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## Anatomic variation associated entrapment neuropathies of the upper limb: review of literature

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### ABSTRACT

#### Introduction:

There are numerous situations in the upper limbs in which a nerve becomes compressed or entrapped, between two other structures located in the body, in sequence other neurological entrapment syndromes can be seen. The purpose of this survey is to assess an update of literatures regarding entrapment neuropathies in the upper extremity and their correspondences with neuromusculoskeletal anatomical variations and certain clinical defects.

#### Methods:

Analytical literature of review's methods survey within diverse multifarious organized collection of data. Databases are used to carefully define affiliation among nerve entrapment and anatomical disparity of neuro-musculoskeletal organization, using an organized structure of key terms projected via "Cochrane Handbook For Systemic Reviews Of Interventions".

**Results:** Assess the detailed research thesis has been practically displayed that anatomical anomalies of the upper extremity, interrelated with entrapment of the nerve resembling compressions regarded as being caused by some type of extra muscle or anatomical deviation in the site of muscular attachment. This confirms the significance of knowledge of the ordinary anatomy to observe these structures and their possible disparities, this is important to aid in preventing delayed diagnosis and treatment.

**Conclusions:** Compression neuropathy is a medical indication for a patient who attends a neurological department for consultation. Despite the fact that certain types of compression are easily diagnosed or quite common; for example carpal tunnel neuropathy and ulnar syndrome at the elbow, somehow other illnesses result from more incomprehensible etiologies and require distinguishing knowledge of all neuromusculoskeletal disorders which is exact and important to avoid iatrogenic impairment due to unanticipated anatomic variations.

## Introduction:

Entrapment neuropathy means compression in peripheral neuron bundle as they pass throughout constricted anatomical zones that is bounded by stiff tissues<sup>1</sup>. Nerve root compression in the upper extremity is the major problem faced by physicians diagnostic workup<sup>2</sup>. Physician credit suitable management depending on critical symptom to avoid advanced complications<sup>3</sup>. According to anatomical basis the etiology of compression may be attributed to variation of muscles; nerves; vessels in addition to the tendons. concerning to various reviews, the particular reasons of muscular anatomical abnormality was not recognized up till now, nonetheless, these variations may occur as a result of anomalies in embryological signaling pathways<sup>4</sup>. The deviation from the normal doesn't limit the function of the systemic organ of human body, while in specific circumstances, these anomalies may deteriorate the present pathological status or

recommend new ones<sup>5</sup>. There are several situations in the upper limbs in which a nerve becomes compressed or entrapped, between two other structures in the body in sequence other neurological entrapments syndrome can be seen. For example: added carpus bone; supernumerary muscular structures as a: overgrowth; hypertrophic; hyperplasia; and anomalous. However certain type of the neuropathies are common, some are uncommon and certain are even controversial, i.e., the maximum compression level in superior extremity is neurocompression of median neural axon at narrow osseous canal situated on the palmar aspect of the wrist, created carpal tunnel syndrome<sup>6</sup>. Although Gantzer muscle is seen at a rare rate of 20.3%, it could be the reason for Median nerve anterior interosseous nerve compressions due to its close proximity to these structures particularly when the muscle is hypertrophied<sup>7</sup>. The Gantzer muscular which is an extra muscular fiber of the flexor pollicis longus muscle presented bilaterally in the

antebrachial region<sup>8</sup>, it takes its origin from the flexor digitorum superficialis muscle fibers then inserts into the “flexor pollicis longus or flexor digitorum profundus”<sup>9</sup>. Moreover, one of the vestigial muscular tissue has been described as causes of median nerve squeezed at the base of the handcarpal is unusual palmaris longus muscle<sup>10</sup>. Which is the most variable muscles in upper limb, it is not present in 11.2% of the population<sup>11</sup>. The variation of muscular tissue morphology<sup>12</sup>, such as having an extra belly, merging with another muscular fiber, diverging tendon, inverting muscle fibers, the unusual pathway of tendon also numerous tendinous attachments are not uncommon. structural variation of flexor digitorum superficialis is another important cause of nerve compression<sup>13</sup>. It takes its origin from dense connective tissue band of the flexor digitorum Superficialis muscle and passes alongside with transverse carpal ligament to be attachment close to metacarpophalangeal joint of the the

