

**Table 10 (supplementary material):
Study characteristics – other adverse events and reoperations**

Author Year of publication Design Recruitment period	Population gender Population age Levels	FU N pts at start	N pts in analysis	Re- operations	Infection	Neurological	Adjacent level disease/ degeneration	Proximal junctional kyphosis (PJK)	Other adverse events
Cavagna JSDT 2008 "prospective series of patients" 2001-2002	26 w 13 m mean 73y (65-87); all >65y 1-level: 8 2-level: 18 3-level: 9 4-level: 4	2-4y 40 pts	39 (1 died)	0	0	2	nd	nd	hematoma: 0 cutaneous complication: 0
Chen Osteop Int 2016 RCT Oct 2011- Mar 2012	total: 65w 14m Zolendronic: 27w 6m ctrl: 29w 7 m Zolendronic:65y (sd 8) Ctrl: 63y (sd 7) 1 level	1 y 79 pts	69 (3 expired,2 deep wound infection, 5 withdrawal) zolendronic: 33, ctrl 36	nd	nd	nd	nd	nd	nd
Ohtori Spine 2013 RCT Jan 2007 - April 2011	all female teriparatide: 78y, SD: 6.0 (60-82) risedronate: 75y, SD: 5.0 (55-84) ctrl: 77y, SD: 5.8 (60-78) 1 or 2 levels: teriparatide: 1 level: 15 pts 2 level: 5 pts" risedronate: 1 level: 14 pts 2 level: 6 pts" ctr: 1 level: 14 pts 2 level: 8 pts	12 m 62 pts total teriparatide: 20 pts (25 levels) risedronate: 20 pts (26 levels) ctrl: 22 pts (30 levels)	62 pts total teriparatide: 20 pts risedronate: 20 pts ctrl: 22 pts	nd	nd	nd	nd	nd	"no adverse events in any of the groups"

Delank Orthopäde 2010 retrospective case series 2002 - 2007	42f 22 m 64.7 y, SD: 4.3 ≥ 3 levels	29.4m SD 5.4 70 pts	64 pts	24	nd	nd	24 pts (37.5%) of these: 16 symptomatic	nd	nd
Cho ESJ 2015 prospective comparative study with no information on method of group allocation Mar 2011- Nov 2012	only women Teriparatide group: 71.0y ± 4.9 Bisphosphonate group: 68.2y ± 8.4 bisphosphonate group: 1-level: 20 2-level: 4 teriparatide group: 1-level: 19 2-level: 4	Teriparatide group: 24.7m SD 2.0 Bisphosphonate group: 29.9m SD 8.1 47 pts	47 Bisphosphonate group: 24 (28 level) Teriparatide group : 23 (27 level)	nd	nd	nd	nd	nd	nd
Tu JSR 2014 retrospective matched cohort study Jan 2007 - April 2010	<u>Zolendronate group:</u> 27w 5m <u>Control group:</u> 26w 6m <u>Zolendronate group:</u> 70.8y ± 6.09 (59 to 82) <u>Control group:</u> 69.7y ± 6.02 (59 to 86) Zolendronate group: 1 level: 23 2 level: 9 Control group: 1 level: 24 2 level: 8	2y 64 pts (32 pts per group)	64 Zolendronate: 41 level in 32 pts control: 40 level in 32 pts	nd	nd	nd	nd	nd	nd
Matsumura Spine 2006 retrospective comparative April 2000 - March 2002	FT: 13w 17m OB: 28w 17m FT: 64.4y (52-78) OB: 67.2y (55-82) 1 level	Fenestrated Tube (FT): 34.5m SD 9.6 Open Box (OB): 32.7m SD 4.8 FT: 30 pts OB: 45 pts	Fenestrated Tube (FT): 30 Open Box (OB): 45	nd	nd	nd	nd	nd	nd

