

Percutaneous Transpedicular Lumbar Fixation

Submitted partial fulfillment of M.D. degree in Neurosurgery

By:

Medhat Ahmed El-Toukhy

Supervised by:

Prof. Dr.: Essam Rashad Al-Gahawy

Professor of Neurosurgery

Faculty of medicine

Cairo University

Prof. Dr.: Mohamed M. Mohi El-Din

Professor of Neurosurgery

Faculty of medicine

Cairo University

Prof. Dr.: Hazem Abdel Badiee

Professor of Neurosurgery

Faculty of medicine

Cairo University

Prof. Dr.: Ahmed Salah El-Din

Professor of Neurosurgery

Faculty of medicine

Cairo University

2013

***TO MY FATHER, TO WHOM I OWE
EVERYTHING, AND TO MY
SIBLINGS, HAZEM , SALMA AND
AHMED WHO WILL CARRY OUR
FAMILY LEGACY***

Acknowledgment

First of all I would like to express my great thanks to Allah: his magnificent help is the first factor that helped in completion of this work. I would like to thank all of those who taught me through the years of my life.

*I would like to express my deepest gratitude to Prof. **Dr Essam Rashad Al-Gahawy** (Professor of Neurosurgery, Cairo University) for his great help, continuous encouragement and endless patience.*

*I would like to express my deepest gratitude to Prof. **Dr Mohamed M. Mohi El-Din** (Professor of Neurosurgery, Cairo University) whose kindly advices, care and understanding, had greatly helped me to finish my work,*

*I would like to express my deepest gratitude to Prof. **Dr Hazem Abdel Badiee** (Professor of Neurosurgery, Cairo University) whose kindly advices, care and understanding, had greatly helped me to finish my work,*

*I also express my deepest gratitude to Prof. **Dr Ahmed Salah El-Din** (Professor of Neurosurgery, Cairo University) for his faithful encouragement, support and guidance.*

	Contents	Page No.
1	Acknowledgment	
2	Contents	
3	List of tables	
4	List of Figures	
5	Introduction and protocol	
6	Anatomy of lumbar spine	1
7	Classification of lumbar spinal fracture	24
8	Patient Management	43
9	Treatment options of lumbar fractures	61
10	Patients and Methods	79
11	Results	103
12	Case presentation	115
13	Discussion	129
14	Summery	143
15	Conclusion	145
16	References	146
17	Arabic summery	

List of Figure

Figure No.	Content	Page No.
1	Hair tract on the dorsal surface of the body	2
2	Lines of skin tension on the dorsum of the trunk and head	2
3	Muscle and fascia of the posterior abdominal wall	4
4	A lumbar vertebra from above and behind	6
5	A lumbar vertebra from above and behind	6
6	Median sagittal section through upper lumbar vertebral column showing discs and ligaments	9
7	Boundaries of intervertebral foramen	11
8	A and B Lateral radiographies of lumbosacral vertebral column in an adult male aged 26 years. C, Anterior radiograph of lumbosacral vertebral column in a young adult male aged 22 years	13
9	Height resolution computed tomography through posterior abdominal wall at the level of the body of the 4 th lumbar vertebra showing zygapophyseal joints between 4 th and 5 th lumbar vertebrae.	14
10	Median sagittal MRI lumbar spine	14

11	Erector spinae muscle group	17
12	Lumposacral part of multifids muscle	18
13	Rotators	19
14	Back view of trunk	21
15	Back of trunk, arms abducted	22
16	Back of trunk, oblique view	23
17	Denis three columns	26
18	Types of burst fractures	27
19	Types of Seat belt injury	30
20	Flexion rotation fracture	31
21	Shear type of fracture dislocation	31
22	Flexion distraction fracture-dislocation	32
23	load sharing classification with A- showing the degree of comminution, B- showing the apposition of fragments and C-showing the kyphotic deformity	35
24	Injury morphology. A- Compression (compression fracture or burst), B-Rotation/ translation, C- Distraction.	38
25	Neurological distribution of spinal cord in lower limb	46
26	(A) shear fracture dislocation, (B) widening of inter-pedicular distance and mal-alignment of spinous process.	48
27	(A) Transverse process fracture. (B) AP radiograph of the lumbar spine demonstrates loss of L3 vertebral body height	49

