▶ lumbar
- ▶ fusion

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the left side of the ilium reported pain that was concordant with the side that was actually harvested.

Conclusions LB is as safe and efficacious as ICBG for instrumented fusion in the lumbar spine to treat degenerative disease. When ICBG is used, graft harvest through the single-incision midline approach reduces postoperative iliac crest pain compared with a two-incision approach.

Study Rationale and Context

Solid bone fusion is the primary goal of all fusion procedures for lumbar degenerative disease. Autologous iliac crest bone has long been considered the gold standard for these fusion procedures. However, there are recognized drawbacks to depending on iliac crest bone graft (ICBG), including increased operative time, increased blood loss, increased donor site morbidity, and a limitation to the amount that can be realistically harvested for multilevel fusion. There are alternatives for “expanding” the amount of ICBG including aspiration systems; however, this option potentially substantially increases the cost of these procedures and the aspirations are not as enriched with osteoinductive elements as harvested iliac crest marrow. The other readily available autologous bone source in these fusion procedures is local bone (LB) graft harvested at the time of decompression, which is often referred to as “bad bone” by many surgeons compared with the “good bone” of ICBG. However, there is growing interest and supportive evidence for the utilization of LB alone or in combination with ICBG or other bone extenders as the primary fusion substrate, which is especially true for shorter segment fusions; the practice requires efficient harvest of all available LB as opposed to using the drill primarily for the decompression. It also involves a meticulous preparation of the harvested bone including removal of soft tissue elements and morselization to increase the surface area for fusion. In addition, regardless of the fusion substrate, there is no substitution for meticulous preparation of the fusion bed before placement of the fusion substrate. The first systemic review question is designed to address the utilization of LB graft compared with ICBG.

When the decision is made to use ICBG, there are numerous methods described to reduce donor site morbidity, including persistent pain, which is a major concern. One of the fundamental questions is whether to harvest the crest through the same midline incision used for the primary procedure or to use a separate incision. There are advocates and arguments for both procedures including cosmesis, fewer incisions (same incision), less soft tissue undermining and dead space, and better closure of the fascia overlying the crest (separate incisions). The second systemic review question is designed to address these issues.

Clinical Questions

1. Is autologous LB graft as safe and effective as ICBG in lumbar spine fusion?
2. In lumbar fusion using ICBG, does a single-incision midline approach reduce postoperative iliac crest pain compared with a two-incision traditional approach?

Materials and Methods

Study design: Systematic review.

Search: PubMed, bibliographies of key articles.

Dates searched: January 1980 to October 27, 2014.

Inclusion criteria: (1) Comparative studies in peer-reviewed journals; (2) patients undergoing spinal fusion for degenerative disease in the lumbar spine with either ICBG or LB grafting; (3) outcomes included at least one of the following: fusion, patient-reported outcomes, morbidity/pain, or adverse events.

Exclusion criteria: (1) Skeletally immature patients (< 8 years of age), history of tumor in the implantation site, trauma/fracture, infection, or scoliosis; (2) fusion supplemented with a growth factor (recombinant human bone morphogenetic protein-2 [rhBMP-2]), allograft, synthetic bone graft, or other autograft; (3) nonclinical studies, case reports, case series; (4) sample size less than 10 in either treatment arm.

Outcomes: (1) Fusion; (2) clinician-based and patient-reported pain: Japanese Orthopaedic Association Score (JOAS), Oswestry Disability Index (ODI), visual analog scale (VAS), ICBG tenderness, concordant pain; (3) donor site complications, general complications.

Analysis: Qualitative synthesis. Due to heterogeneity in the patient populations (including differences in fusion definition, preparation of graft material, follow-up length, fusion procedure type/approach), and in differences in study design and outcomes reported, a meta-analysis was not performed.

Details about methods can be found in the online supplementary material.

Overall strength of evidence: The overall strength of evidence across studies was based on precepts outlined by the Grades of Recommendation Assessment, Development and Evaluation (GRADE) Working Group.¹ Study critical appraisals and reasons for upgrading and downgrading for each outcome can be found in the online supplementary material.

