Appendix 1 Table B. Off-Label BMP Comparative Studies

Investigator (yr, country, ref #) Surgical Site	Study design	Comparison(s) No. pts (BMP dose)	Surgical intervention	Inclusion/exclusion criteria	Outcomes measured	Duration of F/U (rng)	Withdrawal or loss to F/U (%)	USPSTF quality rating	Comment
Boden et al., 2002 USA (84) **Lumbar Spine**	Multicenter nonblinded RCT	rhBMP2/CRM plus Texas Scottish Rite Hospital (TSRH) Spinal System (TSRHSS) n=11 (40 mg/pt) rhBMP2/CRM alone n=11 (40 mg/pt) ICBG plus TSRHSS n=5	single-level primary instrumented posterolateral lumbar fusion plus rhBMP2 ICBG	Inclusion: primary symptomatic single-level lumbar DDD, low back or leg pain unresponsive to minimum 6 mos. nonoperative therapies, grade I or less spondylolisthesis, 18 years or older, Oswestry DI score at least 30 Exclusion: prior fusion at index level, medications that interfere with fusion, scan-confirmed osteoporosis, autoimmune disease, prior exposure to BMP, endocrine disorders that affect osteogenesis,	Radiographic fusion using plain film radiographs and CT analysis, Oswestry Low Back Pain Disability Index, SF-36 physical component subscale, neurological functional status, back, leg and graft site pain numerical rating scales, perioperative data, second surgeries, complications and adverse events	mean 17 mos (12-27 mos.)	rhBMP2/CRM alone 2 (18%) were found to have > grade I spondylolisthesis and were excluded from analysis	FAIR	IDE pilot study for device which has not received FDA marketing approval Pilot study of rhBMP2 plus an osteoconductive compression-resistant matrix (CRM) composed of 60% hydroxyapatite and 40% tricalcium phosphate bulking agent, plus absorbable collagen sponge (ACS)

				tumor, infection					
Burkus et al., 2005 USA (85) **Lumbar Spine** Note: includes all pts from Burkus et al., 2002, rec# 11510; same pts as Burkus et al., 2006, rec# 6640	Multicenter, nonblinded RCT	rhBMP2 n=79 (8-12 mg/pt) ICBG N=52	primary single-level anterior lumbar fusion with a pair of threaded allograft cortical bone dowels (CBD) plus rhBMP2 or ICBG	Inclusion: radiographic documentation of primary symptomatic single-level lumbar DDD, age ≥ 18 years, spondylolisthesis grade ≤ 1, symptoms related to neuroradiographic findings unresponsive to minimum 6 mos. nonoperative therapies Exclusion: spinal conditions other than DDD, DDD at disc space levels other than L4-L5 or L5-S-1, previous anterior fusion at index level, obesity (> 40% above ideal wt), active bacterial infection, medication(s) that could interfere with fusion (e.g., steroids, NSAIDs)	Radiographic fusion based on plain film radiographs with use of anteroposterior, lateral, and flexion-extension views, 1-mm slice CT scans with coronal and sagittal reconstructions, Oswestry Low Back Pain Disability Index, SF-36 physical component subscale, back, leg and graft site pain numerical rating scales, work status perioperative data, second surgeries, complications and adverse events	24 mos	rhBMP2 3 (3.8%) ICBG 2 (3.8%)	FAIR	rhBMP2 soaked absorbable collagen sponges (ACS)

