## PERCUTANEOUS VERTEBRAL BODY STENTING FOR OSTEOPOROTIC THORACO-LUMBAR VERTEBRAL FRACTURES

## **Thesis**

Submitted for partial fulfillment of M.D. degree in Orthopaedic Surgery.

By

**Eslam Elsayed Aly Mahmoud** 

M.B.B.Ch., M.Sc.

**Under supervision of** 

Prof.Dr.Naguib Basha

Prof. of Orthopaedic Surgery

Cairo University

### Prof.Dr. Hazem Bayoumi Elsebaie

Assistant Prof.of Orthopaedic Surgery

Cairo University

#### **Dr.Omar Suliman**

Assistant Prof. of Orthopaedic Surgery

Cairo University

Cairo University

2012

# بسم الله الرحمن الرحبم

### **ABSTRACT**

Vertebroplasty and kyphoplasty are established minimally invasive techniques for compression fractures of osteoporotic vertebral bodies. Procedural disadvantages, include incomplete fracture reduction or a significant loss of reduction after balloon deflation, prior to cement injection. In order to avoid this loss of reduction, a newer alternative has been introduced, based on the principles of balloon kyphoplasty and vascular stenting. A total of 30 elderly patients with 45 symptomatic VCFs were enrolled in a prospective study of vertebral body stenting (Vbs). Clinical outcomes were measured pre- and postoperatively using the visual analogue scale (VAS), Oswestry Disability Index (ODI) and ambulatory status (AS). Most of outcomes were improved post-operatively and at follow-up visits. So, elderly patients with symptomatic VCFs had rapid, significant, and sustained improvements in back pain, back function, and quality of life following vertebral body stenting.

**Key words:** Vertebral Body Stenting (VBS), balloon kyphoplasty, vertebral compression fracture, loss of reduction, back pain.

## Acknowledgment

I would like to express my sincere gratitude to,

**Prof.Dr.Naguib Basha** Professor of orthopedic surgery, Faculty of Medicine, Cairo University for his valuable support and guidance.

I would like to express my deepest appreciation to, **Prof.Dr. Hazem Bayoumi Elsebaie** Assistant

Professor of orthopedic surgery, Faculty of Medicine,

Cairo University for his valuable encouragement, expert assistance and objective criticism.

My deepest thanks to assistant **prof. Dr. Omar Suli- man** Assitant professor of orthopedic surgery, Faculty of Medicine, Cairo University, for his generous help, constant encouragement and continous support.

I would like to thank all those encourage and support me throughout the years of my life especially my family, my collegues and my friends.

I would like to thank **Dr Mohamed Hegazy** who has a great experience in using all methods of cement augmentation techniques for osteoporotic and pathological vertetebral fractures.

Chapter	Content	Page
	List of figures	V
	List of tables	XI
	List of abbreviations	XIII
	Introduction	1
Chapter 1	Anatomy and biomechanics	5
Chapter 2	Review	25
	<ul> <li>- Pathological Vertebral Compression Fractures.</li> <li>- Percutaneous Vertebroplasty.</li> <li>- Balloon Kyphoplasty.</li> <li>-Vertebral body stenting.</li> <li>-Biomechanical Evaluation.</li> </ul>	25 42 71 87 98
Chapter 3	Material and method	110
Chapter 4	Results	128
Chapter 5	Case presentation	150
Chapter 6	Discussion and conclusion	180
Chapter 7	REFERENCES	199
	Arabic summary	