forefinger<sup>14</sup>. However, accessory muscle pass throughout the carpal channel during the extension and flexion of the wrist which can cause more compression of median nerve<sup>15</sup>. further rare muscular anomaly is a variation in Palmaris profundus muscles that generated significant neuropathy when its tendon pass beneath the flexor retinaculum, and cross carpal channel then attachment with lower border of the inferior retinaculum and the palmar fascia<sup>16</sup>.

Ulnar nerve entrapment usually originates at two significant sites one of them cubital channels which is space in the dorsal medial region in the elbow and the other one in the ulnar tunnel aligned the wrist<sup>17</sup>. The ulnar nerve sequestration is more common occurs at the elbow region than in the wrist, furthermore in some patients compression of ulnar was observed idiopathic<sup>18</sup>. However, Other reasons for the effect of pressure on the ulnar nerve are anomalies, of the muscle fibers, Anconeus-epitrochlear which regards an atypical minor muscular

fiber its origin from medial humerus epicondyle and inserts in the olecranon, it supports ulnar nerve from dislocation<sup>19</sup>. At the wrist, a Accessory fleshy muscular fibers are more common anatomical deviation in Guyon's channel which is beginning from the inferior fascia of antecubital and end on the base of the digitus minimus<sup>20</sup>. Its incidence percent is about twenty-four percentile, as a result of the passage of the abnormal muscle fiber above the musician's nerve bundle, compression of the musician's nerve inside Guyon channels has been happening<sup>21</sup>.

Regarding the radial nerve the previous studies mention the nerve can be compressed in any site throughout its course, however, there are critical places of radial nerve neuropathy such as approached to the radiocapitellar junction, the musculospiral groove, radial sulcus which situated between the medial as well as the lateral of three-headed muscles of the arm, the supinator archway which is made of a fibrous

tissue band in the interior of the both heads of the musculus supinator. The compression of the posterior interosseous nerve can be happened as a result of an abnormality in tendon of the an extensor muscle in the posterior superficial compartment of the forearm (musculus extensor carpi radialis brevis), at the "arc of Froese"<sup>22- 23</sup>.

#### Aim of this study

Is to supply the researches with the significant anatomical sites in which the possibility of compression neuropathy of upper limbs are communal occurs due to neuromusculoskeletal anatomical variations and aiding clinicians in diagnosis and treatment.

#### Patients and methods

Awidespread summary of previous research was performed searching scholarly systematic articles as well as biological sciences books that deals with dissection and description of the human body structures which published in period between 2015 to 2022. A computer-

based collection was considered to collect and listing of information on the suitable literature about the topic and obtain it as a reference . The subsequent databases were used:- Medline by the use of Pubmed, Web of Science, Scopus and Google Scholar, Medscape”, Researchgate Etc. by means of strategy with an organised structure of key terms applied to search a database. Developed by the “Cochrane Handbook For Systemic Reviews Of Interventions” Handbook constitutes a principle methods that appropriate to each review for instance planning studies, searching with selecting a review, in addition to collection of the data, etc<sup>24</sup>. This review describing anatomical variations that cause compression of the plexus brachialis with its chief terminal nerves in upper extremity. Analysis of literature achieved by means of significant terms: “neuromuscular structural anomalies”- “compressive neuropathies”- “carpal tunnel syndrome”- “variant anatomical structures”- “Muscle variations”- “Anconeus Epitrochlearis Muscle”-