Dimar et al., 2009 USA (86) **Lumbar Spine** Note: contains pts in Glassman et al., 2007, rec# 4040; Dimar et al., 2006 rec# 5480; Glassman et al., 2005, rec# 8040	Multicenter nonblinded RCT	rhBMP2/CRM n=239 (40 mg/pt) ICBG n=224	single-level primary instrumented posterolateral lumbar fusion plus rhBMP2 or ICBG	Inclusion: primary symptomatic single-level lumbar DDD, low back pain or radicular leg pain unresponsive to minimum 6 mos. nonoperative therapies, grade I or less spondylolisthesis, 18 years or older, Oswestry DI score at least 30 Exclusion: prior fusion at index level, medications that interfere with fusion, scan-confirmed osteoporosis, autoimmune disease, prior exposure to BMP or collagen, endocrine disorders that affect osteogenesis, tumor, infection, pregnancy, or inability to harvest bone graft	Radiographic fusion using plain film radiographs and CT analysis, Oswestry Low Back Pain Disability Index, SF-36 physical component subscale, neurological functional status, back, leg and graft site pain numerical rating scales, perioperative data, second surgeries, complications and adverse events	24 mos	rhBMP2/CRM 23 (9.6%) ICBG 30 (13%)	FAIR	IDE trial for AMPLIFY device, which has not received FDA marketing approval AMPLIFY comprises rhBMP2, an osteoconductive, compression-resistant matrix (CRM) composed of 15% hydroxyapatite and 85% tricalcium phosphate ceramic bulking agent plus absorbable collagen sponge (ACS)

Glassman et al., 2007 USA (99) **Lumbar Spine**	Retrospective with historical control group	rhBMP2 n=91 (12 mg/pt) ICBG n=35	single- or multi-level primary or revision instrumented posterolateral lumbar fusion	Inclusion: not explicitly delineated Exclusion: not explicitly delineated	Radiographic fusion based on plain film radiographs and 1-mm slice CT scans with coronal and sagittal reconstructions	mn 27 mos (24-38)	91 patients received rhBMP2, only 48 (53%) comparable to ICBG historical controls	POOR	ICBG historical control group taken from Glassman et al., 2005 (rec# 8040) rhBMP2 soaked absorbable collagen sponges (ACS)
Glassman et al., 2008 USA (87) **Lumbar Spine**	Multicenter nonblinded RCT	rhBMP2 n=50 (dose not reported) ICBG n=52	single- or multi-level primary instrumented posterolateral lumbar fusion plus rhBMP2 or ICBG	Inclusion: patients > 60 years, primary symptomatic lumbar DDD with spinal stenosis, spondylolisthesis, instability, adjacent level degeneration Exclusion: Not reported	Radiographic fusion based on 1-mm slice CT scans with coronal and sagittal reconstructions, Oswestry Low Back Pain DI, SF-36 physical component subscale, back and leg pain numerical rating scales	24 mos	106 enrolled, 100 (94%) available for 24 mos. F/U 4 excluded (2 from each arm) in perioperative period due to improper fusion level (1), fusion not performed (1), refusal to follow-up (1), cross-over (1), 2 died	POOR	All patients > 60 years old, but includes those with single- and multi-level DDD, with fusion performed according to each surgeon's preferences using the same instrumentation rhBMP2 soaked absorbable collagen sponges (ACS) Enrollment not strictly limited to Medicare population
Haid et al., 2004 USA (88) **Lumbar Spine**	Multicenter, nonblinded RCT	rhBMP2 n=34 (4.2-8.4) ICBG N=33	single-level primary posterior lumbar interbody fusion (PLIF) with interbody fusion cages plus rhBMP2 or ICBG	Inclusion: symptomatic, single-level lumbar DDD, grade I spondylolisthesis, with disabling low back or leg pain, unresponsive to minimum 6 mos.	Radiographic fusion based on plain film radiographs with lateral and flexion-extension views, and 1-mm slice CT scans, Oswestry Low Back Pain Disability Index,	24 mos	rhBMP2 4 (12%) ICBG 0	POOR	Trial was halted after preliminary CT scans showed bone growth posterior to the PLIF cages, and was not restarted