# The table of the figures

Fig.	Page	
Number	1 age	
Fig 01		Vertebral Column
Fig 02		Thoracic Vertebrae
Fig 03		Lumbar Vertebrae
Fig 04		Sacrum and Coccyx
Fig 05		Intervertebral Disc
Fig 06		Articulation between vertebral column
Fig 07		Spinal Cord in Situ
Fig 08		Trabecular pattern of the vertebral body
Fig 09		Motion of spine
Fig 10		Normal spine curvature and weight bearing axis
Fig 11		Schematic Load Deflection Curve Illustrating Alterations in
1.9		Vertebral Body Structure During Compressive Stress
Fig 12		A centrally situated, postmortem fracture of the end-plate
Fig 13		Coronal and transverse computed tomographic (CT) scans
		of dry vertebrae
Fig 14		A transverse 1 mm computed tomographic section of the
		same vertebra taken 8 mm more distally
Fig 15		Follow-up image several months later demonstrates pro-
		gressive compression fracture in L2 (white arrow)
Fig 16		Thin-section axial CT (a) and sagittal reformatted CT im-
		ages (b) demonstrating severe compression fracture of T12
		with extension of the fracture line through the posterior wall
		of the vertebral body and retropulsion of the superior end
		plate into the spinal canal
Fig 17		Tc-99m-labeled methylene diphosphonate radionuclide
		bone scan image, posterior view, demonstrating increased
		uptake at the level of a subacute L2 VCF (white arrow)
Fig 18		(a) Sagittal T1-weighted MR image demonstrating VCFs at
		T9, T11, T12, and L1. Note retropulsion of the posterior-
		superior margin of L1 (black arrow). The acutely com-
		pressed T9 and T11 vertebrae demonstrate hypointense mar-
		row signal. Old fractures of T12 and L1 demonstrate normal
		marrow signal indicating healing.(b) T2-weighted MR im-
		age demonstrates heterogeneously increased signal in the T9 and T11 vertebral bodies, representing fracture edema. Old-
		er compression fractures at T12 and L1 demonstrate normal marrow signal. (c) Sagittal STIR MR image demonstrates
		edema in T9 and T11. On examination under fluoroscopy,
		these were the painful levels.
Fig 19		T2-weighted MR image demonstrating chronic severe com-
rig 19		pression fracture of L3 and acute compression fracture of
		L2
Fig 20		(a) Sagittal T1-weighted MR image in a 68-year-old man
115 20		with longstanding thoracolumbar compression fracture and

