

ANATOMY OF THE BRACHIAL PLEXUS

Essay

*Submitted For Partial Fulfillment
Of Master Degree
In Basic Medical Science (Anatomy)*

By

Shaimaa Mohamed Mohamed Hafez
M.B.B.Ch.

Under Supervision of

Dr. Olfat Anwar Abd El-Aty

*Assistant Professor of Anatomy
Faculty of Medicine for Girls
Al-Azhar University*

Dr. Hala Hamed Musalim

*Lecturer of Anatomy
Faculty of Medicine for Girls
Al-Azhar University*

**Faculty of Medicine for Girls
Al-Azhar University
2014**



"وَأَتَاكُمْ مِنْ كُلِّ مَا سَأَلْتُمُوهُ وَإِنْ تَعْدُوا
نِعْمَتَ اللَّهِ لَا تَحْصُوهَا إِنْ الْإِنْسَانُ لظَلُومٌ
كَفَّارٌ"

صدق الله العظيم

سورة ابراهيم

الآية ٣٤

Acknowledgement

*First thanks to **Allah** to whom I relate any success in achieving any work in my life.*

*I wish to express my deepest thanks, gratitude and appreciation to **Dr. Olfat Anwar Abd El-Aty**, Assistant Professor of Anatomy for her supervision, kind guidance, valuable instructions and continuous help.*

*Special thanks and sincere appreciation to **Dr. Hala Hamed Musalim**, Lecturer of Anatomy for her sincere efforts and fruitful encouragement.*

I am indebted for my family.

To the soul of my father.
To the soul of my father.

List of contents

<i>Title</i>	<i>page No.</i>
Introduction	1
Aim of work.....	4
Chapter (1): Anatomy of the brachial plexus.....	5
Chapter (2): Development of the brachial plexus.....	45
Chapter (3): Histology of peripheral nerves.....	55
Chapter (4): Variations in the formation of the brachial plexus.....	58
Chapter (5): Injuries of the brachial plexus.....	113
Chapter (6): Repair and rehabilitation of the brachial plexus injuries.....	159
Summary.....	170
Recommendation.....	175
References	177
Arabic summary	

List of figures

<i>Figs. No.</i>	<i>Title</i>	<i>Page No.</i>
<i>Figure (1):</i>	A schematic plan of the left brachial plexus.....	6
<i>Figure (2):</i>	The brachial plexus, its branches and the muscles which they supply.....	7
<i>Figure (3):</i>	Relations of the brachial plexus and its branches to the axillary artery and vein.....	9
<i>Figure (4):</i>	Branches of the brachial plexus.....	11
<i>Figure (5):</i>	Medial wall of the axilla and long thoracic nerve.....	14
<i>Figure (6):</i>	Posterior aspect of the shoulder showing the suprascapular nerve and artery.....	16
<i>Figure (7):</i>	Posterior wall of the axilla and posterior cord of the brachial plexus.....	17
<i>Figure (8):</i>	The distribution of axillary nerve and arterial anastomosis around the upper end of the humerus.....	19
<i>Figure (9):</i>	The distribution of the radial nerve.....	21
<i>Figure (10):</i>	The course and branches of the radial nerve.....	22
<i>Figure (11):</i>	Dissection of the forearm to show principal vessels and nerves.....	23
<i>Figure (12):</i>	Cutaneous innervation of the hand.....	23
<i>Figure (13):</i>	Radial nerve in the hand.....	24
<i>Figure (14):</i>	Medial and lateral pectoral nerves.....	25
<i>Figure (15):</i>	Motor and sensory branches of the musculocutaneous nerve.....	26
<i>Figure (16):</i>	The site of innervations of the lateral antebrachial cutaneous nerve.....	27
<i>Figure (17):</i>	Median, ulnar and musculocutaneous nerves in the.....	28
<i>Figure (18):</i>	Anterior aspect of the left elbow, superficial structures.....	30
<i>Figure (19):</i>	Anterior view of the arm showing deep structures.....	31
<i>Figure (20):</i>	Median nerve in the hand.....	32
<i>Figure (21):</i>	Anterior view of the palm of the hand.....	34
<i>Figure (22):</i>	Cutaneous innervation of the hand by median nerve.....	35
<i>Figure (23):</i>	Medial cutaneous nerve of the arm and forearm.....	37
<i>Figure (24):</i>	Ulnar nerve in the hand.....	40
<i>Figure (25):</i>	The ulnar nerve and vessels passing in the tunnel of Guyon.....	42
<i>Figure (26):</i>	Deep structures in the left palm and wrist showing the deep branch of the ulnar nerve.....	43
<i>Figure (27):</i>	Scanning electron micrographs to show the development of the upper limb.....	46