				nonoperative therapies Exclusion: NR	back, leg and graft site pain numerical rating scales, SF-36 physical component subscale, neurological status, work status perioperative data, second surgeries, complications and adverse events				
Johnsson et al., 2002 Sweden (92) **Lumbar Spine**	Multicenter nonblinded RCT	rhBMP7 n=10 (7 mg/pt) ICBG n=10	single-level primary uninstrumented posterolateral lumbar fusion with rhBMP7 or ICBG	Inclusion: radiographic evidence of lumbar DDD, L5 spondylolisthesis, maximal vertebral slip of 50%, intractable lumbosacral pain unresponsive to 6 mos. nonoperative therapies, no radiating leg pain, age > 20 years Exclusion: NR	Radiographic fusion with plain film radiographs, radiostereometric analysis (RSA), patient's subjective evaluation of back pain	12 mos	1 (declined)	POOR	Efficacy study compared rhBMP7 (OP-1 Putty) and ICBG, based on RSA results
Kanayama et al., 2006 Japan, USA (93) **Lumbar Spine**	Multicenter nonblinded RCT	rhBMP7 n=9 (7 mg/pt) AGB/CRM n=10	single-level primary instrumented posterolateral lumbar fusion with rhBMP7 or AGB/CRM	Inclusion: radiographic evidence of lumbar DDD, grade I spondylolisthesis with stenosis, neurogenic	Radiographic fusion with plain film radiographs and CT scan, surgical exploration of fusion mass, Oswestry Low Back Pain DI	rhBMP7 mn 16 mos AGB mn 13 mos	rhBMP7 1 (declined to complete study)	POOR	rhBMP7 Putty (OP-1 Putty) compared to local autograft bone admixed with hydroxyapatite plus tricalcium phosphate biphasic cerami cgranules

				claudication, unresponsive to minimum 3 mos. nonoperative therapies, age < 85 years Exclusion: > 5 degrees kyphosis in flexion, history of fusion at index level, active spinal or systemic infection, known sensitivity to any component of the BMP device, pregnancy or lactation, possible need for additional lumbar surgery within 6 mos					
Mummanen i et al., 2004 USA (100) **Lumbar Spine**	Retrospective single-center cohort study	rhBMP2/AGB n=25 (8.4 mg/pt) ICBG N=19	single- or multi-level primary transforamin al lumbar interbody fusion (TLIF) with interbody fusion cages with rhBMP2 plus AGB or ICBG alone	Inclusion: symptomatic, single-level lumbar DDD, grade I spondylolisthesis, with disabling low back or leg pain, unresponsive to minimum 6 mos. nonoperative therapies Exclusion:	Radiographic fusion based on static and dynamic plain film radiographs, modified Prolo Scale that evaluates pain, functional status, economic status, and medication use (Salehi et al., 2004)	mn 9 mos (3-18 mos)	4 of 44 (9)	POOR	Study compared rhBMP2 in conjunction with ICBG or local autograft bone and ICBG alone

				NR					
Pradhan et al., 2006 USA (101) **Lumbar Spine**	Prospective consecutive patient single-center cohort study	rhBMP2 n=9 (dose NR) ICBG n=27	single-level primary anterior lumbar interbody fusion (ALIF) with femoral ring allograft (FRA) plus rhBMP2 or ICBG	Inclusion: primary single-level ALIF, low back pain with or without referred leg pain and sciatica, symptoms unresponsive to minimum 6 mos. nonoperative therapies Exclusion: any prior anterior lumbar spine surgery or posterior destabilizing surgery, osteopenia, osteoporosis, osteomalacia, bone growth stimulation	Radiographic fusion based on plain film radiographs and 1-mm slice CT scans	rhBMP2 mn 26 (rng 23-29) ICBG mn 36 (rng 29-55)	0	FAIR	Reported radiographic and adverse outcomes rhBMP2 soaked absorbable collagen sponges (ACS)
Singh et al., 2006 USA (102) **Lumbar Spine**	Prospective single-center case-matched cohort study	rhBMP2/ICBG n=39 (12-36 mg/pt) ICBG N=11	single- or multi-level primary instrumented posterolateral lumbar fusion with rhBMP2 plus ICBG or ICBG alone	Inclusion: radiographic evidence of DDD, grade I-II spondylolisthesis, lower extremity radiculopathy in a defined dermatomal distribution, unresponsive to	Radiographic fusion based on 2-mm slice CT scans with sagittal and coronal reconstructions	24 mos	2 (4.9) from rhBMP2/ICBG group	POOR	Study compared rhBMP2 in conjunction with ICBG or local autograft bone and ICBG alone Provided radiographic outcomes only