T12 vertebral body (white arrow). Low signal on T1- weighted images indicates edema, marrow replacement such as tumor, fibrosis, or simply bony sclerosis. (b) Sagittal T2- weighted MR image demonstrates hypointense signal in the fractured T12 vertebral body (white arrow), indicating scle- rosis or fibrosis rather than edema or tumor  (a) Sagittal T1-weighted MR image in a 35-year-old woman with metastatic breast carcinoma shows multiple hypoin- tense foci of marrow replacement within the lumbar verte- brae and sacrum. There is a compression fracture of the L2 vertebral body (white arrow). (b) T2-weighted MR image shows intermediate but heterogeneous signal throughout the vertebral bodies. (c) T1-weighted MR image after contrast material injection shows diffuse enhancement of most me- tastatic lesions. A portion of the L2 vertebral body (white arrow) does not enhance, which is suggestive of sclerosis  Fig 22 Follow-up image several months later demonstrates pro- gressive compression fracture in L2 (white arrow)  (a) Sagittal T1-weighted MR image demonstrating VCF at L2 secondary to hemangioma. (b) Sagittal T1-weighted MR image demonstrates diffuse but heterogeneous Gadolinium enhancement of L2 hemangioma. Note expansion of the posterior wall of L2 into the spinal canal  Trajectory of the transpedicular approach. A, Fosteroanterior view. B, Lateral view. C, Axial represen- tation  Fig 25 Trajectory of the extrapedicular approach for needle or tro- car placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Fig 26 Percutaneous vertebroplasty technique  Fig 27 A, Lateral radiograph during vertebroplasty of a compres- sion fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This al- lows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduc- tion. B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac com- pression created by tumo		11
with metastatic breast carcinoma shows multiple hypointense foci of marrow replacement within the lumbar vertebrae and sacrum. There is a compression fracture of the L2 vertebral body (white arrow). (b) T2-weighted MR image shows intermediate but heterogeneous signal throughout the vertebral bodies. (c) T1-weighted MR image after contrast material injection shows diffuse enhancement of most metastatic lesions. A portion of the L2 vertebral body (white arrow) does not enhance, which is suggestive of sclerosis Fig 22  Follow-up image several months later demonstrates progressive compression fracture in L2 (white arrow)  Fig 23  (a) Sagittal T1-weighted MR image demonstrating VCF at L2 secondary to hemangioma. (b) Sagittal T1-weighted MR image demonstrates diffuse but heterogeneous Gadolinium enhancement of L2 hemangioma. Note expansion of the posterior wall of L2 into the spinal canal  Fig 24  Trajectory of the transpedicular approach. A, Fosteroanterior view. B, Lateral view. C, Axial representation  Fig 25  Trajectory of the extrapedicular approach for needle or trocar placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Fig 26  Percutaneous vertebroplasty technique  A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction. B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection		weighted images indicates edema, marrow replacement such as tumor, fibrosis, or simply bony sclerosis. (b) Sagittal T2-weighted MR image demonstrates hypointense signal in the fractured T12 vertebral body (white arrow), indicating scle-
tense foci of marrow replacement within the lumbar vertebrae and sacrum. There is a compression fracture of the L2 vertebral body (white arrow). (b) T2-weighted MR image shows intermediate but heterogeneous signal throughout the vertebral bodies. (c) T1-weighted MR image after contrast material injection shows diffuse enhancement of most metastatic lesions. A portion of the L2 vertebral body (white arrow) does not enhance, which is suggestive of sclerosis  Fig 22 Follow-up image several months later demonstrates progressive compression fracture in L2 (white arrow)  Fig 23 (a) Sagittal T1-weighted MR image demonstrating VCF at L2 secondary to hemangioma. (b) Sagittal T1-weighted MR image demonstrates diffuse but heterogeneous Gadolinium enhancement of L2 hemangioma. Note expansion of the posterior wall of L2 into the spinal canal  Fig 24 Trajectory of the transpedicular approach. A, Fosteroanterior view. B, Lateral view. C, Axial representation  Fig 25 Trajectory of the extrapedicular approach for needle or trocar placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Fig 26 Percutaneous vertebroplasty technique  Fig 27 A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction.  B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection	Fig 21	
gressive compression fracture in L2 (white arrow)  (a) Sagittal T1-weighted MR image demonstrating VCF at L2 secondary to hemangioma. (b) Sagittal T1-weighted MR image demonstrates diffuse but heterogeneous Gadolinium enhancement of L2 hemangioma. Note expansion of the posterior wall of L2 into the spinal canal  Fig 24  Trajectory of the transpedicular approach. A, Fosteroanterior view. B, Lateral view. C, Axial representation  Fig 25  Trajectory of the extrapedicular approach for needle or trocar placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Fig 26  Percutaneous vertebroplasty technique  Fig 27  A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction. B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection		tense foci of marrow replacement within the lumbar vertebrae and sacrum. There is a compression fracture of the L2 vertebral body (white arrow). (b) T2-weighted MR image shows intermediate but heterogeneous signal throughout the vertebral bodies. (c) T1-weighted MR image after contrast material injection shows diffuse enhancement of most metastatic lesions. A portion of the L2 vertebral body (white arrow) does not enhance, which is suggestive of sclerosis
(a) Sagittal T1-weighted MR image demonstrating VCF at L2 secondary to hemangioma. (b) Sagittal T1-weighted MR image demonstrates diffuse but heterogeneous Gadolinium enhancement of L2 hemangioma. Note expansion of the posterior wall of L2 into the spinal canal  Fig 24  Trajectory of the transpedicular approach. A, Fosteroanterior view. B, Lateral view. C, Axial representation  Fig 25  Trajectory of the extrapedicular approach for needle or trocar placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Fig 26  Percutaneous vertebroplasty technique  Fig 27  A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction. B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection	Fig 22	
L2 secondary to hemangioma. (b) Sagittal T1-weighted MR image demonstrates diffuse but heterogeneous Gadolinium enhancement of L2 hemangioma. Note expansion of the posterior wall of L2 into the spinal canal  Fig 24  Trajectory of the transpedicular approach. A, Fosteroanterior view. B, Lateral view. C, Axial representation  Fig 25  Trajectory of the extrapedicular approach for needle or trocar placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Fig 26  Percutaneous vertebroplasty technique  Fig 27  A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction. B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection		
Fig 24  Trajectory of the transpedicular approach. A, Fosteroanterior view. B, Lateral view. C, Axial representation  Trajectory of the extrapedicular approach for needle or trocar placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Fig 26  Percutaneous vertebroplasty technique  A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction. B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection	Fig 23	L2 secondary to hemangioma. (b) Sagittal T1-weighted MR image demonstrates diffuse but heterogeneous Gadolinium enhancement of L2 hemangioma. Note expansion of the
A, Fosteroanterior view. B, Lateral view. C, Axial representation  Trajectory of the extrapedicular approach for needle or trocar placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Fig 26  Percutaneous vertebroplasty technique  A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction.  B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection	Fig 24	
car placement. A, Posteroanterior view. B, Lateral view. C, Axial representation  Percutaneous vertebroplasty technique  A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction.  B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection	8	A, Fosteroanterior view. B, Lateral view. C, Axial represen-
A, Lateral radiograph during vertebroplasty of a compression fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction.  B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection	Fig 25	car placement. A, Posteroanterior view. B, Lateral view. C,
sion fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction.  B, With the thecal sac opacified, axial CT scans provide the most sensitive method to monitor PV for thecal sac compression created by tumor displaced during cement injection	Fig 26	Percutaneous vertebroplasty technique
most sensitive method to monitor PV for thecal sac com- pression created by tumor displaced during cement injection	Fig 27	sion fracture due to breast carcinoma. Note that the thecal sac was first opacified with myelographic contrast. This allows one to watch for deformation of the thecal sac that would indicate tumor displacement during cement introduction.
		most sensitive method to monitor PV for thecal sac com-
Fig 28 A. Lateral radiograph of an extremely collapsed lower tho-	Fig 28	A, Lateral radiograph of an extremely collapsed lower tho-
A, Lateral radiograph of an extremely conapsed lower thoracic vertebra. Superior and inferior endplates are identified (black arrows). There is a small air-filled cleft; 13-gauge needles are being introduced via transpedicular route.  B, A lateral image showing one 13-gauge needle in good position before vertebroplasty.  C, Final image after bipedicular vertebroplasty. Good filling of the vertebra was achieved despite the severe collapse.  The patient had a good pain response to the procedure	rig 28	racic vertebra. Superior and inferior endplates are identified (black arrows). There is a small air-filled cleft; 13-gauge needles are being introduced via transpedicular route.  B, A lateral image showing one 13-gauge needle in good position before vertebroplasty.  C, Final image after bipedicular vertebroplasty. Good filling of the vertebra was achieved despite the severe collapse.
Fig 29 Measurement of the collapsed vertebral body and reference	Fig 29	