28	increase inter-pedicular distance	49
29	Loss of height of anterior and posterior parts of vertebral body	50
30	(A) Forward translation of body and loss of sagittal curves, (B) loss of Continuity of body, pedicle pars and lamina.	50
31	(A) Coronal and (B) sagittal and (C) axial image CT showing Burst fracture L3.	51
32	Axial CT scans demonstrating a fracture dislocation. Note the presence of two vertebral bodies on the same axial cut.	52
33	Showing different rotation in retropulsed fragment	55
34	CT transverse cut different rotation in retropulsed fragment. (A) Rotation 0° (B) Rotation 0°-90° inverted cortical sign.	56
35	Hematoma after burst fracture L1 in Sagittal T1 (A) and axial T1 image (B) deforming thecal sac.	57
36	Posterior vertebral fracture fragment.	58
37	T2-weighted MR image demonstrates extensive posterior ligamentous disruption	60
38	Posterolateral decompression of the	67

	spinal canal.	
39	Anterior decompression.	69
40	screw extender assembly.	74
41	dilators.	74
42	Cannulated screw and plate.	75
43	Plate dissector and holder.	75
44	Skin wound at the end of surgery.	76
45	percutaneous spine fixation using Sextant system	77
46	percutaneous spine fixation using Sextent system.	77
47	Vertebral body angle	81
48	mid sagittal diameter	82
49	MRI of case no. 4	83
50	Screw , setscrew and rods	87
51	Screw Extender Assembly.	88
52	Screw Extender Assembly with rod inserter attached.	88
53	Rod templates.	89
54	Tap	89
55	Dilator	89
56	screw extender assembly	90
57	Position of the patient	91
58	skin marks for skin incision by permanent marker and needle marks	92
59	deferent end of Jamshidi-needles.	92
60	Point of entry on the skin of patient	93
61	Trocar removed and wires pass.	94
62	Passing dilators.	95

63	Tapping screw track.	97
64	Inserting the screw with screw extender.	97
65	2 screw extenders mated together	98
66	2 screw extenders with measure template and knife applied.	98
67	Applying the rod.	99
68	Skin stabs at end.	99
69	Bone mass index of the cases	104
70	The mechanisms of injury	104
71	the level of fracture vertebrae.	105
72	types of fractures.	106
73	Screws not converging and projecting from the lateral aspect of pedicle.	113
74	Plain X-ray pre-operative showing L2 burst fracture	116
75	CT transverse cuts showing retro pulsed canal fragment	116
76	MRI T1 WI sagital cuts pre-operative showing L2 fracture.	117
77	MRI T2 WI sagital cuts pre-operative showing L2 fracture.	117
78	MRI T1 WI axial cuts pre-operative showing L2 fracture.	118
79	MRI T2 WI axial cuts pre-operative	118

	showing L2 fracture.	
80	Post-operative X-ray of case no. 4	119
81	CT post-operative showing screw accuracy of case no. 4	119
82	Burst fracture L3.	120
83	post operative X-ray of case no.14.	121
84	Post operative CT showing accuracy of pedicle screws of case no. 14.	121
85	Dynamic X-ray L4 L5 spondylolithesis grade 1	122
86	Preoperative MRI sagital cuts showing L4 L5 spondylolithesis grade 1.	123
87	Preoperative MRI axial cuts of case no. 18.	123
88	Intra-operative X-ray of case no.18.	124
89	Post-operative skin closure.	125
90	X-ray lateral and A-P views showing compression fracture of L2	126
91	MRI sagital cuts showing compression fracture of L2	127
92	MRI axial cuts showing compression fracture of L2	127
93	Intera-operative X-ray showing screw accuracy of case no. 3.	128

List of Tables

Table No.	Content	Page No.
1	Denis Fracture Classification	33
2	Thoracolumbar Injury Classification and Severity Score (TLICS)	38
3	Age and sex distribution of the cases	103
4	Indication of surgery in the study	107
5	Level of fixation	108
6	The distance between the fingers and the ground (DFG) of the cases	110
7	Vertebral body angle pre-operative and post-	111
8	Preoperative canal compromise and postoperative	112
9	causes of prolonged postoperative hospital stay	113
10	Denis work scale	114

• Skin

The skin of lumbar region is thick and highly protective, but has low discriminatory sensation. The superficial fascia is thick and fatty and its attachment to the deeper fascial layers is strong in the midline but become weaker more laterally. The quantity, texture and distribution of hair vary with sex, race and the individual through well defined hair tracts have been delineated (**Fig.1**) Lines of skin tension run horizontally in lumbosacral regions (**Fig.2**)

