



Cairo University
Faculty of Medicine
Orthopaedic Department

KYPHOPLASTY IN ACUTE OSTEOPOROTIC DORSOLUMBAR FRACTURES

Thesis

Submitted for Partial Fulfillment of the M.D. Degree in Orthopaedic Surgery

By

Elsayed Mahgoub Radwan

M.B., B.CH, M.Sc.

Supervisors

Prof. Dr. Hassan Mustafa Elgamal

*Professor of Orthopaedic Surgery,
Faculty of Medicine, Cairo University*

Prof. Dr. Wael Mohammed Tawfiek Kobtan

*Professor of Orthopaedic Surgery,
Faculty of Medicine, Cairo University*

Dr. Mohamed Ayman Elrouby

*Lecturer of Orthopaedic Surgery,
Faculty of Medicine, Cairo University*

(2014)

ABSTRACT

SEVERAL TECHNIQUES HAVE BEEN DEVELOPED FOR KYPHOSIS SECONDARY TO OSTEOPOROTIC VERTEBRAL COMPRESSION FRACTURES DURING THE LAST 2 DECADES. TECHNIQUES OF VERTEBRAL BODY AUGMENTATION HAVE BEEN DEVELOPED IN AN EFFORT TO TREAT THESE REFRACTORY CASES. THE HIGH PRESSURE INJECTION OF LOW VISCOSITY OF (PMMA) HAS POTENTIAL RISK FOR NEURAL COMPROMISE AND PULMONARY EMBOLISM BY UNCONTROLLED LEAKAGE. THEREFORE, BALLOON KYPHOPLASTY AND VERTEBROPLASTY USING A LARGE CANNULA LOW PRESSURE INJECTION OF PMMA IN A HIGH VISCOSITY STATE HAS BEEN INTRODUCED. PERCUTANEOUS KYPHOPLASTY (PKP) IS A RECENTLY DEVELOPED, MINIMALLY INVASIVE SURGICAL TREATMENT FOR OVCF. COMPLICATIONS FOR BALLOON KYPHOPLASTY INCLUDE NON-TARGET PMMA EMBOLIZATION, ADJACENT VERTEBRAL BODY OR RIB FRACTURE AND INFECTION.

KEY WORDS: VERTEBRAL BODY, COMPRESSION FRACTURES, PMMA, KYPHOSIS, PERCUTANEOUS KYPHOPLASTY.

ACKNOWLEDGEMENT

First, I would like to express my deepest thanks to "ALLAH", the most merciful. This would not be achieved without "ALLAH" willing and support.

*I would like to express my deep appreciation and gratitude to Prof. Dr. **Hassan Mustafa Elgamal**, Professor of Orthopaedic Surgery, Faculty of Medicine, Cairo University, who was very kind with me throughout this work and devoted much of his precious time for meticulous guidance that made this work to come to light.*

*I wish to express my deep gratitude and sincere thanks to Prof. Dr. **Wael Mohammed Tawfik Koptan**, Professor of Orthopaedic Surgery, Faculty of Medicine, Cairo University. Who helped me to get a better understanding of the subject; for his valuable guidance and meticulous supervision of this work and he has been enthusiastic and generous in time and effect.*

*I am very thankful to Dr. **Mohamed Ayman Elrouby** Lecturer of Orthopaedic Surgery, Faculty of Medicine, Cairo University, for his advice, valuable criticism and fruitful suggestions.*

Last but not least, I present my sincere thanks to all members of Orthopaedic Department, Faculty of Medicine, Cairo University, who offered me great help and support.

Elsayed Mahgoub

2014

Dedication

*To my **father**, for guiding me with wisdom, support, love and whose skills in parenting induced the discipline necessary to take on the monumental task of writing and editing this essay.*

*To my **mother**, whose amazing grace, enduring support and motivation.*

*To my **wife**, who supported me and graciously forgave my many absences from family activities so that I could complete the work.*

This essay would never have been completed without the encouragement and the help of my brothers and my sisters to whom I'm indebted a lot.