Nagahama JNS 2011 RCT nd	alendronate: 18 f 1 m control: 16 w 1 m total group: 68.8 y (47 - 85) alendronate: 70.2 y control: 67.4 y 1 level	12 m 40 pts	36 pts (total) alendronate: 19 control: 17 "Four patients were lost to follow-up because of cerebral hemorrhage, gastrointestinal adverse event due to alendronate, deep wound infection, or withdrawal from participation"	nd	nd	nd	nd	nd	<u>in complete population:</u> cerebral hemorrhage: 1 pt gastrointestinal AE: 1 pt (due to alendronate)
Wu AOTS 2012 RCT Jan 2004 - Jan 2009	EPS: 54f 26m CPS: 57f 20m EPS: 62.3 SD: 3.5 CPS: 61.9y SD: 2.8 one or more levels Means: EPS: 6.1 screws/pt CPS: 6.0 screws/pt EPS 488 screws in 80 pts CPS 464 screws in 77 pts	24m 157 pts in total: Expandable Pedicule Screws (EPS): 80 pts, 488 screws Conventional Pedicule Screws (CPS): 77 pts 464 screws	142/157 EPS group: 88.8% ==> 71 pts CPS group: 92.2% ==> 71 pts	EPS: 1/80 pts CPS: 4/77 pts	nd	nd	nd	nd	nd

<p>Kim KH JNS 2010 retrospective cohort study Jan 2004 - Dec 2006</p>	<p>ALIF w/ PSF: 29f 2 m ALIF w/ PSF w/ PMMA: 30f 1m ALIF w/ PSF: 61y (48-72) ALIF w/ PSF w/ PMMA: 64y (49-77) 1 level</p>	<p>group I ALIF w/ (PSF) alone: 36m (25-42) group II instrumented ALIF w/ ant. PMMA: 34m (25-58) 62 pts (total) group I ALIF w/ percutaneous Pedicle screw fixation (PSF) alone: 31 pts group II instrumented ALIF w/ anterior PMMA augmentation: 31 pts</p>	<p><u>Clinical outcome:</u> group I ALIF w/ (PSF) alone: 31 pts group II instr. ALIF w/ ant. PMMA [VP]: 30 pts <u>Radiological outcome:</u> group I ALIF w/ (PSF) alone: 24 pts group II instr. ALIF w/ant. PMMA [VP]: 22 pts</p>	<p>nd</p>	<p>0</p>	<p>nd</p>	<p>Clinical ASD group I: 23% (7/31 pts) group II: 10% (3/30 pts) Radiological ASD group I: 66.7% (16/24 pts) group II 68.2% (15/22 pts)</p>	<p>nd</p>	<p>wound dehiscence (abdomen) requiring closure: 1 pt pulmonary effusion: 1 pt persistent ileus: 2 pts (w/ regard to anterior PMMA augmentation:) no pulmonary embolism</p>
<p>Xie BMC MD 2011 retrospective cohort study Dec 2000 - Dec 2006</p>	<p>25f 6m PMMA group: 13f 1m autograft group: 12f 5m total group: mean 60.9y, SD = 7.9 (42.3-77.8) PMMA group: 63.1y, SD = 9.0 (42.3-77.8) autograft group: 59.0y, SD = 6.6 (50.4-72.8) Means SD, range: PMMA group: 5.9 ± 1.9 (3-9) autogr. group: 6.0 ± 2.5 (2-10)</p>	<p>3.8y SD 1.4 N/A retrospective</p>	<p>31 pts in total PMMA group: 14 pts autograft group: 17 pts</p>	<p>0</p>	<p>autograft group: 1/17 pts PMMA group: 0 pts 1</p>	<p>0</p>	<p>nd</p>	<p>nd</p>	<p><u>PMMA group:</u> pneumonia: 1 <u>Autograft group:</u> UTI: 1 wound infection: 1 donor site pain: 4</p>

Jang NMC 2013 retrospective comparative Mar 2002 - Dec 2005	augmented: 16 f 1 m control: 15f 2 m <u>augmented:</u> mean age: 67.6y SD 5.0 <u>control:</u> mean age: 68.2y SD 5.1 1 level (L4-5)	2y 34 pts 17 pts in each group	34 pts augmented screws: 17 pts control: 17 pts	control: 1/17 pts augmented screws: 1/17 pts	nd	nd	nd	nd	none mentioned
Piñera ESJ 2011 prospective study (?)/data collection Oct 2006 - Feb 2009	20f 3m mean 77y (70– 81) mean: 1.8 levels (1-5) 1 level: 8 pts (35%) 2 level: 12 pts (52%) ≥3 level: 3 pts (13%)	32m (20-49) 23 pts	23 pts "we augmented 103 cannulated screws of 58 cemented vertebrae in 23 pts"	3	3	nd	4 pts (17%) with progressive adjacent disc degeneration with collapse and low grade spondylolisthesis. All of them presented with associated deterioration of pain and function scales, but none accepted revision surgery at the time of this report.	nd	UTI: 2 pts bronchospasm in the recovery room without pulmonary complications: 2 pts
Dai Clinics 2015 nd, consecutive patients June 2010 - Feb 2013	30w 13m 60.4y ±11.6 (46 to 82) nd	15.7m SD5.6 43	43 125 CICPSs (cement- injectable cannulated pedicle screw)	nd	0	0	nd	nd	pulmonary embolism: 0