“anterior interosseous syndrome”- “cubital tunnel syndrome”- “Accessory abductor digiti minimi”- “The arcade of Struthers”- “Guyon's Tunnel Syndrome”- “radial canal syndrome”- “Gantzer muscle. studies ruled out patients with other causes of nerve compression, idiopathic cause, pregnancy, systemic medical diseases, neuropathy as a result of trauma or infectious in addition to excluding the animals

## Result and Discussion

In the 1st moment, the researchers devoted themselves to resubmitting titles and abstracts of these articles which were purified by searching the title to identify the way to be discussed and related matters. Subsequently, the investigators studied the full texts of these papers. It has submitted nearly 100 articles, studied in full text, to confirm that they contain the basic principles. As shown in table (1)

### *Neuropathy Of Upper Brachial Plexus with Clinical Presentation*

1. Root/trunks neuron fiber entrapments of the brachial plexus :

The brachial plexus is a complex anastomosing of neurons which pass throughout thoracic outlet and it moves and senses signals in the upper limb<sup>25</sup>. Direct pressure on roots-cord-trunks and terminus nerves is dependent on the arrangement of a adjacent anatomical structure rather than central and peripheral nervous system for example “Thorax outlet syndrome”. This syndrome has many causes, occasionally, space is too tight for to travel of neuron and vessels easily pass across this narrow space among the first ribs and clavicle. Additional reasons of nerve pressure that cause thorax outlet syndrome can comprise:

A supranumerary rib and the fibromuscular bands attached to them which comes from 7th cervical vertebra<sup>26</sup>. The extra rib is found in 1-2% of all individuals, only 10% of patients have manifestation, and the majority do not feel any symptoms throughout life , Gilbert and others discovered that there are many types

of neck rib, full articulation with first rib about thirty percent of neck rib are entire ribs articulate to the 1st rib by a diarthroses joint. The other 70% are partial supernumerary rib , means that it is not directly related to the first rib<sup>27</sup>. Nevertheless, it might termination in a swelling that looks as a lump in the neck otherwise it could be converted into a fibrous tissue band that attributes to the actual first rib. Extra rib and its associated fibrous band are located within the scalene canal, causing narrowing of space through which the nerves are passing<sup>28</sup>. Accordingly, the partial extra rib with a related band may perform similarly to a complete rib<sup>29</sup> . The cervical and abnormal 1<sup>st</sup> ribs be able to press the lower trunk of plexus brachialis and produce polyneuropathy<sup>30</sup>, generally, fifty-one and three tenths percent of the symptomatic people can squeezed the subclavian artery and trigger stenosis as well as post-stenotic aneurysm, and forty-eight percent have neurological thoracic outlet syndrome<sup>31</sup>. Noteworthy other atypical tissues may arise tension or



compression on the neural structures throughout the thoracic outer orifice<sup>32</sup>.

For instance, congenital abnormalities of the scalene **muscular tissue** have been reported<sup>33</sup> which found that there is a great diversity in the structures and sizes of these muscles, Increased size of the constituent cells of the musculus serratus anterior, serratus lateralis is present in more than half of the exterminated cases<sup>34</sup>. Whereas thirty percent of individuals are found to have an atypical muscular tissue called scalenus minimus. This variations can affect the size of the scalene triangle and cause signs and symptoms of nerve compression in the patient <sup>35,36</sup>. Anatomical changes of thin muscular slip that arises from the latissimi dorsum muscle in 55.1 percent and is inserted into the floor of bicipital groove of the proximal part of humerus bone, while(35%)originates from the deep fascia of the arm, and 19.8 percent from a bony process on the outer side of the shoulder coracoid edge<sup>37</sup>,

while axillary arch overpasses the armpit. The probability of plexus brachialis constriction is highpoint because of its proximity to the neurovascular bundle<sup>38</sup>.