				minimum 6 mos. nonoperative therapies Exclusion: active smokers, prior fusion at the index level(s) malignancy, metabolic bone disease that would preclude instrumentation or inhibit osteogenesis (i.e., Paget disease, osteomalacia, osteogenesis imperfecta), local or systemic bacterial infection, temperature > 38 degrees at surgery, alcohol or drug abuse in treatment, historyof titanium alloy allergy					
Slosar et al., 2007 USA (103) **Lumbar Spine**	Prospective consecutive patient single-center cohort study	rhBMP2 n=45 (3-9 mg/pt) ALG N=30	single- or multi-level primary instrumented anterior lumbar interbody fusion (ALIF) with femoral ring allograft	Inclusion: primary single- or multi-level symptomatic DDD, grade I-II spondylolisthesis, unresponsive to minimum 6 mos. nonoperative therapies	Radiographic fusion based on plain film radiographs and CT scans, Oswestry Low Back Pain Disability Index, Numerical Rating Scale (NRS) for	24 mos	rhBMP2 2 (4) ALG 1 (3)	POOR	FRA inserts used instead of interbody fusion cages to contain rhBMP2 on ACS or ALG

			(FRA) plus rhBMP2 or allograft bone chips (ALG)	Exclusion: DDD at > 3 levels, grade > 2 spondylolisthesis, tumor, infection, psychological contraindications	pain (location not specified)				
Vaccaro et al., 2008 USA (94) **Lumbar Spine**	Multicenter, nonblinded RCT	rhBMP7 n=207 (7 mg/pt)	single-level primary uninstrumented posterolateral lumbar fusion with rhBMP7 or ICBG	Inclusion: radiographic evidence of lumbar DDD grade I or II lumbar spondylolisthesis, neurogenic claudication, unresponsive to minimum 6 mos. nonoperative therapies, skeletally mature Exclusion:	Primary Overall Success at 24 mos, a composite measure that required success in all of the following: a 20% improvement in Oswestry Low Back Pain DI, absence of treatment-emergent serious adverse events related to the device, absence of	rhBMP7 mn 53 mos (44-65)	335 enrolled and randomized, 295 (88%) were treated rhBMP7 20 voluntarily withdrew or were disqualified based on the inclusion and exclusion criteria	GOOD	IDE study for rhBMP7 device (OP-1 Putty) that did not receive FDA marketing approval Summarize data from 36+ mos. F/U
		ICBG n=86		> Grade II spondylolisthesis, nondegenerative spondylolisthesis of any grade, spinal instability on flexion-extension radiographs with > 50% translation of vertebral body or > 20 degrees of angular motion,	a decrease in neurologic status (assessing muscle strength, reflexes, sensation, and straight leg raise), and radiographic fusion success Modified Overall Success at 36 + mos, a composite measure that required success in	ICBG 54 (45-66)	ICBG 20 refused autograft or did not qualify after randomization based on the inclusion and exclusion criteria		