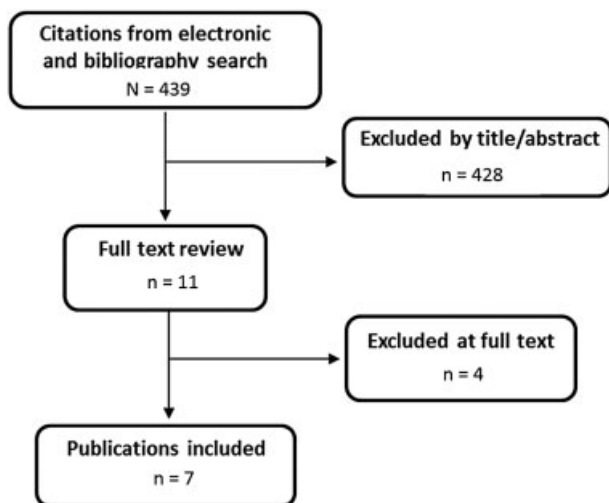


Fig. 1 Flowchart showing results of literature search.

Results

- We identified seven comparative studies that met the inclusion criteria (► **Fig. 1**). A list of excluded studies can be found in the online supplementary material.
- Three studies compared fusion for degenerative disease in the lumbar spine with either autologous LB or autologous ICBG, one randomized controlled trial (RCT)² and two retrospective cohorts³⁻⁵ (► **Table 1**).
- Four studies, one RCT⁶ and three retrospective cohorts,⁷⁻⁹ evaluated the origin of donor site morbidity in the lumbar spine using autologous ICBG. Of these, two studies compared the single-incision midline approach with the two-incision traditional approach.^{6,7} The other two studies evaluated whether patients were able to correctly identify the side of harvest site based on pain (► **Table 2**).^{8,9}

Local Bone versus Iliac Crest Bone Graft for Fusion in the Lumbar Spine

- There were no differences in fusion, leg pain, low back pain, or functional outcomes between the patients receiving LB or ICBG in one RCT and two retrospective cohorts (► **Table 3**).^{2,4,5}
- In the patients receiving LB versus ICBG, there was a higher incidence of donor site pain (0 versus 15%, respectively, $p = 0.025$) and sensory loss (0 versus 20%, respectively, $p = 0.01$) (► **Table 4**).^{2,4,5}
- There were no donor site complications attributed to LB grafting (► **Table 4**).^{4,5}
- There were no differences between the treatment groups with respect to complications not related to the donor site, such as infection, dural tears, pedicle screw misplacement, or instrumentation failure (► **Table 5**).^{2,4,5}

Origin of Graft Site Morbidity in Patients Receiving ICBG for Fusion in the Lumbar Spine

Midline versus Traditional Approach

- Patients with graft harvested through the single-incision midline approach had lower mean pain scores over the iliac crest compared with those patients with graft harvested through the two-incision traditional approach (0.25 versus 2, respectively, $p < 0.0001$),⁶ with a higher proportion reporting no iliac crest tenderness (82.1 versus, 45.1%, respectively; ► **Figs. 2 and 3**).⁷
- A higher proportion of the patients having grafts harvested through the single-incision midline approach were satisfied with the graft procedure and cosmesis than the patients with grafts harvested through the two-incision traditional approach (96.5 versus 81.3%, $p < 0.5$).⁶
- No statistical difference in complications (sacroiliac penetration, donor site pain > 1 year, residual donor site numbness, seroma, temporary sensory loss, donor site pain > 30 days, reoperation, or surgical complications) was found between the single-incision midline approach and the two-incision traditional approach for graft harvest (► **Table 6**).

Right versus Left Side Harvest Site

- In the patients with ICBG harvested through the single-incision midline approach on either the right or the left side of the ilium, only 36% of the patients were able to correctly identify the side when asked whether they knew which iliac crest was harvested. Of these, only 8% had confidence in their answer (► **Fig. 4**).⁹
- Only 19% of the patients with ICBG harvested through the single-incision midline approach on either the right or the left side of the ilium reported pain that was concordant with the side that was actually harvested (i.e., right side harvest site, right side pain reported; ► **Fig. 4**).⁸
- When comparing patients receiving lumbar fusion without ICBG (rhBMP-2 used) with the patients with ICBG harvested through the single-incision midline approach, there was no difference in the proportion of patients reporting pain or tenderness (50.8 versus 56.6%, respectively; ► **Fig. 4**).⁸

Clinical Guidelines

None found.

Evidence Summary

- There was no difference in effectiveness or safety in lumbar fusion comparing ICBG with LB grafts (► **Table 7**). The strength of the evidence for this conclusion was very low.
- There was less pain and tenderness over the iliac crest harvest site when a single-incision midline approach was used compared with a two-incision traditional approach in lumbar fusion (► **Table 8**). The strength of evidence for this conclusion was very low.

