

EVALUATION OF POSTERIOR MICROSCOPIC CERVICAL FORAMINOTOMY IN MANAGEMENT OF CERVICAL DISC DISEASE

Thesis

Submitted for Partial Fulfillment of
The Doctorate Degree (M.D) in
Neurosurgery

By

Ahmed M. Allam
(M.B, B.CH, M.Sc.)

Supervised by

Prof. Dr. Ismael Ibrahim
*Professor of Neurosurgery,
Faculty of Medicine, Cairo University*

Prof. Dr. Nasser El-Ghandour
*Professor of Neurosurgery,
Faculty of Medicine, Cairo University*

Prof. Dr. Wael El-Mahdy
*Professor of Neurosurgery,
Faculty of Medicine, Cairo University,*

Dr. Ahmed Hegazy
*Assistant Professor of Neurosurgery,
Faculty of Medicine, Cairo University*

**Faculty of Medicine
Cairo University
2012**

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

ACKNOWLEDGMENTS

*It's a pleasure to acknowledge deep gratefulness I owe to **Prof. Dr. Ismail Ibrahim**, Professor of Neurosurgery, Faculty of Medicine, Cairo University whose expertise, lucid presentation and fatherly help have eased my task.*

*I would like to express my gratitude and immense indebtedness to **Prof. Dr. Nasser El-Ghandour** Professor of Neurosurgery, Faculty of Medicine, Cairo University, for his precious guidance, invaluable support and generous supervision.*

*I pay a very special tribute to **Prof. Dr. Wael El-Mahdy**, Professor of Neurosurgery, Faculty of Medicine, Cairo University, for his teaching, unlimited help, valuable advice and generous supervision.*

*My Gratitude to **Prof. Dr. Ahmed Hegazy**, for his surgical guidance and support and unlimited help advice and effort.*

*I am honored to express my sincere thanks and profound gratitude to **Prof. Dr. Abdel-Alim Ragab** and **Prof. Dr. Essam Rashad**, for their unfailing support, encouragement, valuable advice and unlimited help and kindness.*



CONTENTS

| | Page |
|---|------|
| ▪ Introduction | 1 |
| ▪ Aim of the Work | 3 |
| ▪ Review of Literature | 4 |
| o Surgical Anatomy | 4 |
| o Spinal Biomechanics | 28 |
| o Pathophysiology of Cervical disc Disease | 35 |
| o Epidemiology | 46 |
| o Clinical presentation of Cervical Radiculopathy | 47 |
| o Investigations | 57 |
| o Treatment of cervical radiculopathy | 66 |
| ▪ Patients and Methods | 86 |
| ▪ Results | 99 |
| ▪ Case Presentation | 116 |
| ▪ Discussion | 133 |
| ▪ Summary and Conclusion | 145 |
| ▪ References | 148 |
| ▪ Arabic Summary | 159 |

LIST OF TABLES

| No. | Title | Page |
|------------|--|-------------|
| 1 | Function and innervations of cervical spine muscles | 26 |
| 2 | Check list for the diagnosis of clinical instability in the lower cervical spine | 32 |
| 3 | Incidence of nerve root condition in the neural foramen | 42 |
| 4 | Thompson's classification scheme for disc degeneration | 45 |
| 5 | The cervical radicular syndromes | 54 |
| 6 | Conditions that can mimic specific cervical radicular syndromes | 56 |
| 7 | MRC Grading system for muscle strength | 87 |
| 8 | Muscle stretch reflex grading scale | 87 |
| 9 | Sex distribution in the study group | 99 |
| 10 | Age among the study group | 100 |
| 11 | Frequency of symptoms among the study group | 101 |
| 12 | Frequency of signs among study group | 102 |
| 13 | Distribution of the operated levels | 105 |
| 14 | Association between transient ISP and outcome | 107 |
| 15 | Outcome among the study | 108 |
| 16 | Showing frequency of motor deficit improvement at 12 month follow | 109 |
| 17 | Association between previous ACDF and outcome | 110 |
| 18 | Association between number of levels and outcome | 111 |
| 19 | Association between operated level and outcome | 112 |
| 20 | Association between age and outcome | 112 |
| 21 | Association between cervical curve and outcome | 113 |
| 22 | Association between compressing pathology and outcome | 114 |
| 23 | Microscopic and endoscopic foraminotomy in various series | 142 |
| 24 | Anterior cervical discectomy in various series | 142 |