<p>Patil ESJ 2013 retrospective cohort study 2006-2011</p>	<p>total population: 26 f 14 m <u>Group 1:</u> 10 f <u>Group 2:</u> <u>A:</u> 10f 4m <u>B:</u> 3f 7m <u>C:</u> 2f 4m total population: mean 64y (45 - 85) <u>Group 1:</u> 71.3y (58-89) <u>Group 2:</u> <u>A:</u> 64.2 y (45- 70) <u>B:</u> 67.3y (48- 85) <u>C:</u> 69y (48-77) nd, <i>graphs suggest 2 levels (?)</i></p>	<p>34m (12-62) 40 pts total 30 pts w/ instrumentation</p>	<p>40 pts total 30 pts w/ instrumentation</p>	<p>nd</p>	<p>-44</p>	<p>nd</p>	<p>nd</p>	<p>nd</p>	<p>persistent back pain: 2pts</p>
<p>Lee KJS 2011 retrospective case series Feb 2004 - Aug 20077</p>	<p><u>Group I:</u> 45f 22m <u>Group II:</u> 63f 27m <u>Group I:</u> 67.2y (49-72) <u>Group II:</u> 63.3y (51-74) Mean: 6 screws/pt (947 screws in 157 pts)</p>	<p>12 m (10-23) NA, retrospective, (157 pts)</p>	<p>157 pts (947 pedicle screws) <u>Group I:</u> 67 pts (469 screws) Compression /burst fractures (62)and idiopathic scoliosis (5) ==> only 8 %2w/ idiopathic scoliosis; include this group because up to 10% "maverick" is allowed <u>Group II:</u> 90 pts (497 screws) Disc Herniation: 21 pts Stenosis w/ or w/o instability: 12 pts, Spondylolisthesis: 57</p>	<p>nd</p>	<p><u>Group I:</u> 0 pts <u>Group II:</u> 2 pts</p>	<p>nd</p>	<p>nd</p>	<p>nd</p>	<p><u>Group I & II:</u> fatal death:0 fat embolism: 0 pulmonary embolism: 0 <u>Group II:</u> symptomatic cement extravasation: 2 pts deep wound infection : 2 pts (diabetic pts, controlled w/ IV antibiotics, all implants left in situ)</p>

Yuan ESJ 2015 prospective Jan 2010 - Jan 2012	24w 3m 70.1y (51 to 92) Mean N affected levels: 2.8 (2-5) <i>unclear if this is the pathology or the number of fused levels</i>	12 m 27 (149 screws)	26 (1 died of postoperative pneumonia)	nd	0	0	nd	nd	dyspnea: 0 pulmonary embolism: 0 death due to postoperative pneumonia: 1
Ayodogan JSDT 2009 retrospective case series 2003-2006	24f 12m 66 y (59-78) Mean 5 levels (3-8)	37m (24-48) 36 of 49 pts having minimum 2y FU	36 pts	nd	4	0	nd	nd	pulmonary embolus: 1 pt
Hsieh BMS MD 2013 retrospective May 2006- Nov 2010	19 w 3 m mean age 73.6 y SD 6.5 2 levels	12 m 22 pts in group 1 (short segment fixation with intervertebral expandable pillars (I-VEP)) 24 pts in group 2 Vertebroplasty (not considered in this analysis)	22 pts in group 1 (short segment fixation with intervertebral expandable pillars (I-VEP)) 24 pts in group 2 Vertebroplasty (not considered in this analysis)	nd	0	1	nd	nd, only measurement of KA "kyphotic angle" of affected, vertebra as well as above and below are available	pulmonary embolism: 0