Table 1 Characteristics of included studies using ICBG versus LB for question 1 (Is autologous LB graft as safe and effective as ICBG in lumbar spine fusion?)

Author (y); study design; LoE	Intervention/control	Characteristics	Inclusion/exclusion criteria	Follow-up	Diagnosis	Funding
Ohtori et al (2011) ² ; RCT; II	Decompression and PLIF with instrumentation Intervention: • Local bone graft (spinal processes of L4–L5 and lamina between L4–L5) (structural) Control: • ICBG (structural)	N = 82 Intervention: • n = 42 • Male = 51% • Age = 66 ± 5.5 y Control: • n = 40 • Male = 49% • Age = 67 ± 6.0 y	Inclusion: • Fusion with bone graft • L4 degenerative spondylolisthesis with spinal stenosis • Low back and neck pain for ≥ 12 mo Exclusion: • Previous back surgery • Spinal tumor, infection, trauma	Range 2–5 y; % NR	• L4 degenerative spondylolisthesis (100%)	None stated
Ito et al (2010, 2013) ^{3,4,a} ; retrospective cohort; III	PLIF with radiolucent carbon fiber cages Intervention: • Local bone graft (morselized from laminectomy) Control: • ICBG (morselized)	N = 109 Intervention: • n = 56 • Male = 58.9% • Age = 48.6 ± 15.3 y Control: • n = 53 • Male = 49.1% • Age = 50.1 ± 13.4 y	Inclusion: • PLIF performed at one level • Radiolucent carbon fiber cages inserted Exclusion: • Previous back surgery, except recurrent disk herniation • Multilevel procedure • Use of metal cages • Lumbar spine spondylolysis • Patients > 65 y	Mean 50 mo (24–60 mo), % NR	Intervention: • Disk hernia (11%) • Spondylolisthesis (47%) • Canal stenosis (42%)	None stated
Sengupta et al (2006) ⁵ ; retrospective cohort study; III	Decompression and PLIF with instrumentation Intervention: • Local bone graft (obtained from decompression and morselized) Control: • ICBG (structural)	N = 76 Intervention: • n = 40 • Male = 38% • Age = 60 y Control: • n = 36 • Male = 31% • Age = 60 y Total: • Decompression: 2+ levels 45% • Fusion: 2+ levels 33%	Inclusion: • NR Exclusion: • NR	≥ 24 mo (mean 28, range: 24–72 mo), 76/109 (68%)	• Stenosis (61%) • Degenerative spondylolisthesis with stenosis (16%) • Isthmic spondylolisthesis with disk degeneration (16%) • Degenerative scoliosis (>20 degrees) with stenosis (7%) • Previous spine surgery (28%)	None stated

Abbreviations: ICBG, iliac crest bone graft; LB, local bone; LoE, level of evidence; NR, not reported; PLIF, posterior lumbar interbody fusion; RCT, randomized controlled trial.
^aIto et al (2013): large overlap in patient population with study by Ito et al (2010); this 2013 article excluded patients > 65 y, most recent publication included.

Table 2 Characteristics of included studies using ICBG for question 2 (In lumbar fusion using ICBG, does a single-incision midline approach reduce postoperative iliac crest pain compared with a two-incision traditional approach?)

Author (y); study design; LoE	Intervention/control	Characteristics	Inclusion/exclusion criteria	Follow-up (range); n/N (% follow-up)	Diagnosis/procedure	Funding
Bezer et al (2004) ⁶ ; RCT; II	Intervention: ICBG harvested through the same midline incision (intrafascial approach) Control: ICBG harvested through a separate incision (traditional approach)	N = 117 Intervention: • n = 58 • Male = 41.3% • Age = 48 y Control: • n = 59 • Male = 45.8% • Age = 51 y	Inclusion: • NR Exclusion: • NR	2 y; % NR	Diagnosis: • Degenerative disease (100%) Fusion: • Decompression with PLIF (instrumented) Graft: • Cancellous bone chips and strips (outer table technique)	None stated
David et al (2003) ⁷ ; retrospective cohort; III	Intervention: ICBG harvested through the same midline incision (two layers of lumbar fascia were split down to the iliac crest) Control: ICBG harvested through a separate vertical or oblique incision (traditional approach)	N = 107 Intervention: • n = 56 • Male = 62.5% • Age = 41.8 y Control: • n = 51 • Male = 56.9% • Age = 43.7 y	Inclusion: • Follow-up of at least 1 year Exclusion: • NR	Midline approach: mean 27.8 mo Traditional approach: mean 25.3 mo; 72.3% (107/148)	Diagnosis: • Degenerative disease or trauma (% NR) Fusion: • From L3 or lower to L5 or S1 • Either index fusion surgery or fusion as a part of a decompression and instrumentation procedure Graft: • NR	None stated
Howard et al (2011) ⁸ ; retrospective cohort; III	Intervention: ICBG harvested from the right or left side Control: no ICBG harvested (rhBMP-2)	N = 112 • Male = 64.3% • Age = 56.6 (range, 16–84) y Intervention: • n = 53 Control: • n = 59	Inclusion: • NR Exclusion: • Patients with possible or definite pseudarthrosis based on imaging studies • Fusions extending into thoracic spine	41 mo (range, 6–211 mo), median 25 mo; % NR	Diagnosis: NR Fusion: • Instrumented posterolateral fusion at 1 or 2 levels Graft: • Excised by midline approach (outer table technique), cancellous chips • Defect was either packed with Gel-foam (Pfizer, New York, NY, United States) or backfilled with ceramic bone void filler (Pro Oseon; Interpore Cross, Irvine, CA, United States)	None stated