## 2 Suprascapular nerve compression :

Anatomical knowledge about the suprascapular notch and ligament that situated superior to the scapula is principal to appreciate the suprascapular nervous tissue entrapped syndrome. A neural tissue compression due to uncharacteristic notch situated superior to the scapula together with its ligament<sup>39</sup>. To be exact, this is extreme significant for medicinal, osteopathic medicine, neurosurgeons and orthopaedist surgeons to make an accurate diagnosis for cases suffering from signs of nervous tissue compression and to perform correct and clear planning for surgical operations of the upper extreme. The pressure of the nerve occurs when neural tissue of the suprascapular pass underneath the (spinoglenoid) lower transverse scapula ligament exactly sitting between the base of the glenoid

process and spinous scapula as the neurovascular structure cross from the suprascapular fossa to infrascapular fossa<sup>40</sup>.

Bagoji et al., mention the various morphological studies show diverse scales and form of the indentation in the upper edge of the scapula. The author's search for the morphology of 138 scapulae found a variety of forms of hollow above scapula, "48.55%-21.01%-10.14%-1.44%" had U-V-J-W shaped notch, respectively while 6.52 percent of individuals had none. Another study said that 1.44% of scapulae had big duplet orifice. Interestingly notch in about 4.34% of the samples was complete and absent in 5.07% scapulae<sup>41</sup>. The complete absence of the indentation and osteogenesis of the ligament are the prominent aberrations for compression neuropathy<sup>42</sup>. V-designed notch is more critical factor for all cases of compression of neuron. (Fig 1)

### 3. Musculocutaneous Peripheral neuropathy :

The musculocutaneous nural fiber is a terminus branch in lateral segment in plexus brachialis which conveys spinal neuron axons from between cervical vertebrae(c5-c6-c7). The musculocutaneous nerve passes between coracobrachialis muscular fibers after crossing through the armpit<sup>43</sup>, where regarded as the common site of neuron fiber compression<sup>44</sup>. Neuropathy of the musculocutaneous causing frailty and wasting Biceps brachii, Coraco brachialis and Brachialis muscles with numbness radial side of the forearm, Coracohumeral hypertrophy causes the same above complaint<sup>45</sup>. Although neuromuscular-cutaneous compression are moderately common, there are significant structural changes that could be scientifically important in clinical.

Recent study reported a novel variation at elbow pit, in which musculo-cutaneous nerve tissue pass beneath the extra biceps brachii tendon cause squeeze and numbness in the ulnar side of the arm<sup>46</sup>.



Interestingly musculus biceps brachii has IVth heads, this may be attributed to the musculo-cutaneous neuropathy<sup>47</sup>. Furthermore, The musculo-cutaneous nerve terminates as the lateral cutaneous nerve of antebrachial after its crossing through a rough band of fibrous connective tissue called “bicipital aponeurosis”<sup>48</sup>. In which, it has highly alteration in morphologically and topographically that influence the neuron that passes in it <sup>49 50</sup>. (Fig. 2)

#### 4. Axillary nerve compression :

Because the path of the axillary nerve is short, so the possibility of its compression is little, therefore, there are few studies dealing with the relationship of nerve compression with anatomical differences in neighboring structures<sup>51</sup>. Despite unusual accessory tendon of the broadest latissimi dorsorum muscle in the armpit<sup>52</sup>. No specific warning signs have been conveyed<sup>53</sup>. In its new revision, found an extraordinary accessory subscapularis musculus, which applied compression on the

posterior cord and created specific neuropathy leading to quadriangular space syndrome. The similar events occur within the quadrilateral space originated from fibrotic bands entrapping the axillary nerve along its pathway<sup>53</sup>.

#### 5. Compression of the median nerve :

The median neuron fiber supply the flexor-compartment of the antibrachium (forearm) through out several motor branches<sup>54</sup>. Along its path, it undergoes many constriction places by adjacent atypical anatomical structure, this is important for the clinic because of its high incidence<sup>55</sup>. The pronator teres muscle is one of the important upper extremity muscles that causes pressure on the median- nerve- fibers in its upper its pathway, at the same time the carpal-tunnel is a general sites for neuropathy of the distal part of the median nerve<sup>56</sup>. An additional elongated musculi fibers of the pollex is defined in the previous article as the “Gantzer muscle”. The addition head has a major consequence in the compressive nerves of both the

median nerve and anterior interosseus nerve and thus results syndrome "Kiloh-Nevin syndrome"<sup>57</sup>.