				active spinal or systemic infection, systemic disease precluding participation (eg, neuropathy), current nicotine use, history of smoking, morbid obesity, known sensitivity to collagen	all of the following: a 20% improvement in Oswestry Low Back Pain DI, absence of treatment-emergent serious adverse events related to the device, absence of a decrease in neurologic status (assessing muscle strength, reflexes, sensation, and straight leg raise) at 24 mos, and radiographic fusion success indicated by CT evidence for the presence of new bone, angulation ≤ 5 degrees, translation movement ≤ 3 mm on flexion/extension radiographs, and absence of retreatment to promote fusion at 36+ mos				
Vaccaro et al., 2008 USA (95)	Multicenter, nonblinded RCT	rhBMP7 n=24 (7 mg/pt)	single-level primary uninstrumented	Inclusion: radiographic evidence of lumbar DDD	Radiographic fusion based on anteroposterior, lateral, and	48 mos	Radiographic results rhBMP7 9 (38%)	POOR	IDE study for rhBMP7 device (OP-1 Putty) that did not receive FDA

Lumbar Spine Note: Long-term F/U study that includes all pts from Vaccaro et al., 2004, (184), and Vaccaro et al., 2005, (185) **Lumbar Spine**			posterolateral lumbar fusion with rhBMP7 or ICBG	grade I or II lumbar spondylolisthesis, neurogenic claudication, unresponsive to minimum 6 mos. nonoperative therapies, minimum Oswestry Low Back Pain Disability Index score 30 Exclusion: prior lumbar fusion or ICBG harvesting, active infection, history of tobacco use, morbid obesity, known sensitivity to collagen, grade III or IV spondylolisthesis, > 20% angular motion of the listhetic segment	dynamic flexion-extension lateral plain film radiographs Oswestry Low Back Pain DI, SF-36 physical and mental componemt subscales, adverse events and complications		Clinical results rhBMP7 5 (21%) Radiographic results ICBG 6 (50%) Clinical results ICBG 5 (42%)		marketing approval
		ICBG n=12							
Baskin et al., 2003 USA (89) **Cervical Spine**	Multicenter, nonblinded RCT	rhBMP2/ALG n=18 (0.6-1.2 mg/pt)	single- or two-level primary instrumented ACDF with rhBMP2/ALG or ICBG/ALG	Inclusion: primary symptomatic single- or two-level cervical DDD with radiculopathy, myelopathy, or both, herniated	Radiographic fusion using plain film radiographs and CT analysis, Neck Disability Index, neck and arm pain, SF-36 physical and mental component	24 mos	rhBMP2/ALG 3 (17%) ICBG/ALG 1 (7%)	FAIR	Pilot study using rhBMP2 soaked ACS packed inside fibular allograft (ALG) bone
		ICBG/ALG n=15							

				disc, posterior osteophytes or both at index level(s), symptoms unresponsive to minimum 6 mos. nonoperative therapies Exclusion: NR	subscales, neurologic status (motor and sensory function), patient satisfaction, complications and adverse events				
Butterman et al., 2008 USA (104) **Cervical Spine**	Prospective nonrandomized cohorts of consecutive patients	rhBMP2/CRA n=30 (0.9-3.7 mg/pt) ICBG n=36	single- or multi-level primary instrumented or uninstrumented ACDF with rhBMP2/CRA or ICBG	Inclusion: primary symptomatic single- or multi-level cervical DDD Exclusion: Prior ACDF at any level, corpectomy, deformity, presence of tumor, inflammatory joint disease, or cervical spine discitis	Radiographic fusion using plain film radiographs and high-resolution CT, Oswestry Neck Disability Index, neck and arm pain, pain medication use, patients' overall opinion of treatment success	24-36 mos	0	POOR	rhBMP2/ACS was placed inside the CRA, with resected osteophytes and local bone shavings, compared to ICBG alone
Crawford et al., 2009 USA (105) **Cervical Spine**	Retrospective cohort of consecutive patients	rhBMP2/BGE n=41 (4.2-12 mg/pt) ICBG n=36	single- or multi-level instrumented posterior cervical spinal fusion with rhBMP2/BGE or ICBG	Inclusion: single- or multi-level symptomatic posterior cervical stenosis, ACDF non-union, or segmentally unstable spondylosis	Perioperative complications, surgical data	≤ 3 mos	0	POOR	rhBMP2/ACS was combined with bone graft extenders (BGE) including local autograft bone, allograft, or ceramics