the anterior border (A), center (C), and posterior border (P). The height of the posterior border (NP) of an adjacent normal vertebral body was measured for reference. The wedge angle (θ) in this case is 28 degrees before vertebroplasty (A) and 11 degrees after vertebroplasty (B)  A, Lateral radiograph during vertebroplasty showing cement extending to the posterior vertebral margin (black arrow). B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum result		
The height of the posterior border (NP) of an adjacent normal vertebral body was measured for reference. The wedge angle (0) in this case is 28 degrees before vertebroplasty (A) and 11 degrees after vertebroplasty (B)  A, Lateral radiograph during vertebroplasty showing cement extending to the posterior vertebral margin (black arrow). B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postvertebroplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this pa		line. Height of a collapsed vertebral body was measured at
mal vertebral body was measured for reference. The wedge angle (θ) in this case is 28 degrees before vertebroplasty (A) and 11 degrees after vertebroplasty (B)  A, Lateral radiograph during vertebroplasty showing cement extending to the posterior vertebral margin (black arrow). B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postvertebroplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after v		
angle (θ) in this case is 28 degrees before vertebroplasty (A) and 11 degrees after vertebroplasty (B)  A, Lateral radiograph during vertebroplasty showing cement extending to the posterior vertebral margin (black arrow). B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms.  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles wer		
Fig 30  A, Lateral radiograph during vertebroplasty showing cement extending to the posterior vertebral margin (black arrow). B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the so		mal vertebral body was measured for reference. The wedge
Fig 30  A, Lateral radiograph during vertebroplasty showing cement extending to the posterior vertebral margin (black arrow). B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastimum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissu		angle $(\theta)$ in this case is 28 degrees before vertebroplasty (A)
Fig 30  A, Lateral radiograph during vertebroplasty showing cement extending to the posterior vertebral margin (black arrow). B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastimum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissu		and 11 degrees after vertebroplasty (B)
extending to the posterior vertebral margin (black arrow). B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT I month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure	Fig 30	
B, Post-PV CT scan demonstrates a small leak into the epidural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (bl	11800	
dural venous plexus (black arrow). This leak was asymptomatic.  C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
matic. C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty. A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow). B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures. C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation. D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows). E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain. B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
C. Portion of a chest radiograph after PV showing small radiopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
diopaque cement emboli (white arrows) in peripheral pulmonary vessels. This patient had no pulmonary symptoms  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT I month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
Fig 31  Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
Chest radiograph and CT of 41-year-old woman with LCH after percutaneous vertebroplasty.  A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
after percutaneous vertebroplasty. A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow). B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures. C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation. D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows). E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33 A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain. B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34 Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
A, Chest radiograph shows pleural-based consolidation in the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach	Fig 31	
the middle-lobe (arrow-head). Multiple high-density tubular opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		after percutaneous vertebroplasty.
opacities outlining pulmonary vessels (white arrows). Note a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		A, Chest radiograph shows pleural-based consolidation in
a right pleural effusion (black arrow).  B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. High-density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		the middle-lobe (arrow-head). Multiple high-density tubular
B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. Highdensity intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		opacities outlining pulmonary vessels (white arrows). Note
B, Chest CT scan at the level of bronchus intermedius shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. Highdensity intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		a right pleural effusion (black arrow).
shows characteristic appearance of pulmonary infarct in the middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. Highdensity intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
middle lobe and pleural-based truncated cone consolidation (white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. Highdensity intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
(white arrow) between major and minor fissures.  C, Chest CT scan with soft tissue window settings. Highdensity intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
C, Chest CT scan with soft tissue window settings. High- density intra-luminal cement (arrow) outlining the pulmo- nary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Com- parison with Fig. 1B shows partial resolution of the pulmo- nary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radicu- lopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain. B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
density intra-luminal cement (arrow) outlining the pulmonary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
nary artery and its bifurcation.  D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
D, CT scan with bone settings at the level of vertebroplasty (L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
(L3) shows cement in right latero-vertebral vein draining in the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
the vena cava (arrows).  E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
E, Follow-up chest CT 1 month after vertebroplasty. Comparison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
parison with Fig. 1B shows partial resolution of the pulmonary infarct in the middle lobe and persistence of cement in pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
rig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
pulmonary artery (arrow)  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
Fig 32  A, Postvertebroplasty CT scan demonstrates large cement leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		nary infarct in the middle lobe and persistence of cement in
leaks into the spinal canal, neural foramin (black arrow), and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach	Fig 32	A, Postvertebroplasty CT scan demonstrates large cement
and perispinus region. This patient had paresis and radiculopathy  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
Fig 33  A, Postkyphoplasty CT scan. The lateral wall was disrupted by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
by the balloon inflation, and a large cement leak into the mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach	Fig 33	
mediastinum resulted (white arrow). For weeks following the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach	11500	
the procedure, this patient had severe, persistent pain.  B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
B, Lateral radiography after vertebroplasty with a slow-set PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		· · · · · · · · · · · · · · · · · · ·
PMMA. The needles were withdrawn and the cement was still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
still liquid enough to flow into the needle tracts and into the soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
soft tissue (white arrows). This created local discomfort to pressure  Fig 34  Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
Fig 34 Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		
Fig 34 Drawing depicting the needle entry site into the bone (black arrow) for a transpedicular approach		soft tissue (white arrows). This created local discomfort to
arrow) for a transpedicular approach		
arrow) for a transpedicular approach	Fig 34	Drawing depicting the needle entry site into the bone (black
		arrow) for a transpedicular approach
	Fig 35	