In other name volar interosseous nerve syndrom, It is uncommon medical condition in which deep volar flexor compartment of the brachium can be affected. Nerve compression mainly occur at: the beginning of the musculus of pronation "pronator teres", the superior border of the flexor musculus digitorum sublimis bridge, hypertrophy lacertus fibrosis and bursa, and ossified spurs<sup>58</sup>. Meanwhile authors found that the median nerve provisions the muscles front of the arm by 3.3 percent instead of the musculocutaneous nerve, in other cases two nerves may be communicating with each in other 13.3percent<sup>59-60</sup>.

Both heads of pronator teres have different morphology especially the ulnar belly<sup>61, 62, 63</sup>. Clinically, entrapment of median nerve by the ulnar tendon is greater intensity than if it was muscular head do<sup>64</sup>, in 1% of

humans, squeezed of the median nerve in the lower third of brachium (arm) due to a fibrous connective tissue band outspreading from protuberance of supracondylar to epicondyle in ulnar aspect of humerus bone "Struthers' ligament". These disorders are characterized by acute pain along the course and weakness to its muscle supply of median neuron burning character, sometimes occur in the form of attack and are accompanied by vasomotor disturbances in the form of cyanosis and sensations of numbness and paresthesia. Misdiagnosed as "carpel tunnel syndrome" leading to treatment being offered<sup>65</sup>.

Caetano et al., analyzed the influence of lacertus fibrosus on median nerve squeezing, when taken fifty-five limbs, In 42 limbs, a broad aponeurosis of the musculus biceps brachii, muscle thickened widely in which make pressure on median neuron.

In some cases, tendinous fascia of the deep head musculus pronator

teres reflections with hypertrophy forming a sharp fibrous arch is another example of neuropathy of nervus medianus<sup>66</sup>, accessory humerus muscles; which receipts its beginning from the diaphysis of the upper arm bone, and its terminal extension in the tuberosity of the ulnar, common flexor tendon and proximal radial shaft accessorius muscle pass at the ulnar side of elbow and traverse the median nerve as brachial vessels then tendinous connective tissue enclose median nerve and cause squeeze to it<sup>67</sup>.

Interestingly revision of George et al., analysed variant anatomical combination of arterial, neural, muscular. the authors found a rare type of superficial brachii artery is found that wanders around the Median nerve in the upper humerus in addition, the muscle bundle of the brachialis muscle with the arteria profunda brachii overlies the Median nerve at the elbow. The clinical impact-value for surgeon, it should be borne in mind that its effect is in the case of an abnormal arterial of the

upper extremity, and may be differently varied from the relevant nervous structures<sup>68</sup>. Likewise, the occurrence of aberrant muscles locate beneath the musculus flexor superficial compartment of forearm called the palmaris profundus<sup>69-70-71</sup>. Musculus palmaris profundus is an extraordinary variance in the carpal channel that must be recognized definitely from its anatomical orientations, however these muscles can take its origin from Lateral edge of radius, ulna, flexor digitorum superficialis or medial epicondyle of humerus<sup>72</sup>. Distally, The palmaris profundus is attachment to palmar aponeurosis to encircle the median nerve in a common fascial stringy connective tissue sheath and flexor retinaculum, where its possible to squeeze it at the carpal region<sup>73</sup>. Variations in the muscles bellies and attachments of the lumbricals are common with any being possibly unipennate or bipennate. Individuals with carpal tunnel syndrome tend to have tight atypical lumbrical muscles which increase this incursion, thereby increasing symptoms of