				Exclusion: acute trauma, infection, presence of tumor, concomitant anterior fusion					
Smucker et al., 2006 USA (106) **Cervical Spine**	Retrospective case-control	rhBMP2/CRA n=69 (dose NR) CRA n=165	single- or multi-level instrumented ACDF with rhBMP2/CRA or CRA alone	Inclusion: NR Exclusion: NR	Cervical swelling complications	≤ 6 wks	NR	POOR	Most patients received cortical ring allograft (CRA) (88% with rhBMP, 81% of controls)
Vaidya et al., 2007 USA (107) **Cervical Spine**	Retrospective cohorts of consecutive patients	rhBMP2 n=22 (1-3 mg/pt) ALG/DBM n=24	single- or multi-level primary instrumented ACDF with interbody fusion cages rhBMP2 on ACS or ALG/DBM	Inclusion: primary symptomatic single- or multi-level cervical DDD amenable to ACDF Exclusion: Prior ACDF at index level(s), trauma, presence of tumor, those more amenable to posterior surgery or combined surgery	Radiographic fusion using plain film radiographs and CT, Oswestry Neck Disability Index, arm and neck pain, perioperative outcomes and complications including swelling, hoarseness, and dysphagia	24 mos	NR	POOR	rhBMP2/ACS was placed in polyetheretherketone (PEEK) interbody fusion cages, compared to use of allograft (ALG) spacers with demineralized bone matrix (DBM)
Boraiah et al., 2009 USA (108) **Acute Tibial Fractures**	Retrospective case series	rhBMP2 (1) n=17 (12 mg/pt) (2) n=23 no BMP	Acute traumatic tibial plateau fractures	Not stated	Radiographic fusion Additional surgeries complications	18 mos. (12-26)	0	POOR	Type I collagen sponge as carrier Various other void fillers were used making assessment of BMP difficult

									They were unclear about the dose so does is estimated from the label.
Jones et al., 2006 USA (90) **Acute Tibial Fractures**	Multi-center prospective RCT	rhBMP2 (1) n=15 (12 mg/pt with allograft bone chips (2) n=15 autogenous bone graft	Reconstruction of diaphyseal tibial fractures with cortical defect	Inclusion: Skeletally mature male or non-pregnant or lactating female age 16 or greater, dyaphyseal tibial fracture with a residual fracture defect consistent with cortical defect, had primary treatment with IM nail or external skeletal fixation.	Surgical morbidity Radiographic evidence of fracture healing Impact on health related quality of life (SMFA)	12 mos	6 patients (20%)	FAIR	
Ristiniemi et al., 2007 Finland (110) **Acute Tibial Fractures** (same pts as rec#4560)	Retrospective cohort of matched patients	Rh-BMP7 N=20 Matched Zone 43 fracture (OREF) N=20	Distal tibial fracture (OTA zone 43) treated with external fixation by BMP7 and graft	Inclusion: Zone 43 tibial fracture, fixation with two-ring hybrid external fixation, treatment with rhBMP7 (controls matched from other patients undergoing Zone 43 external fixation)	AP and lateral radiographs Radiographic evidence of fracture fusion and full weight bearing Range of motion of ankle joint IOWA ankle score RAND	BMP 12 months (11-13) Matched 28 months (12 to 45)	1 BMP death due to unrelated causes – union had healed at time of patient's death (2.5%) Matched 2 pts unavailable for long term followup (5%)	POOR	
Bilic et al., 2006 Croatia,	Single-center, unblinded RCT	rhBMP7/AGB n=6 (3.5 mg/pt)	revision of nonunion	Inclusion: symptomatic proximal pole	Radiographic union, pain, movement, grip	24 mos	1	GOOD	Mixed rhBMP7/ACS with either ALG or AGB