El Saman EJTES 2013 retrospective cohort study nd	total population: 16f 8m <u>Group 1 (no augmentation):</u> 5f 4m <u>Group 2 (PMMA augmentation):</u> 11f 4m total population: mean 75y, SD: 8.9 (58 - 92) <u>Group 1:</u> mean 75y, SD: 8.2 (59 - 91) <u>Group 2:</u> mean 76y, SD: 9.3 (58 - 92) Mean: 8 screws/pt (4- 16)	430 days (44- 1467) 24 pts group 1 (no augmentation): 9 pts (86 screws) group 2 (PMMA augmentation): 15 pts (117 screws)	24 pts group 1 (no augmentation): 9 pts group 2 (PMMA augmentation): 15 pts	nd	nd	nd	nd	kyphosis angle available for fractured vertebra but not for proximal junction	<u>loss of correction (bisegmental Cobb angle):</u> group 1 (no PMMA): 4.9°, SD: 3.8°% group 2 (w/ PMMA): 1.1°, SD: 0.78°
Kim HS JKNS 2008 retrospective nd	19 w 1 m 60.5y (42 to 67) 2 levels	15m (12-25) 20 pts	20	nd	0	0	nd	nd	"no major complications": (such as deep infection, leakage, pull-out) seroma requiring debridement with secondary suture: 1 pt
Kim WJ CORR 2006 retrospective case series Sep 2001 - Nov 2004	32f 0m 64.6y (54-78) Mean 6.2 levels/pt (2- 13)	more than 2 y 32 pts	32 pts in total 24 w/ vertebroplasty or pedicle augmentation (VP group) 8 w/o vertebroplasty or pedicle augmentation in patients with weak screw purchase in the time when it was reimbursed (non - VP group)	2	nd	VP group: 1/24 (transient) non-VP group: 0/8	nd		<u>VP group:</u> Wound dehiscence: 1/24 Recurrence of deformity: 2/24 Duodenal ulcer perforation: 1/24 Hemorrhagic gastritis: 1/24 <u>non-VP group:</u> Wound dehiscence: 0/8 Recurrence of deformity: 0/8 Duodenal ulcer perforation: 0/8 Hemorrhagic gastritis: 0/8

Pflugmacher JOT 2009 prospective case series June 2002 - Aug 2005	14f 11m 59 y (52-72) 2 levels	12 m 25 pts, 25 levels	21	0	0	0	nd	nd	bleeding: 0 pulmonary embolism: 0 stroke: 0 cardiac arrest: 0 loss of kyphotic correction (vertebral body angle): 3.3° loss of kyphotic correction (local Cobb angle): 3.6°
Gu JOSR 2015 nd, Nov 2010- Aug 2011	23 w 8 m (MIPS group) 73.9y ± 6.4 (MIPS group) 2 level	MIPS group: 27.2m SD 2.5 31 pts (MIPS group)	31 (MIPS group) <i>[also PVP (percutaneous vertebroplasty) group w/ 37 pts. but not considered here]</i>	nd	nd	0	nd	nd	nd
Yamana ESJ 2010 case series, no info whether pro- or retrospective, not clear if patient consent refers to procedure or study participation 2000 - 2008	24f 10m 77y (67 - 89) levels: 1 in 3 pts 2 in 26 pts 3 in 3 pts 5 in 2 pts (not sure how this goes with only 3 pts with >1 level of fracture)	37m 34 pts	34 pts additional "augmentation" w/ HA sticks: 16 pts	nd	nd	0	nd	nd	complications involving the bone cement that was utilized: pulmonary infarction: 0 rapid decrease in blood pressure: 0
Nakashima H JMS 2014 retrospective nd	30w 5m 70.7y (60 to 84) 2 levels: 34 pts 3 levels: 1 pt	3.8y (0.6-11.3) 35 pts	35	3	3	nd	nd	nd	Atelectasis: 5 Pneumonia: 2 postoperative delirium: 2 upper gastrointestinal hemorrhage: 1