(Continued)

Table 2 (Continued)

Author (y); study design; LoE	Intervention/control	Characteristics	Inclusion/exclusion criteria	Follow-up (range); n/N (% follow-up)	Diagnosis/procedure	Funding
Pirris et al (2014) ⁹ ; retrospective cohort; III	Intervention: • ICBG harvested from the right side Control: • ICBG harvested from the left side	N = 25 • Male = 40% Intervention: • n = 13 • Male = % NR • Age = NR Control: • n = 12 • Male = % NR • Age = NR	Inclusion: • Agreement to be blinded to the side of harvest and accept reconstruction of the site Exclusion: • Previous iliac crest harvest • Refusal of iliac crest grafting • Diagnosis of osteoporosis • Request to have the harvest site on a specific side • Anatomy that prevents midline graft harvest • Knowledge of the harvest side	8.3 mo (range, 1–22 mo); 100% (25/25)	Diagnosis: • Degenerative disorders (80%) • Spinal deformity (16%) • Tumor (4%) Fusion: • Posterior lumbar arthrodesis (instrumented, with pedicle screw fixation) ^a Graft: • Graft was harvested through same midline skin incision but separate fascial incision • Harvest site was reconstructed with allograft	Gary and Lynne Sneed Family Neuroscience Research Fund

Abbreviations: ICBG, Iliac crest bone graft; LoE, level of evidence; NR, not reported; PLIF, posterior lumbar interbody fusion; RCT, randomized control trial; rhBMP-2, recombinant human bone morphogenetic protein-2.

^aIn two cases surgery involved a minimally invasive paramedian muscle splitting approach to the spine.

Table 3 Fusion, pain, and patient-reported outcomes following lumbar fusion with local bone compared with iliac crest bone graft

Author (study design)	Mean follow-up (range), mo	Fusion, pain, and patient-reported outcomes			RD (95% CI) or MD ± SD ^a	p Value
		Outcome	Local bone	ICBG		
Structural autograft						
Ohtori et al (2011) ² (RCT)	48-60	Fusion % (n/N) Leg pain (0-10), mean ± SD Low back pain (0-10), mean ± SD JOAS leg pain (0-3), mean ± SD JOAS low back pain (0-3), mean ± SD Final ODI, mean ± SD	83.3% (35/42) 1.5 ± 0.6 1.8 ± 0.6 2.4 ± 0.5 2.4 ± 0.8 22 ± 5	85% (34/40) 2.0 ± 0.8 2.2 ± 0.7 2.7 ± 0.6 2.5 ± 0.7 22 ± 4	-1.6% (-14.9%, 11.6%) -0.5 ± 0.15 -0.4 ± 0.14 -0.3 ± 0.12 -0.1 ± 0.17 0	NS NS NS NS NS NS
Morselized autograft						
Ito et al (2013) (retrospective cohort) ⁴	50 (24-60)	Fusion % (n/N) JOAS (recovery rate)	98% (52/53) 82.7%	96% (51/53) 80.5%	1.9% (-4.4%, 8.2%) 2.2%	NS NS
Sengupta et al (2006) ^b (retrospective cohort) ⁵	24-72	Fusion % (n/N) Leg pain (>3/10), % (n/N) Back pain (>3/10), % (n/N) Excellent/good, % (n/N) ODI (mean improvement in score)	65% (26/40) 75% (30/40) 75% (31/40) 87.5% (35/40) 36%	75% (27/36) 64% (23/36) 75% (27/36) 72% (26/36) 32%	-10% (-30.5%, 10.5%) 11.1% (-9.5%, 31.8%) 2.5% (-16.7%, 21.7%) 15.3% (-2.6%, 33.1%) 4%	NS NS NS NS NS