compression<sup>74</sup>. Sbai et al. (2019)<sup>75</sup> wrote about a middle-aged woman who had soreness, tingling, loss of sensation, and weakness of movement in the lateral three fingers of the left hand. After an operation, it was found that atypical lumbrical tendon of the lumbar nerve was cause of the carpal chunnel syndrome<sup>75-76-77</sup>, finally a typical transverse carpal connective tissue ligament and muscle and flexor retinacula, it is a rare causes of median nerve compression that has been discovered by scientists during surgical exploration<sup>78</sup>. Furthermore, transverse carpal muscle is said to be development from aberrant of epiblastic tissue that came from the pronator quadratus muscle<sup>78</sup>.

#### 6.Compression of the ulnar nerve (nervus ulnaris) :

The ulnar nerve is one of the main branches belong to brachial plexus that provide a large area of hypothenar eminence and along its course the nerve passes some sites of ulnar nerve entrapment where the ulnar nerve is wedged or squeezed

causing discomfort, loss of sensation, and;weakness<sup>79</sup>. Ulnar nervus embraced is categorized according to the locality of the encompassed. ulnar nerve routes in many narrow zone by way of its passes from the ulnar aspect of the brachium , where, the nerve is susceptible to squeeze. The nerve is susceptible to damage, especially, when an abnormality occurs in the typical structure.

The elbow region is furthermost common place for entrapment of ulnar nerve, then the carpal region<sup>80</sup>. Causes or combinations of ulnar nerve entrapment include: Neck problems, thoracic outlet syndrome, cervical vertebral dysfunction, and scalene anterior muscle compression,chest problems: compression of the pectoralis minor muscle, brachial plexus anomalies, elbow: , cubital tunnel syndrome, forearm: tightening of the ulnar flexor muscle of the wristand; wrist,carpal chunnel syndrome.

Elbow region “ cubital tunnel”, is the communal squeezed areas for ulnar nerve neuropathy which is

well-known as “cubital tunnel syndrome”. The channel established from bone; muscle; ligament; within elbow that stretched from epicondylar process in the medial aspect of humeral bone, toward bony projection “olecranon” in ulnar bone, furthermore tunnel covered by ligamentous arc “Osborne's” which links both deep and superficial heads of flexor carpi ulnaris muscle. This problem may end after some time, but prolonged strain or recurrent trauma may be a source of chronic troubles. At the carpus region, The ulnar nerve crosses the distal fibro-osseous channel recognized as “Guyon's channel” which located between the ligamentous connective tissue at the superior border of the pisiform to a proximal attachment hypothenar eminence.

A congenital anatomical difference had an influential and major cause of ulnar nerve squeezing, which was revealed in previous studies, as follows: the existence of one of the atypical muscles in upper

limbs extensor digitorum brevis which make pressure on ulnar side 5<sup>th</sup> metacarpus<sup>81</sup>. 2nd most common widespread musculoskeletal structural variants is an accessory abductor digiti minimi muscle which is found in quarter of specimens<sup>82</sup>. Additionally, in Guyon canal there are several aberrant muscles which have a different origin as fascia of the forearm, carpal bone special pisiform, flexor retinaculum, long tendon of the anterior compartment of forearm; Furthermore, hypothenar muscles, flexor retinaculum, or the upper end of 5th metacarpus is the distal attachments of these abnormal muscles. Sometimes, the atypical muscle and abductor digiti minimi fuse and are named as accessory abductor digiti minimi<sup>83</sup>. Various researches analysis peripheral neuropathy due to compression by an aberrant hypothenar muscle<sup>84</sup>. Thus, it must be noted that the anatomical differences must be known and familiar by the surgeons, which is important to avoid clinic incorrect diagnosis and other surgical complication<sup>85</sup>. The