<p>Nakashima H Spine 2015 retrospective comparative 1997-2010</p>	<p>AP group: 19w 5m VP group: 15w 6m AP group: 71.3y VP group: 74.6y No. of levels (mean): AP group: 2.4 ±0.9 levels/pt VP group: 3.1 ±1.1 levels/pt</p>	<p>AP group: 45.3m SD 21.2 VP group: 39.8m SD 12.7 total: 45 pts AP group: 24 pts VP group: 21 pts</p>	<p>total: 45 AP group: 24 VP group: 21</p>	<p>1</p>	<p>1</p>	<p>nd</p>	<p>nd</p>	<p>???</p> <p><u>AP group:</u> Severe kyphosis (> 30°) in thoracolumbar lesion (T10– L2) 1</p> <p><u>VP group:</u> Severe kyphosis (> 30°) in thoracolumbar lesion (T10– L2) 4</p>	<p><u>AP group:</u> Severe kyphosis (> 30°) in thoracolumbar lesion (T10– L2): 1 pt Dural tear: 1 pt Delirium: 2 pts Pneumonia or atelectasis: 1 pts Lung infarction: 0 pts</p> <p><u>VP group:</u> Severe kyphosis (> 30°) in thoracolumbar lesion (T10– L2): 4 pts Dural tear: 0 pts Delirium: 1 pts Pneumonia or atelectasis: 0 pts Lung infarction: 1 pt</p>
<p>Nakajima JNS 2016 retrospective 1993-2013</p>	<p>20 w 10 m 79.3y ± 4.7 (70 to 88) nd, assume 2 level fusion ("by fixation of the vertebrae above and below with PSF")</p>	<p>2.4y (1-4.5) 30 pts (28 pts w/ pedicle screws assuming VCR involves pedicle screws)</p>	<p>30 pts w/ cleft: 14 (all w/VP, 14%(2) w/o pedicle screws) pts w/o cleft: 16 (none w/ VP)</p>	<p>reoperations in complete population: 2/28 pts</p>	<p>nd</p>	<p>nd</p>	<p>nd</p>	<p>nd</p>	<p>nd</p>

Kashii ESJ 2013 retrospective cohort study 2000 - 2009	AR: 14f 13 m PS: 31f 5m VP: 14f 11m AR: 73.6y, SD= 6.9 PS: 74.2y, SD=5.9 VP:78.3y, SD=5.4 No. of levels (mean, total group): 4.25 ± 1.46 (3- 9) fig 3 suggests: AR group: appr. 3.1 PS group: appr. 6 VP group: appr. 3.9	35.5m (24-123) 88 pts	88 pts (total) anterior neural decompression and reconstruction (AR): 27 pts posterior spinal shortening osteotomy with direct neural decompression (PS): 36 pts posterior indirect neural decompression and short segment spinal fusion combined with VP using CP: 25 pts	9	9	2	nd	nd	dural tear: 7pts (8%) massive bleeding / hemorrhagic shock: 11 pts hemorrhagic shock after surgery : 3 pts (3.4%) severe postoperative pneumonia: 2 pts (2.3%)
Uchida JNS 2010 retrospective cohort nd	A: 23 f 5 m B: 21 f 4 m total: mean 71 y (51 - 85) A: 72.2y, SD: 9.0 B: 69.3y, SD: 7.5 Group A: 2 level: 15 pts 4 level: 10 pts 3 level: 3 pts Group B: 2 level: 8 pts 4 level: 13 pts 3 level: 4 pts	total: 4.4 y Group A, 3.9 y Group B, 4.7 y Group C, 4.5 y <i>not considered</i> 83 pts (total), 53 pts considered here	83 pts (total), 53 pts considered here A: SSF + vertebroplasty + HA blocks or CPC filling: 28 pts B: Short Segment Fixation (SSF): 25 pts C: <i>anterior procedure (not considered here): 30 pts</i>	nd	nd	nd	nd	nd	A: loss of correction: 4.6° SD: 4.5° B: loss of correction: 8.6° SD: 6.2°
Sudo ESJ 2010 retrospective case series nd	15 f 6 m 69.3 y (54 - 83) 2 level: 10 pts 3 level: 2 pts 4 level: 4 pts 5 level: 1 pt 6 level: 2 pts 7 level: 2 pts	42m 21 pts (NA)	21 pts	0	nd	nd	nd	nd	loss of correction: mean 5.1° myocardial infarction: 1 pt "no obvious surgery related complications"

Sawakami JSDT 2012 retrospective cohort 1999-2006	27f 11m 73.7y (51 - 86) Mean: augmented group: 3.5 ±0.4 levels/pt non-augmented group: 3.4 ±0.3 levels/pt	31 m 40 pts	38 pts total (2 had died) w/ PMMA augmented pedicle screws: 17 pts w/ non- augmented pedicle screws: 21 pts	4	2	0	nd	nd	Correction loss compared to immediate postop XR: augmented group: 3° non-augmented group: 7.2°
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ALIF: anterior lumbar interbody fusion, ASD: adjacent segment degeneration, CPC: calcium phosphate cement, FU: follow-up, HA: Hydroxyapatite, PMMA: Polymethylmethacrylate, VCR: vertebral column resection

w/: with, w/o: without, m: months, pt: patient, pts: patients y: year(s)