Abbreviations: CI, confidence interval; ICBG, iliac crest bone graft; JOAS, Japanese Orthopaedic Association Scale; MD, mean difference; NS, not significant; ODI, Oswestry Disability Index; RCT, randomized controlled trial; RD, risk difference; SD, standard deviation; VAS, visual analog scale.

^aMD = local bone - ICBG.

^bICBG is structural; local bone is morselized.

Table 4 Donor site complications at final follow-up comparing local bone graft with ICBG

Outcome	Study	Fusion		RD (95% CI) ^a
		Local bone	ICBG	
Pain	Ohtori et al (2011) ²	0% (0/42)	15% (6/40) ^b	-15.0% (-26.1, -3.9%)
	Ito et al (2013) ⁴	0% (0/53)	9% (5/53)	-11.3% (-19.9%, -2.8%)
	Sengupta et al (2006) ⁵	0% (0/40)	5.6% (2/36)	-5.6% (-13.0%, 1.9%)
Hematoma/seroma	Ohtori et al (2011) ²	0% (0/42)	0% (0/40)	0%
	Sengupta et al (2006) ⁵	0% (0/40)	5.6% (2/36)	-5.6% (-13.0%, 1.9%)
Sensory loss	Ohtori et al (2011) ²	0% (0/42)	20% (8/40) ^c	-20% (-32.4%, -7.6%)

Abbreviations: CI, confidence interval; ICBG, Iliac crest bone graft; RD, risk difference; NS, not significant.

^aMean difference = local bone - ICBG.

^b $p = 0.025$.

^c $p = 0.01$.

Table 5 Other complications (other than donor site complications) at final follow-up comparing local bone graft with ICBG in lumbar fusion: non-ICBG autograft versus ICBG

Outcome	Study	Fusion	
		Local bone	ICBG
Deep infection	Ohtori et al (2011) ²	2.3% (1/42)	0% (0/40)
Superficial infection	Ito et al (2013) ⁴	0% (0/53)	1.9% (1/53)
Infection (type NS)	Sengupta et al (2006) ⁵	5.0% (2/40)	8.3% (3/36)
Deep vein thrombosis	Sengupta et al (2006) ⁵	10.0% (4/40)	8.3% (3/36)
Dural tear	Sengupta et al (2006) ⁵	12.5% (5/40)	8.3% (3/36)
Hematoma (spinal canal)	Ohtori et al (2011) ²	0% (0/42)	0% (0/40)
Pedicle screw misplacement	Ito et al (2013) ⁴	7.5% (4/53)	5.6% (3/53)
	Sengupta et al (2006) ⁵	2.5% (1/40)	8.3% (3/36)
Instrumentation failure	Sengupta et al (2006) ⁵	5.0% (2/40)	2.8% (1/36)
Numbness in buttock	Sengupta et al (2006) ⁵	0% (0/40)	8.3% (3/36)

Abbreviations: ICBG, iliac crest bone graft; NS, not specified.

Discussion

Question 1: Is Autologous Local Bone Graft as Safe and Effective as Iliac Crest Bone Graft in Lumbar Spine Fusion?

When patients do not improve after lumbar fusion, the question always becomes “Did we achieve adequate fusion?” Fusion cannot be completely evaluated radiographically and is not always associated with outcome, but continues to be our ultimate goal. The choices of fusion substrate are numerous but fiscal restraints and long-term efficacy/ safety studies would still argue that an autologous source would be ideal. We have tried to address the issue of safety and efficacy with autologous sources (local autograft versus ICBG) in the available literature. This issue is especially pertinent in shorter-segment fusions and fortunately the available studies that met the screening criteria all involved short-segment fusions for degenerative disease. Based on the available evidence, the LB graft is a reasonable alternative to ICBG for single-level instrumented fusions