anconeusepitrochlearis or “epitrochleoanconeus” muscle, which is one of a typical musculi that takes its derivation from the medial epicondyle of the brachium as an extension from inside head of “triceps brachii muscle” of arm and end in olecranon process of the ulna as a distal attachment<sup>86</sup>. The later traverses the ulnar nerve superficially after crossing hindmost cubital canal<sup>87</sup>. However, during action of elbow joint cubital channel dimension minimizes as result atypical “anconeus epitrochlearis” musculi can squeeze the ulnar nerve in the cubital channel also thickening of this atypical muscle cause the same problem. It is believed that the retinaculum of cubital tunnel is a remnant of supernumerary muscle “anconeus epitrochlearis” Its incidence may range from 1% to 25%<sup>88-89</sup>. One exceptionally rare case of coracobrachialis longus muscle, which represented an extremely rare variation named the humeroepitrochlearis, its beginning from from the apex of a hook-shaped

bone called “coracoid process” to end on medial epicondyle of the humerus<sup>90</sup>. Various variations of humeroepitrochlearis are described, generally in ancient anatomical texts, many names used to define them that confused both surgical doctor and anatomists. To facilitate the description of differences and terminology, Georgiev et al., classified these atypical muscles into Brevis, which attaches to the upper part of the humerus, and the longus musculi, which attaches to lower humerus end. Several authors reported coracobrachialis musculi disparities. researchers., propose that the coracobrachialis have triceps brachii muscle “Brevis, normal, and coracoepitrochlearis muscle” at the same time quadriceps of coracobrachialis longus muscle that takes attachment from coracoid process has been discovered by other authors<sup>91</sup>. Various revisions studied morphological disparities of the coracobrachialis muscle which involved addition slips connection to epicondyle; supracondylar crest; intermuscular fascia of medial



aspect of the humerus<sup>92-93</sup>. This variation is very important since it correlated with several nerve compression as musculocutaneous, median and ulnar nerve, moreover a coracobrachialis longus squash on the ulnar nerve alongside of medial epicondyle<sup>94</sup>. The rare anatomical pathway of the ulnar nerve was first defined by author that found the occurrence of a small ulnar vessels in Guyon's canal which produced distant atrophy of the ulnar nerve, where patients suffered from loss of sensation in the ulnar fingers and atrophy of the back muscle<sup>95-96</sup>.

#### 7. compression of radial nerve (nervus radialis)

The nervus radialis is considered the major nerve of brachial plexus and it has a long path in which the nerve is exposed to pressures from the neighboring structures from its origin to its terminal branches<sup>97</sup>. Compression of the nervus radialis occurs when it routes from the axillary region toward the back of arm throughout the wedge-shaped interval. Nervus radialis cross over

the latissimus dorsi tendon before it turns back into space to reach a spiral groove in which anatomical squeezing can happen by the hypertrophy of teres major which bounded the superior margin of the lower triangular space from behind. An increase in the growth of teres major muscle cells will create an extrinsic quantity effect on the neurovasculature structure, especially the nervus radialis that cross underneath it. Patient suffered from serious transient Quadriplegia due to injury of peripheral nerves and this problem was simply solved just as the dissection of inferior boundary of muscle by surgical operation<sup>97</sup>.

After the radial axons cross axillary region runs throughout radial groove. in several cases, fibrous arches become constricted and cause a limited passageway for the nervus radialis which leads to squeezing the nervus radialis during muscular extension and nervus radialis paralysis may be present<sup>98</sup>. The lateral inter-muscular fascia (septum) is another place in which scientists

have discovered a rare but important cause of squeezing the radial nerve where it penetrates a defect with one cm in diameter in the lateral muscular fascia as *nervus radialis* travels from extensor to flexor section or at the lower end of spiral groove the radial nerve pierces the lateral intermuscular septum and enters in to anterior compartment of the arm to reach anterior aspect of lateral epicondylar<sup>99</sup>.