	device, obturator, cannula, and inflatable bone tamp balloon
Fig 36	Kyphoplasty Technique
Fig 37	Balloon kyphoplasty operation
Fig 38	An 89-year-old male presented with a 2-week history of severe back pain without any history of trauma. Imaging studies on presentation revealed a compression fracture at L3, with loss of height on the plain radiograph, and marrow replacement with edema on the MRI (A). The patient underwent kyphoplasty at L3 and reported excellent pain relief (B). Two weeks after the procedure, the patient experienced an acute increase in back pain. Plain radiograph reveals a compression fracture at L2, with MRI confirming marrow replacement with edema at this adjacent level (C). The patient had a second kyphoplasty procedure and reported excellent pain relief (D)
Fig 39	a,b Lateral radiograph demonstrating correction of kyphotic deformity. a Preoperative X-ray; b post balloon kyphoplasty restoration of vertebral body height
Fig 40	A,b,c &d images reports to initial cadaveric study by Furderer et al.
Fig 41	BKP-representative (a–c) and VBS-representative (d–f) lateral fluoroscopic images during vertebra augmentation under a constant preload of 110 N. a, d After fracture generation and before reduction; b, e after full balloon inflation; c, f after balloon deflation and removal . These images represent to the cadaveric study by Robert Rotter et al . (published March 2010) .
Fig 42	A.p view & lat. View show transpedicular insertion of the catheter-mounted stents
Fig 43	Shows the balloons inflated in place with the stents splinting the vertebral body.
Fig 44	Shows how the stents are augmented with PMMA cement
Fig 45	Application of the vertebral body stenting through a transpedicular approach.
Fig 46	Schematic of the experimental set-up. The pneumatic cylinders provided compression to the specimen. Actuation of the MTS delivered pure moments to the specimen using a bilateral system of cables, pulleys and flywheels. In this case the specimen is being put in flexion by upward (+y) movement of the MTS  Differences in nuclear pressure (mean with one standard
Fig 4/	Differences in nuclear pressure (mean with one standard