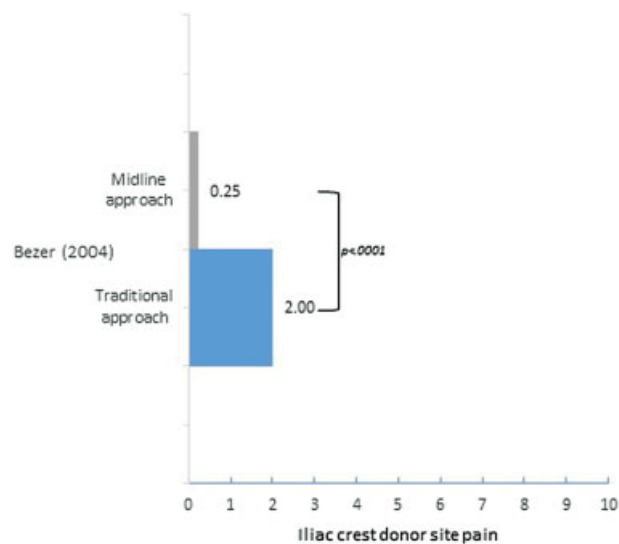


Fig. 2 Mean pain level comparing a two-incision traditional approach with a single incision with a midline approach in one randomized controlled trial of patients receiving lumbar fusion.⁶

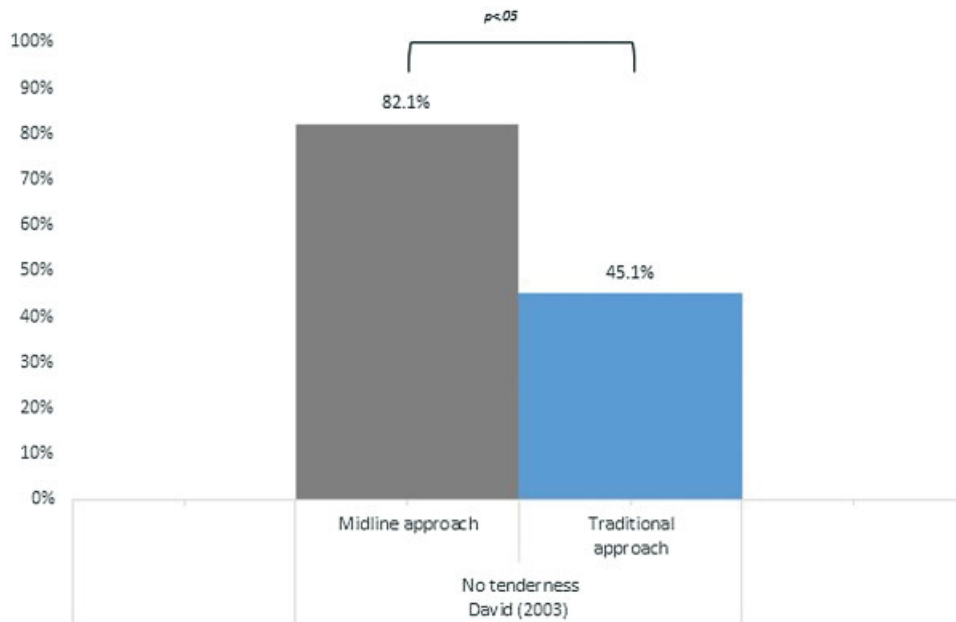


Fig. 3 Proportion of patients with iliac crest tenderness reported by David et al.⁷

for lumbar degenerative disease at a very low evidence level.

Weaknesses of this study include that there were only three studies that met the criteria for inclusion, of which one was an RCT (level 2) and two were retrospective cohort studies (level 3). All of the studies used interbody fusion

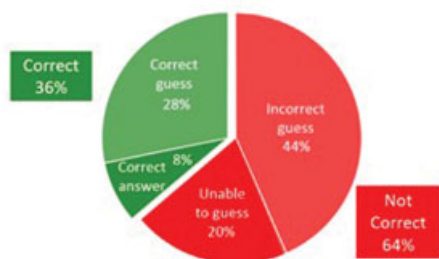
and posterior instrumentation, and so it is harder to extrapolate to posterolateral fusions in addition to instrumentation or noninstrumented fusions. The RCT had relatively small numbers and no report of percent follow-up. The two cohort studies had no percentage follow-up in one and 68% follow-up in the other. These factors contribute to a very low