Figure (28):	Lateral view of a human embryo at Carnegie stage 13, approximately 28 day.....	47
Figure (29):	Motor axons growing out from neurons in the basal plate.....	49
Figure (30):	Scanning electron micrograph of a cross section through the spinal cord of a chick embryo.....	50
Figure (31):	Cross section through half the embryo showing innervation to developing musculature.....	50
Figure (32):	Illustrations of the development of the dermatomal patterns of the limbs.....	53
Figure (33):	Forelimbs with their sensory innervation to the dermatomes represented.....	53
Figure (34):	The nerve cell.....	55
Figure (35):	Peripheral nerve fiber.....	57
Figure (36):	Anatomic preparation of the left brachial plexus of a newborn cadaver with a contribution from C4 to C5.....	60
Figure (37):	Brachial plexus and anterior scalene muscle in ventral view.....	62
Figure (38):	Anterior view of a right brachial plexus with a superior trunk variation.....	64
Figure (39):	Formation of abnormal upper trunk of the brachial plexus.....	65
Figure (40):	Abnormal upper trunk with its branches and relations.....	66
Figure (41):	Photograph of dissected right side of neck and axilla.....	67
Figure (42):	An abnormal upper trunk of the brachial plexus and its branches.....	69
Figure (43):	Variation in the formation of the lower trunk of the brachial plexus.....	69
Figure (44):	Photograph of right axilla showing two trunks and two cords.....	71
Figure (45):	Two cord stage of the infraclavicular part of the brachial plexus.....	72
Figure (46):	Formation of posterior cord by union of posterior division of C5 and C6 ventral.....	72
Figure (47):	Axillary nerve originates from posterior division of upper trunk and posterior cord.....	73
Figure (48):	Variation in formation of lateral cord and median nerve of brachial plexus.....	74
Figure (49):	Formation of posterior cord of the brachial plexus.....	75
Figure (50):	Photograph of dissected and colored right axilla	76
Figure (51):	Anterior view of a right brachial plexus with the	77

	posterior cord	
Figure (52):	Dissection of the posterior triangle of the neck showing the dorsal scapular nerve variations.....	79
Figure (53):	Dissection of the posterior triangle of the neck.....	80
Figure (54):	Ventral view of the left cervicoaxillary region. Middle scalene muscle is removed.....	82
Figure (55):	Right BP with collateral origin variations for lower subscapular nerve and thoracodorsal nerve.....	83
Figure (56):	Radial nerve from the inferior and middle trunks only.....	86
Figure (57):	Variation in the termination of the posterior cord...	87
Figure (58):	Radial nerve splitting into anterior and posterior divisions.....	88
Figure (59):	Radial nerve in posterior compartment of arm.....	89
Figure (60):	Figure showing the communicating branch between the ulnar and radial nerve.....	89
Figure (61):	Communication between radial nerve and medial cutaneous nerve of forearm.....	91
Figure (62):	Absence of Musculocutaneous nerve (1).....	93
Figure (63):	Absence of musculocutaneous nerve (2).....	94
Figure (64):	Absence of musculocutaneous nerve (3).....	94
Figure (65):	Musculocutaneous nerve rejoining median nerve after piercing Coracobrachialis.....	95
Figure (66):	Photograph showing an unusual muscular branches innervating anterior compartment of muscles in the arm...	96
Figure (67):	Figure shows the connection of musculocutaneous nerve with median nerve.....	97
Figure (68):	Schematic diagram showing variant branching pattern of brachial plexus.....	99
Figure (69):	Variant formation of median and ulnar nerves.....	100
Figure (70):	The right brachial plexus of a newborn cadaver showing a variation in the formation of the median nerve.....	100
Figure (71):	Right upper limb dissected infraclavicular part of the brachial Plexus.....	101
Figure (72):	Dissection of the front of the arm.....	102
Figure (73):	Showing the fusion of the median and musculocutaneous nerves.....	104
Figure (74):	Showing the innervation of biceps brachii and Brachialis by the median nerve.....	105
Figure (75):	Median nerve innervating biceps brachii and brachialis muscles in the absence of musculocutaneous nerve.....	105
Figure (76):	Communication between median and musculocutaneous nerve.....	106

Figure (77):	Shows ulnar nerve coming from median nerve...	107
Figure (78):	Ulnar nerve (1) trifurcation into superficial (2) and deep (3) division.....	109
Figure (79):	Ulnar nerve gives a dorsal branch high in the forearm...	111
Figure (80):	The dorsal branch of the ulnar nerve.....	111
Figure (81):	The ulnar nerve divides into superficial and deep branches.....	112
Figure (82):	Injury to the upper part of brachial plexus.....	116
Figure (83):	Lower brachial plexus Injury	117
Figure (84):	Nerve root avulsion.....	120
Figure (85):	Anatomy of the brachial plexus roots and types of injury.	120
Figure (86):	Brachial plexus palsy of the left arm.....	121
Figure (87):	Pseudomeningocele in the neck.....	124
Figure (88):	Example of neuroma in continuity.....	124
Figure (89):	Magnetic resonance imaging brachial plexus.....	131
Figure (90):	Anteroposterior x-ray of the cervical spine.....	133
Figure (91):	Photographs showing Gilliat-Sumner hand in a patient TOS.....	133
Figure (92):	A 57-year-old male with histopathologically proven malignant schwannoma.....	135
Figure (93):	A 60-year-old female presenting with right upper limb weakness	137
Figure (94):	Winging of the right scapula due to serratus anterior palsy.....	139
Figure (95):	White arrows indicating atrophy of supraspinatus and infraspinatus muscles.....	141
Figure (96):	Wrist drop	143
Figure (97):	Radial nerve in the hand (sensory innervation).....	144
Figure (98):	Complete median nerve injury (Benedictine sign).....	148
Figure (99):	Ligament of Struthers	149
Figure (100):	Playboy bunny sign.....	151
Figure (101):	Intraoperative view of the distal forearm	153
Figure (102):	Median nerve in the hand (sensory innervations)...	153
Figure (103):	Ulnar nerve palsy.....	156
Figure (104):	Ulnar nerve in the hand (sensory innervations).....	156
Figure (105):	Types of brachial plexus injury postganglionic injury.....	160
Figure (106):	The result after 18 months in a patient after injury to the C5 and C6 roots of the brachial plexus.....	165