LIST OF ABBREVIATIONS

ADL	Activities of daily living
AS	Ambulatory status
atm	atmospheric pressure
BKP	Balloon kyphoplasty
BMD	Bone mineral density
CT	Computed tomography
DEXA	Dual energy absorptometry
FDA	Food and drug administration
FU	Follow-up
IBT	Inflatable balloon tamps
IVD	Intervertebral disc
MRI	Magnetic resonance imaging
ODI	Oswestry disability index
OVCFs	Osteoporotic vertebral compression fractures.
P/Y	Person /year
PKP	Percutaneous balloon kyphoplasty
PMMA	Polymethylemethacrylate
PSI	Pound/ (inch) ²
ROM	Range of movement
RTA	Road traffic accident
SLR	Straight leg raising test
STIR	Short T1 inversion recovery
VAS	Visual analogue scale
VCFs	Vertebral compression fractures.

LIST OF TABELS

Table No.	Title	Page
(1)	The effect on anterior column loading due to different vertebral augmentation techniques.	46
(2)	Study demographics.	53
(3)	Data of the treated patients: initials, age of the patient, sex, level treated, age of the fracture (pre-operative symptoms), pre-operative vertebral kyphosis and postoperative vertebral kyphosis.	54
(4)	Age groups of the patients.	81
(5)	Mechanism of injury.	82
(6)	Index fracture age.	82
(7)	Index fracture treated.	83
(8)	Etiology of Fracture.	83
(9)	Mode of anesthesia.	84
(10)	Post-operative hospital stay	85
(11)	Data of the treated patients: level treated pre-operative vertebral kyphosis, reduction achieved, and correction in percent.	87
(12)	Improvement in Spinal Sagittal Alignment.	88

(13)	Change in Kyphotic angle.	89
(14)	Pain score as given on VAS (1– 10), pre-operatively and at follow-ups. For average values, one patient counts as a single procedure.	90
(15)	Modes of improvement.	91
(16)	Oswestry Disability Index.	92
(17)	ODI scores, pre-operatively and at follow-ups. One month, 3 months & 6 months post-operatively.	94
(18)	Medical complications.	95
(19)	Percentage of cement leakage.	96
(20)	Location of cement leakage.	97

LIST OF FIGURES

Fig. No.	Title	Page
(1)	Thoracic Vertebrae	5
(2)	Lumbar Vertebrae	6
(3)	Coronal and transverse computed tomographic (CT) scans of dry vertebrae, 1 mm slice thickness.	13
(4)	A transverse 1 mm computed tomographic section of the same vertebra taken 8 mm more distally. It shows little sign of osteoporosis with no detectable axial thickening. Trabeculae near the tension-resisting end plate are better preserved and show less anisotropy.	13
(5)	Follow-up image several months later demonstrates progressive compression fracture in L2 (white arrow).	18
(6)	Thin-section axial CT (a) sagittal reformatted CT in ages (b) demonstrating severe compression fracture of T12 with retropulsion of the superior end plate into the spinal canal.	19
(7)	Tc-99m-labeled bone scan image, posterior view, demonstrating increased uptake at the level of a subacute L2 VCF (white arrow)	19
(8)	(a) Sagittal T1-weighted MR image demonstrating VCFs at T9, T11, T12, and L1. (b) T2-weighted MR image demonstrates heterogeneously increased signal in the T9 and T11 vertebral bodies	20
(9)	T2-weighted MR image demonstrating chronic severe compression fracture of L3 and acute compression fracture of L2.	21

(10)	<p>(a) Sagittal T1-weighted MR image in a 68-year-old man with longstanding thoracolumbar compression fracture</p> <p>(b) Sagittal T2- weighted MR image demonstrates hypointense signal in the fractured T12 vertebral body (white arrow), indicating sclerosis or fibrosis rather than edema or tumor.</p>	22
(11)	Basic set of instruments for performing balloon kyphoplasty. (A)Jamshidi puncture needle; (B) Osteointroducer; C Kirschner wire.	28
(12)	Pressure gauge.	29
(13)	Cement mixing set.	29
(14)	Optimal consistency of the cement before filling the cavity with the bonefiller.	36
(15)	Differences in nuclear pressure (mean with one standard error bar) between the intact and fractured conditions for the three loading scenarios.	47
(16)	Differences in nuclear pressure (mean with one standard error bar) between the fractured and treated conditions for the three loading scenarios.	47
(17)	These sheets are the sheets that we used for personal data, history taking (Present & past), physical examination and neurological examination.	52
(18)	Classification of thoracolumbar spine fractures according to Magerl/AO spine: type A: compression.	56
(19)	Vertebral Body Balloons, sterile pre inflated size (small-medium-large)	57
(20)	Inflation System, Sterile.	58