Table 6 Complications in included studies using ICBG for question 2

Outcome	Study	ICBG harvest approach	
		Midline	Traditional
Single incision midline approach versus the two incision traditional approach			
Overall complication risk	Bezer et al (2004) ⁶	8.6% (5/58)	20.3% (12/59)
Major complications	Bezer et al (2004) ⁶	1.7% (1/58)	6.8% (4/59)
Sacroiliac penetration	Bezer et al (2004) ⁶	1.7% (1/58)	0% (0/59)
Donor site pain (>1 y)	Bezer et al (2004) ⁶	0% (0/58)	5.1% (3/59)
Residual donor site numbness	Bezer et al (2004) ⁶	0% (0/58)	1.7% (1/59)
Minor complications	Bezer et al (2004) ⁶	7.0% (4/58)	13.6% (8/59)
Seroma	Bezer et al (2004) ⁶	1.7% (1/58)	3.4% (2/59)
Temporary sensory loss	Bezer et al (2004) ⁶	3.4% (2/58)	6.8% (4/59)
Donor site pain (>30 d)	Bezer et al (2004) ⁶	1.7% (1/58)	3.4% (2/59)
Reoperation	Bezer et al (2004) ⁶	0% (0/58)	0% (0/59)
Surgical complications	David et al (2003) ⁷	0% (0/56)	0% (0/51)
Comparison of side of graft harvest site		Midline (either right or left side)	
Deep wound infection	Pirris et al (2014) ⁹	4% (1/25)	
Unintended durotomies	Pirris et al (2014) ⁹	8% (2/15)	
Transient left upper extremity weakness	Pirris et al (2014) ⁹	4% (1/25)	

Abbreviation: ICBG, iliac crest bone graft.

a Pirris,* 2014



b Howard†, 2011

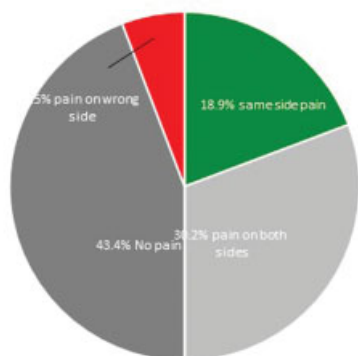


Fig. 4 Percentage of patients correctly identifying side of harvest site based on pain. Patients were asked to guess from which side of the pelvis (left or right) the iliac crest bone graft was taken.⁹

evidence level and suggest the need for larger controlled studies with better follow-up.

Question 2: In Lumbar Fusion Using Iliac Crest Bone Graft, Does a Single-Incision Midline Approach Reduce Postoperative Iliac Crest Pain Compared with a Two-Incision Traditional Approach?

When the decision is made to harvest ICBG, consideration must be given to reducing donor site morbidity, including long-term pain, which is a major factor. There is considerable surgeon variability with regard to harvesting ICBG including the use of one incision or two incisions. Two studies met the screening process and addressed the choice of incisions specifically: one RCT (level 2) and one retrospective cohort studies (level 3). One cohort study looked at ICBG harvest versus no harvest (bone morphogenetic protein) and one study had the patients blinded to the side of harvest through a separate incision and patients underwent reconstruction of the defect at the time of harvest. At a very low level of evidence, there was less pain over the iliac crest harvest site, better patient satisfaction, and comparable complication rates for graft harvested through the midline incision. There was also a low concordance rate for correctly identifying the side of iliac crest harvest when it was harvested through the midline incision. Based on the available literature, harvesting graft through the same midline incision may be a better option than a using a separate incision.

Again, this review was based on a relatively small number of low- to moderate-quality studies available in the literature.

Table 7 Strength of evidence summary for question 1 (Is autologous local bone graft as safe and effective as ICBG in lumbar spine fusion?)

Outcome	Studies (N)	Strength of evidence	RD ^a (95% CI) or MD ± SD ^a	Favors
Fusion	1 RCT (82)	Very low ^b	RD: -1.6% (-14.9%, 11.6%)	Neither
	2 retrospective cohorts (185)	Very low ^c	RD (Ito et al ⁴): 1.9% (-4.4%, 8.2%) RD (Sengupta et al ⁵): -10% (-30.5%, 10.5%)	Neither
Leg pain				
JOAS (0-3)	1 RCT (82)	Very low ^b	MD: -0.3 ± 0.12	Neither
VAS (0-10)	1 RCT (82)	Very low ^b	MD: -0.5 ± 0.15	Neither
VAS % (>3/10)	1 retrospective cohort (76)	Very low ^b	RD: 11.1% (-9.5%, 31.8%)	Neither
Low back pain				
JOAS (0-3)	1 RCT (82)	Very low ^b	MD: 0.1 ± 0.17	Neither
VAS (0-10)	1 RCT (82)	Very low ^b	MD: -0.4 ± 0.14	Neither
VAS (% >3/10)	1 retrospective cohort (76)	Very low ^b	RD: 2.5% (-16.7%, 21.7%)	Neither
JOAS recovery rate	1 retrospective cohort (109)	Very low ^b	RD: 2.2%	Neither
ODI score				
Mean final	1 RCT (82)	Very low ^b	MD: 0	Neither
Mean improvement	1 retrospective cohort (76)	Very low ^b	RD: 4%	Neither
Complications				
Donor site pain	1 RCT (82)	Very low ^b	RD: -15.0% (-26.1, -3.9%)	Neither
	2 retrospective cohorts (185)	Very low ^a	RD (Ito et al ⁴): -11.3% (-19.9%, -2.8%) RD (Sengupta et al ⁵): -5.6% (-13.0%, 1.9%)	Neither