List of abbreviations

Abb.	Full term
SSN	Suprascapular nerve
AIN	Anterior interosseous nerve
U.L	Upper limb
L.L	Lower limb
PNS	Peripheral nervous system
CBPP	Congenital brachial plexus palsy
OBPI	Obstetric Brachial Plexus Injury
MRI	Magnetic resonance imaging
IBN	Idiopathic Brachial Neuritis
nTOS	Neurogenic Thoracic Outlet Syndrome

List of tables

Table No.	Page No.
Table (1)	44
Table (2)	84-85

A decorative graphic of a scroll with a light gray background and a thin black border. The scroll is partially unrolled, with the top and bottom edges curled up. The word "Introduction" is written in a bold, black, serif font in the center of the scroll.

Introduction

Introduction

The brachial plexus is the network formed by the communication between the anterior rami from the fifth to the eighth cervical nerve roots and first thoracic nerve root. The brachial plexus is divided into roots, trunks, divisions, cords and branches. There are five terminal branches and numerous other pre-terminal or collateral branches that leave the plexus at various points along its length. The nerves entering the upper limb provide the following important functions: sensory innervation to the skin and deep structures, such as the joints and motor innervation to the muscles (**Moore et al., 2007; Snell, 2008 and Standring et al., 2008**).

Snell, (2008) reported that, the branches of the roots of the brachial plexus are: the dorsal scapular nerve (C5) and the long thoracic nerve (C5, 6, and 7). The upper trunk gives rise to the suprascapular nerve and nerve to subclavius (C5 and 6). The lateral cord gives the lateral pectoral nerve, the musculocutaneous nerve and the lateral root of median nerve. While the branches of the medial cord are the medial cutaneous nerve of the arm and the medial cutaneous nerve of the forearm, the medial pectoral nerve, the ulnar nerve and the medial root of median nerve. The posterior cord gives the upper and the lower subscapular nerves, the thoracodorsal nerve, the axillary nerve and the radial nerve.

Embryologically, motor nerve fibers begin to appear in the fourth week of gestation, arising from nerve cells in the basal plates of the spinal cord. These fibers collect into bundles known as ventral nerve

Introduction

roots. Dorsal nerve roots formed as collections of fibers originating from cells in dorsal root ganglia. Central processes from these ganglia form bundles that grow into the spinal cord opposite the dorsal horns. Distal processes join the ventral nerve roots to form a spinal nerve. The spinal nerves divide into dorsal and ventral primary rami. The dorsal primary rami innervate the dorsal surface. The ventral primary rami innervate the limbs and ventral body wall and form the major nerve plexuses as brachial and lumbosacral (**Sadler, 2003**).

Variations in the anatomy of the upper limbs, especially in its nerves, vessels and muscles, are common and have been reported by many investigators. In this regard, variations in the formation of the brachial plexus are of a great interest for all the clinicians. Knowledge of such anatomical variations of the brachial plexus and its branches in the upper limb is important because these variants could be injured during surgical procedures, producing unusual clinical symptoms (**Williams et al., 1995; Sud, 2000 and Gupta et al., 2005**).

Diseases, stretching, and wounds in the lateral cervical region of the neck or in the axilla may produce brachial plexus injuries. Injury of the brachial plexus causes severe and chronic impairments in both adults and children, thus requiring an early and long-lasting treatment. Brachial plexus injury, or Erb-Duchenne paralysis, is relatively common among neonates. Although some of these injuries can result from traumatic delivery, others may be caused by intrauterine positioning. Brachial plexus disorders may be hereditary caused by

infantile myofibromatosis, or it may be iatrogenic (**Moore and Dalley, 2006 and Smania et al., 2012**).

Management of brachial plexus injury sequelae is a challenging issue in neurorehabilitation. In the last decades great strides have been made in the areas of early diagnosis and surgical techniques. Successful results in the management are based on the knowledge of anatomic arrangement, pathophysiology considerations, preoperative evaluation and diagnosis. Also surgical technique, postoperative management, rehabilitation and regular patient follow-up are factors influencing its results (**Chuang, 1999 and Smania et al., 2012**).



Aim of the work