(21)	Vertebral Augmentation Access Kit, sterile.	58
(22)	VERTECEM Mixing Kit, sterile.	59
(23)	Syringe Kit, sterile.	59
(24)	Operative theater. A radiolucent table and 2 C-arm fluoroscopy machines Mobile Digital C-Arm.	60
(25)	Positioning of pt and adequate fluoro imaging (by level).	60
(26)	The access instruments (a-Extrapedicular approach, b-intrapedicular approach)	62
(27)	Option A: Trocar access.	63
(28)	Option B: guide wire access	65
(29)	Creation of access channel for balloon insertion by plunger.	66
(30)	Determine the appropriate balloon size by plunger.	66
(31)	Prepare the inflation system.	67
(32)	Connect balloon catheter and create vacuum, standard method.	68
(33)	Inflate Vertebral Body balloons with fluid.	70
(34)	Injection of PMMA Bone Cement.	72
(35)	Diagram showing steps of balloon kyphoplasty.	73
(36)	Maximal fracture reduction technique for a patient with L1 vertebral fracture due to osteoporosis.	74
(37)	VAS	75
(38)	Study population.	81

(39)	Distribution of fractures.	84
(40)	Median VAS scores	89
(41)	Mean ODI scores.	92
(42)	Median ODI scores	93
(43)	medical complications	95
(44)	Percentage of cement leakage.	96
(45)	Case 1	100
(46)	Case 2	102
(47)	Case 3	104
(48)	Case 4	106
(49)	Case 5	108
(50)	Case 6	110
(51)	Case 7	112
(52)	Case 8	114
(53)	Case 9	116
(54)	Case 10	118

Contents

List of abbreviations	I
List of tables	II
List of figures	IV
Introduction	1
Anatomy and biomechanics.....	4
Review	9
Material and method	50
Results	81
Case presentation	99
Discussion and conclusion	119
References	130

INTRODUCTION

Introduction

The National Osteoporosis Foundation has estimated that more than 100 million people worldwide are at a risk for the development of fractures secondary to osteoporosis. Osteoporotic Vertebral compression fractures (OVCFs) constitute a major health care problem in western countries, not only because of the high incidence of these lesions but also due to their direct and indirect negative consequences for patient health-related quality of life and the costs to the health care system. ⁽¹⁾

Compression fractures lead to a loss of height of the vertebral segment, and the resulting spinal deformity can lead to a decrease in pulmonary capacity, malnutrition, decreased mobility, and depression. Kyphosis secondary to osteoporotic vertebral compression fractures is associated with a (2) to (3) times greater incidence of death due to pulmonary causes. Although usual treatment of an osteoporotic vertebral compression fracture consists of bed rest, analgesics, and bracing, some fractures go on to progressive deformity and debilitating pain. ^(2, 3)

Several techniques have been developed for simpler and safer procedures during the last 2 decades. Techniques of vertebral body augmentation have been developed in an effort to treat these refractory cases. ⁽⁴⁾

The high pressure injection of low viscosity of (PMMA) has potential risk for neural compromise and pulmonary embolism by uncontrolled leakage. Therefore, balloon kyphoplasty and vertebroplasty using a large cannula low pressure injection of PMMA

in a high viscosity state has been introduced. Percutaneous kyphoplasty (PKP) is a recently developed, minimally invasive surgical treatment for OVCF. ⁽⁴⁾

PKP with acrylic cement (PMMA) is a procedure aimed at preventing vertebral body collapse and pain in patients with pathologic vertebral bodies. PKP is a promising therapeutic technique for pain control in patients with bone failure. PKP for OVCFs is typically performed by delivering double balloons via a bilateral or unilateral transpedicular approach; balloons are inflated simultaneously for elevating the end plate for accompanying vertebral body height balanced restoration. The deformity is purportedly corrected by the insertion and expansion of a balloon in a fractured vertebral body. ⁽⁵⁾

After reduction of the fracture bone, cement is then deposited into the cavity created by the balloon to repair the fracture. Good clinical outcomes as well as restoration of vertebral body height have been reported with kyphoplasty. Absolute contraindications to any vertebral augmentation procedure include asymptomatic osteoporotic vertebral compression fractures, ongoing local or systemic infection, uncorrectable coagulopathy, or improving pain on medical therapy. Fractures of the posterior elements (without vertebral body fracture) are another absolute contraindication. ^(5, 6, 7)

Complications for balloon kyphoplasty include non-target PMMA embolization, adjacent vertebral body or rib Fracture and infection. ⁽⁸⁾