LIST OF FIGURES

| No. | Title | Page |
|-----------|--|-----------|
| 1 | A cervical vertebra | 6 |
| 2 | Side view of a typical cervical vertebra | 6 |
| 3 | First cervical vertebra, or atlas | 9 |
| 4 | Second cervical vertebra, or epistropheus, from above | 11 |
| 5 | Second cervical vertebra, epistropheus, or axis, from the side | 11 |
| 6 | Seventh cervical vertebra | 12 |
| 7 | Sagittal section of the cervical spine | 15 |
| 8 | Intervertebral disc | 17 |
| 9 | Facet joint Orientation | 18 |
| 10 | Facet joint structures | 19 |
| 11 | A, axial CT scan through the neural foramen. B, a sagittal reformatted CT scan through the cervical neural foramen | 21 |
| 12 | Cervical foramen | 21 |
| 13 | Ligaments of cervical spine | 23 |
| 14 | Deep muscles of posterior cervical spine | 24 |
| 15 | Posterior cervical muscles, nerves | 25 |
| 16 | Cadaveric dissection, axial cut at the C3 level, is shown before (left) and after (right) the lamellar portion of the nuchal ligament has been separated | 27 |
| 17 | Cobb method | 31 |
| 18 | Axial T2 MRI image (A) and CT scan (B) in a patient with a left C6 radiculopathy. There is a left-sided C5 to C6 osteophyte causing neural foraminal stenosis and C6 nerve root compression. | 35 |
| 19 | Axial T2 MRI demonstrating C7-T1 disc herniations | 36 |
| 20 | Herniation types of nucleus pulposus | 39 |
| 21 | A, the nonpathological state, in which the dorsal vertebral body height is less than the ventral vertebral body height, results in normal cervical lordosis. B, loss of the ventral disc interspace height, which occurs with the natural degenerative process, results in loss of lordosis. This causes elongation of the moment arm applied to the spine (D), leading to ventral vertebral body compression. C, a further exaggeration of pathological kyphotic posture may then ensue | 40 |

| No. | Title | Page |
|------------|---|-------------|
| 22 | Axial CT scans of a patient with a lateral cervical osteophyte | 42 |
| 23 | Dynamic views of cervical spine | 58 |
| 24 | Axial cervical CT myelogram demonstrates marked hypertrophy of the right facet joints | 59 |
| 25 | Neural foramenon axial T2 MRI | 61 |
| 26 | 45-degree oblique view MRI showing evident osteophyte/dic complex at C5/C6 | 62 |
| 27 | Right C7 cervical transforaminal epidural steroid injection | 72 |
| 28 | Cervical epidural steroid injection at the C7-T1 interlaminar space | 73 |
| 29 | Surgical Approaches for the Treatment of Cervical Radiculopathy | 75 |
| 30 | Anterior cervical discectomy | 80 |
| 31 | Restoration of lordosis | 81 |
| 32 | Patient positioning for posterior foraminotomy | 89 |
| 33 | Intraoperative fluoroscopy, for level confirmation | 90 |
| 34 | Posterior foraminotomy marked | 92 |
| 35 | Sequential intraoperative photomicrographs of a left-sided hemilaminotomy and medial facetectomy with the removal of an extruded disc. | 94 |
| 36 | A and B: Preoperative views. C: Location of laminotomy and foraminotomy. the lateral portions of the lamina and medial facet joint are drilled. | 95 |
| 37 | Post operative sagittal reconstruction CT scan | 96 |
| 38 | Post operative axial CT scan | 96 |
| 39 | Sex distribution Pie chart | 99 |
| 40 | Age among the study group | 100 |
| 41 | Duration of symptoms among the study group | 101 |
| 42 | Frequency of symptoms | 102 |
| 43 | Frequency of signs among the study group | 103 |
| 44 | Pie chart showing side of radiculopathy among the study group | 103 |
| 45 | Pie charts showing state of cervical spine curve amog the study group | 104 |
| 46 | Pie chart presenting different compressing pathologies among the study. | 106 |
| 47 | Bar chart presenting mean and median operative time | 106 |
| 48 | Study Outcome | 108 |