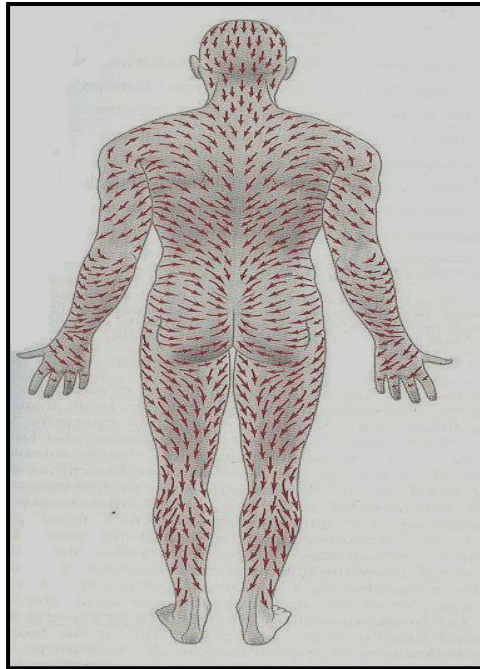
Cutaneous innervations and dermatomes: the skin of lumbar and sacral regions is innervated by lateral branch of dorsal rami of spinal nerves.

Cutaneous vascular supply and lymphatic drainage: the skin of the back of the trunk receives its arterial blood supply mainly from musculocutaneous branches of lumbar and lateral sacral arteries, which all accompany the cutaneous branches of their respective dorsal rami. In addition, there is a supply from the dominant vascular pedicles of the superficial (extrinsic) back muscles. The skin of the back of the trunk drains into the azygoes system, via tributaries of lumbar veins. Lymph from back of the trunk drains to the lateral superficial inguinal nodes.

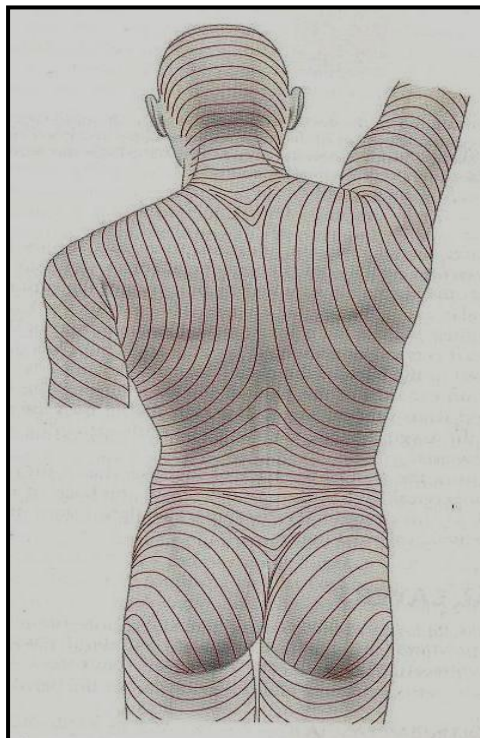
(Adams; et al, 2002)

• Facial layers

Thoracolumbar fascia covers the deep muscles of the back and the trunk. Above, it passes anterior to serratus posterior superior and is continuous with the superficial lamina of the deep cervical fascia on the back of the neck. In the lumbar region the thoracolumbar fascia is in three layers. The posterior layer is attached the spines of lumbar and sacral vertebrae and to the supraspinous ligaments. The middle layer is attached medially to the tip of lumbar transverse processes and the intertransverse ligaments, below to the iliac crest, and above to the lower border of the twelfth rib and the lumbocostal ligament. The anterior layer covers quadratus



(Fig.1) Hair tract on the dorsal surface of the body



(Fig.2) Lines of skin tension on the dorsum of the trunk and head

iliolumbar ligament and the adjoining part of the iliac crest; above, it forms the lateral arcuate ligament (**Boelderl; et al, 2002**).