Netherlands (96) **Miscella-neous Uses**		rhBMP7/ALG n=6 (3.5 mg/pt) ICBG n=6		scaphoid nonunion of ≥ 9 mos. duration with no evidence of progressive healing over previous 3 mos, presence of ≥ 100 sq mm pre-existing sclerotic bone in the proximal scaphoid pole Exclusion: prior surgical treatment, carpal collapse, skeletal immaturity, inability or unwillingness to fulfill F/U requirements	strength				
Dickinson et al., 2008 USA (91) **Miscella-neous Uses**	Single-center RCT	rhBMP2/ACS n=9 (dose not given) ICBG n=12	repair of unilateral cleft lip-palate with an alveolar cleft defect	Inclusion: skeletally mature Exclusion: previous alveolar surgery, contraindication to rhBMP2 treatment, incomplete records	Bone healing of alveolar ridge and augmentation of the nasal alar base, using NewTom maxillofacial CT scans, periapical radiographs to grade alveolar ridge bone healing	12 mos	0	POOR	rhBMP2/ACS
Ekrol et al., 2008 UK (97) **Miscella-**	Prospective randomized cohort	RhBMP2 Non bridging external fixation	Osteotomy of the distal radius for symptomatic	Inclusion: malunion of distal radius (more than 10 degrees of	Clinical/radiographic functioning and complications at 2, 6, 12, 26, 52 wks	52 wks	0%	POOR	RhBMP-7 dose not given

neous Uses		N=4 Bone graft Non bridging external fixation N=6 RhBMP-7 internal fixation w/ pi-plate N=10 Bone graft internal fixation w/ pi-plate N=10	malunion (with and without external fixation) with RhBMP-7 and autologous bone graft	dorsal angulation, more than 2 mm of radial shortening, carpal malalighnment or a combination of these)	Pain (VAS) Range of motion Hand grip strength				
Geesink et al., 1999 Netherlands (98) **Miscella-neous Uses**	Prospective double-blind randomized study	Untreated N=6 DMB N=6 Collagen type I N=6 OP-1 (2.5mg) with Collagen type I N=6	High tibial osteotomy with three osteoinductive materials	Pts with high tibial osteotomy who complied with study criteria	Clinical evaluation: HHS score, pain at site of osteotomy, patient satisfaction Radiological evaluation: AP and lateral radiographs taken to determine briding and bone formation. Dexa BMD measurements Immunologic testing	12 months	0% (three patients missed 1 of the six follow up appointments, none were lost to FU)	FAIR	
Karrholm et al., 2006 UK (111) **Miscella-**	Single-center case-control	Cups rhBMP7/ALG (1 g/pt) n=10 n=11	impaction grafting for revision of hip arthroplasty	NR	Radiostereometric analysis of implant position, Harris hip score, pain	60 mos	Cups rhBMP7/ALG 18	POOR	Mixed rhBMP7/ACS with ALG Study stopped early because of clinical failures

neous Uses		Cups ALG n=10 Stems rhBMP7/ALG (1 g/pt) Stems ALG n=30					Cups ALG 10 Stems rhBMP&/ALG 0 Stems ALG 10		
Maeda et al., 2009 USA, Japan (109 **Miscella-neous Uses**)	Cohort study with nonconcurrent control group	rhBMP2/BGE n=23 (64-320 mg/pt) ICBG n=32	primary instrumented posterior spinal fusion from thoracic spine to the sacrum or ilium, or anterior fusion between same locations using interbody fusion cage	Inclusion: ambulatory patients without other musculoskeletal diagnoses (eg, ankylosing spondylitis or neuromuscular deformity)	Radiographic union, loss of fixation, as shown by progression of deformity with or without pain, disc space collapse, motion across suspected pseudarthrosis	> 24 mos rhBMP2/BGE 2.7± 0.9 yrs ICBG 4.9±1.9 yrs (p < 0.01)	0	POOR	Mixed rhBMP2 with AGB, CRM, or ALG, but compiled data