| No. | Title | Page |
|------------|---|-------------|
| 49 | Association between Previous ACDF and outcome | 110 |
| 50 | Association between number of leverls and outcome | 111 |
| 51 | Association between age and outcome | 112 |
| 52 | Association between outcome and cervical lordosis | 113 |
| 53 | Association between outcome and disc pathology | 114 |
| 54 | Bar chart showing follow up period among the series | 115 |
| 55 | Pre-operative lateral plain x- ray | 117 |
| 56 | Pre-operative MRI | 117 |
| 57 | Pre-operative CT scan (bone window) | 118 |
| 58 | Post-operative CT scan (bone window) | 118 |
| 59 | Post operative CT scan (sagittal reconstruction) | 119 |
| 60 | Pre-Operative CT scan (bone window) | 121 |
| 61 | Pre-Operative MRI (axial) | 121 |
| 62 | Pre-Operative MRI (sagittal) | 122 |
| 63 | Post-Operative CT (bone window) | 122 |
| 64 | Pre-Operative MRI | 124 |
| 65 | Pre-Operative CT | 124 |
| 66 | Post-Operative CT | 125 |
| 67 | Post-Operative CT (sagittal reconstruction) | 125 |
| 68 | Pre-Operative MRI (axial) | 127 |
| 69 | Pre-Operative MRI (sagittal) | 127 |
| 70 | Post-Operative CT (bone window) | 128 |
| 71 | Post-Operative CT (soft tissue) | 128 |
| 72 | Post-Operative plain x-ray at 12 months follow up | 129 |
| 73 | Pre-Operative MRI (axial T2) | 131 |
| 74 | Pre-Operative MRI (axial T1) | 131 |
| 75 | Pre-Operative MRI (sagittal) | 132 |
| 76 | Post-Operative CT | 132 |

ABBREVIATIONS

| | |
|--------|---|
| ACD | : Anterior cervical discectomy |
| ACDF | : Anterior cervical discectomy and fusion |
| Ant. | : Anterior |
| C | : Cervical |
| CSF | : Cerebrospinal fluid |
| CT | : Computerized tomography |
| DDD | : Degenerative disc disease |
| DTPA | : Diethylenetriamine pentaacetic acid |
| EMG | : Electromyography |
| HNP | : Herniated nucleus pulposus |
| IDD | : Internal disc disruption |
| Lt | : Left |
| mm | : Millimeter |
| MRI | : Magnetic resonance imaging |
| NCS | : Nerve conduction studies |
| no. | : Number |
| NSAIDs | : Non steroidal anti- inflammatory drugs |
| PLL | : Posterior longitudinal ligament |
| ROM | : Range of motion |
| Rt | : Right |
| SD | : Standard deviation |
| SEP | : Somatosensory evoked potentials |
| T | : Thoracic |
| TCAs | : Tricyclic antidepressants |