	1 ) 1 ( 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	error bar) between the intact and fractured conditions for the
	three loading scenarios. There were no significant differenc-
	es between the two groups. Note: negative pressure differ-
	ences indicate loss of IVD nuclear pressure after fracture
Fig 48	Differences in nuclear pressure (mean with one standard
	error bar) between the fractured and treated conditions for
	the three loading scenarios. Differences between treatment
	groups were not statistically significant. Note: positive pres-
	sure differences indicate gain of IVD nuclear pressure after
	treatment
Fig 49	Location of fractures
Fig 50	Etiology of index fracture.
Fig 51	These sheets are the sheets that we used for personal data,
	history taking (present & past), physical examination and
	neurological examination.
Fig 52	Classification of thoraco/ lumbar spine fractures according
8	to Magerl/AO spine: type A: compression.
Fig 53	Steps of Vertebral Body Stenting
Fig 54	VAS ( visual analogue scale ).
Fig 55	Study population.
Fig 56	Distribution of fractures .
Fig 57	Median VAS pain scores in which 1 indicates no pain, and
	10 indicates severe pain. Compared with preoperative
	scores, there was significant pain relief ( $P < 0.001$ ) at all
	postoperative values
Fig 58	Mean ODI scores .
Fig 59	Median ODI scores
Fig 60	Percentage of fully ambulatory patients .
rig ou	referringe of fully amount of y patients.
Eig 61	Percentage of assisted ambulatory patients .
Fig 61	referringe of assisted amountainly patients.
Fig 62	Percentage of non ambulatory patients
Fig 63	Shows that 7% of patients developed peri-operative medi-
rig us	
Eig 64	cal complications
Fig 64	percentage of cement leakage.
Fig 65	Location of leakage.
Fig 66	(A–M) Representative case. A,B and C Pre-operative situa-
	tion with severely painful fractures of L3 and L4. D and E
	Treatment of L3 and L4 with VBS. Important correction of
	1
	deformity immediately postoperative, and disappearance of
	the pain. F,G,H and I Acute recurrence of pain after 24
1	weeks; a fracture of the adjacent levels L2,L1 and T11 was