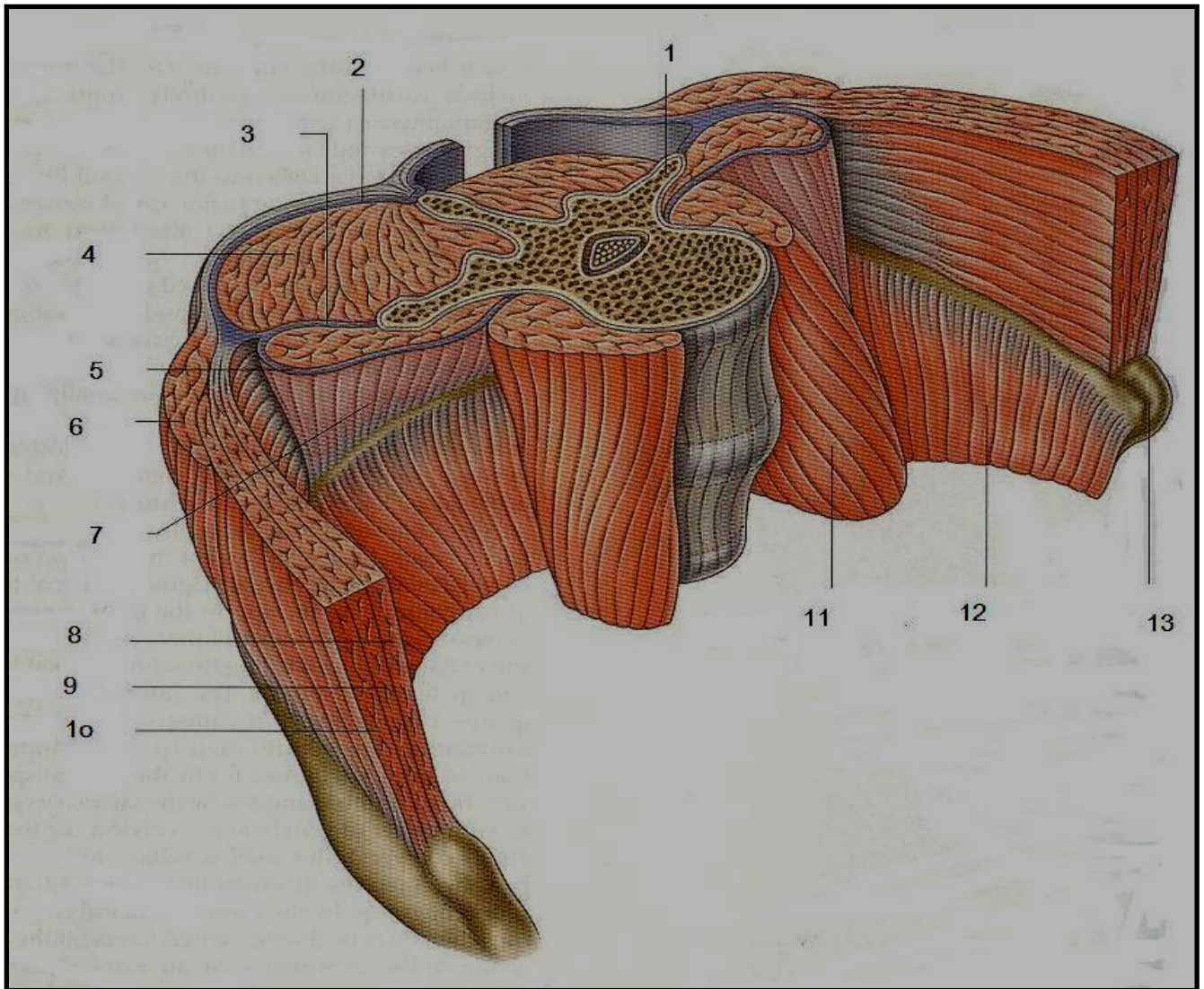
The posterior and middle layers unite to form a tough raphe at the lateral border of quadratus lumborum they are joined by the anterior layer to form the aponeurotic origin of transversus abdominus. Bogduk (1997) describes two laminae in the posterior layer at lumbar levels with varying orientation of the constituent collagen fibers relating to the biomechanical function of the fascia. The posterior and middle layers of the thoracolumbar fascia and the vertebral column together form an osteofascial compartment which encloses the erector spinae muscle group (**Boelderl; et al, 2002**).

The attachments of the fascia, especially those which give it continuity with the abdominal wall musculature, gives it an important role in lifting, through the exact details of this role remain controversial. The fascia may play an important role in load transfer between the trunk and the limbs; its tension is affected by the actions of latissimus dorsi, gluteus maximus and the hamstrings. An erector spinae compartment syndrome may be one cause of low back pain. (**Fig.3**)

• Vertebral column

The **lumbar vertebrae** are the largest segments of the movable part of the vertebral column, and can be distinguished by the absence of a foramen in the transverse process, and by the absence of facets on the sides of the body. (**Fig.4**)

The **body** is large, wider from side to side than from before backward, and a little thicker in front than behind. It is flattened or slightly concave above and below, concave behind, and deeply constricted in front and at the sides. The **pedicles** are very strong, directed backward from the upper part of the body; consequently, the



(Fig.3) Muscle and fascia of the posterior abdominal wall

- | | |
|---|----------------------------------|
| 1-transverse process of lumbar vertebra | 8-transverse abdominis |
| 2-thoracolumbar fascia:posterior layer | 9-internal oblique |
| 3-thoracolumbar fascia:middle layer | 10-external oblique |
| 4-erector spinae | 11-psoas major |
| 5-thoracolumbar fascia:anterior layer | 12-iliacus |
| 6-latissimus dorsi | 13-anterior superior iliac spine |
| 7-quadratus lumborum | |