ABSTRACT

Objective: This study details assessment of the indications, safety, efficacy and complications of posterior microscopic cervical foraminotomy for treatment of cervical radiculopathy associated with cervical foraminal disc herniation and / or cervical foraminal stenosis of degenerative etiology. **Methods:** A prospective study conducted on 31 patients with unilateral single or double level cervical radiculopathy due to cervical degenerative disc disease confirmed by concordant clinical and radiological data, refractory to non-surgical measures for 3 months at least, admitted and operated at Kasr El-Ainy university hospitals between March 2009 and August 2010. Outcomes were assessed by using the Odom's criteria. **Results:** Average age of presentation was 44.1 years, male to female ratio was 1:1.8, and average duration of symptoms was 51.4 weeks. 21 cases had left sided radiculopathy, 10 cases had right sided affection. The most common presenting symptom after brachialgia (100%) was neck pain (87%), most common sign was hyporeflexia (67%). Most common operated level was C5-6 (50%). Excellent and good outcomes were obtained in 87% of the patients. The mean follow up period was 14.5 months with no recurrence, instability or progressive kyphosis. **Conclusion:** Microscopic posterior cervical foraminotomy is a safe and effective approach for treatment of cervical radiculopathy resulting from foraminal hard and soft disc pathologies with comparable results to the ACDF approach.

Key words:

Cervical spine,
Disc herniation,
Foraminotomy,
Radiculopathy,
Neural foramen

INTRODUCTION

INTRODUCTION

Cervical radiculopathy is typically characterized as pain in the anatomic distribution of a single cervical nerve root. Sensorimotor impairment of the same nerve root may or may not be simultaneously present. Not uncommonly, multiple nerve roots may be affected simultaneously, leading to multilevel radiculopathy (*Carette and Fehling, 2005*).

Cervical radiculopathy is usually the result of either a soft lateral disc displacement or spondylosis with resultant foraminal compromise caused either by a calcified disc, osteophyte, or both. (*Carette and Fehling, 2005*).

The management of cervical radiculopathy is a controversial area in spine surgery. Although most patients are thought to achieve resolution of symptoms without surgical intervention, recent data, including randomized controlled studies have provided evidence that surgical intervention may improve short-term disability related to pain when compared with conservative management (*Fouyas et al., 2002*).

When surgical intervention is chosen, the surgical approach can vary significantly. Although posterior approaches have traditionally been favored in the management of radiculopathy (*Gregorius et al., 1976*), in recent years anterior approaches have been favored by some due to the ease of exposure, wider exposure of the disc space, and less patient discomfort. Unfortunately, symptomatic adjacent-segment disease has been found to develop frequently with time after anterior cervical arthrodesis and affects long-term patient outcomes (*Jagannathan et al., 2008*).

The posterior cervical approach was popularized by Spurling and Scoville (**Scoville and Whitcomb, 1966**) and Frykholm (*Frykholm, 1947*).

The results obtained in many early series were quite good, even by today's standards. The limitations of the posterior approach when used to treat compression located more centrally in the spinal canal. By 1955 Smith and Robinson (*Aronson et al., 1968*) had pioneered the anterior approach for discectomy and fusion. The ACD was subsequently modified by Cloward (*Cloward, 1958*) and then by proponents of ACD without fusion. Although during the ensuing three to four decades the anterior approach for cervical disc disease became more widely used, there were some advocates of the posterior approach who reported obtaining good results in large series of patients (*Jagannathan, 2009*).

Progress in imaging techniques has allowed for much more thorough preoperative assessment and characterization of the specific indications for the posterior approach.

There are clear advantages of performing a posterior cervical foraminotomy, particularly in patients with cervical radiculopathy. Posterior decompression allows better access to eccentrically located disc fragments while obviating the need for retraction on the esophagus and laryngeal nerve, which can result in postoperative dysphagia and hoarseness following anterior approaches. Additionally, pseudarthrosis, graft subsidence, and kyphosis, which are well-reported complications of ACDF, can be eliminated when a posterior foraminotomy is performed (*Coric and Adamson, 2008*).

AIM OF THE WORK