Table 7 (Continued)

Outcome	Studies (N)	Strength of evidence	RD ^a (95% CI) or MD ± SD ^a	Favors
Hematoma/seroma at donor site	1 RCT (82)	Very low ^b	RD: 0%	Neither
	1 retrospective cohort (76)	Very low ^b	RD: -5.6% (-13.0%, 1.9%)	Neither
Sensory loss at donor site	1 RCT (82)	Very low ^b	RD: -20% (-32.4%, -7.6%)	Neither

Abbreviations: CI, confidence interval; ICBG, iliac crest bone graft; JOAS: Japanese Orthopaedic Association Score; MD, mean difference; ODI, Oswestry Disability Index; RCT, randomized controlled trial; RD, risk difference; SD, standard deviation; VAS, visual analog scale.

^aRD and MD = local bone - ICBG.

^bDowngraded one time for serious risk of bias and two more times for serious imprecision.

^cDowngraded one time each for serious risk of bias and serious inconsistency, and two more times for serious imprecision.

Table 8 Strength of evidence summary for question 2 (In lumbar fusion using iliac crest bone graft, does a single-incision midline approach reduce postoperative iliac crest pain compared with a two-incision traditional approach?)

Outcome	Studies (N)	Strength of evidence	RD (95% CI) or MD ± SD ^a	Favors
Single-incision midline approach compared with the two-incision traditional approach				
Pain score VAS (0–10)	1 RCT (117)	Very low ^b	MD: 1.75	Single-incision midline approach
Tenderness over the iliac crest	1 retrospective cohort (107)	Very low ^b	RD: 37% (20%, 54%)	Single-incision midline approach
Identification of side of harvest site with a single-incision midline approach				
Correct identification of side of harvest site	1 retrospective cohort (112)	Very low ^b	36%	–
Pain on same side as harvest site	1 retrospective cohort (25)	Very low ^b	18.9%	–

Abbreviations: CI, confidence interval; MD, mean difference; RCT, randomized controlled trial; RD, risk difference; SD, standard deviation; VAS, visual analog scale.

^aRisk difference and mean difference = midline - traditional.

^bDowngraded one time for serious risk of bias, and two times for serious imprecision.

There was variability in the inclusion and exclusion criteria, primary and secondary end points, and again a variable rate of long-term follow-up. Once again, larger and more stringently controlled studies would better address this issue.

Disclosures

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Editorial Perspective

The authors addressed a question of great practical value to all spine surgeons with their formal review: Is locally derived morselized bone collected during neural decompression as good as autologous bone graft harvested from the posterior iliac crest? The authors added some other important factors to the question, such as patient satisfaction with a one- versus two-incision approach and whether patients could accurately identify the side of a posterior iliac crest harvest if done through a single incision. The *EBSJ* reviewers appreciated the clarity of the authors' study design and the practical applicability of their findings, namely that local bone graft can be used in good faith as substitute for autologous iliac crest graft for fusions and that a single-incision technique for posterior lumbosacral incisions seems to be preferred by patients to the more traditional two-incision technique. The authors com-

mented on the very low level of evidence of the study at the basis of their conclusions, meaning that a single, larger, better-designed study could change the conclusions of this study.

On a technical note, variables for a future bone graft healing studies would ideally incorporate some attempt at volumetric quantification of morselized bone grafts deployed and also details such as “stretching” of bone graft with allograft or osteobiologics. Associated patient factors, such as age of patient, atherosclerosis, bone healing impairment, and anti-inflammatory use, could also influence results heavily. Such factors are commonly omitted in bone graft-related studies. Nevertheless, the present study provides clear answers to daily practice habits. *EBSJ* wishes to thank the authors for their helpful contribution.