Surgeons should keep in mind when treating cases of radial neuropathy the rare anatomical differences such as unusual attachment of the *brachioradialis* muscle. In normal circumstances, later muscle fix to the radial aspect of supracondylar edge some time deviation from normal can occur, and *brachioradialis* initiated from acromion as an alternative of *brachium* and fusions with the usual *brachioradialis musculi* at this point *nervus radialis* may be subjected to compression in the anterior compartment of the arm as it passes through out a narrow tunnel

originated from its fiber and fiber of *biceps muscle*<sup>100</sup>. At cubital fossa, when radial nerve comes to be anterior to lateral epicondylar, entrapment of nerve may occur under the atypical trifurcated of “*extensor carpi radialis longus*” as lateral, intermediated, however the “*extensor carpi radialis longus muscle*” connected with crest of lateral edge in supracondylar<sup>101</sup>. Furthermore, muscular medial head will unit with the “*extensor carpi radialis Brevis*” while lateral plus intermediated heads fused to form tendon of second metacarpal bone. As mentioned above the extra head of *biceps cubiti* muscle is important in clinically application because of its influence on neurovascular bundle the compression of radial nerve occurs in narrowing zone underneath greater bony tubercle in humerus in addition *biceps brachii muscle*<sup>102</sup>. Moreover, atypical accessory belly which is form extension of pronator muscular tissue producing sustained squeezing on the radial nerve<sup>103</sup>. Different in histological instituted of Frohse arcade and fibrous edging of

the “Extensor carpi radialis brevis” was important clinically as well as emphasized to probability of causing radial nerve(deep branch)neuropathy<sup>103-104</sup>.

In previous years, there are many authors who have done anatomical and surgical studies on the structure of the Froese arcade and distal margin of the musculus supinator, and its influence on nervus radialis compression they found that the Frohse arcade and the upper distal upper margin have many different form, in the majority of cases was a well-developed fibrous fiber while in other one's was muscular tendinous in structure recent study recommends that the structural changes in anatomical components of arcade forms at superficial supinator musculus head is aging process because of recurrent pronation and supination activities of the antibrachium (forarm). Other research on cadavers indicated that the constitution of the Frohse arcade may be membranous in halve of its sample study<sup>105</sup>. Nuropathy of the

“anterior interosseous nerve” might happen anywhere along its path, but most of the compresion occure close to their origin. The common reason for compression comprise vascular deviation, , muscularis variance , muscular tendone with its fibrous bands of deep pronator muscular head, flexor digitorum sublimis, and humerus connective tissue fascia <sup>105</sup>. Therefore, all modern possibilities of assessment, analysis, and a differential diagnosis must be taken for the correct and accurate treatment. This will take into account possibilities of tissue damage, due to the structural anomalies which surrounding the terminal nerves of brachial plexus, and modify function of nerve affected. whereas this text accomplished, There are many research studies and articles that deal with the subject of neuropathy, and its impact on neighboring deformed structures. Therefore, knowing the anatomical differences has a great impact on correct and early diagnosis, and then effective treatment and preventing the condition from getting worse<sup>106</sup>.

**Conclusion:**

A condition in which a nerve becomes compressed, or entrapped, between two other structures in the body are a communal complaining outpatient how they review medical consultation. Sometimes these cases are easy to diagnose and treat, but in another one, the judgment is very complex and requires accurate and complete knowledge of anatomy with its abnormalities and possible

modifications that occur in the muscular structure, ligament aponeurosis, tendon, and bony tissues and their relationship to the nerve pathway. This requires accurate knowledge of general or uncommon anatomical differences with general respected guidelines that must be followed in case of nerve compression and their clinical application

Table 1. neuropathy of brachial plexus with clinical presentation (Mathias et al.,2021)

Nerve	Anatomical Variation	Clinical presentation
Suprascapular Nerve	variation of the ossified suprascapular ligament different type of suprascapular notches, U-shaped, J-shaped , V-shaped , W-shaped notch suprascapular notch and absence of notch	Suprascapular Neuropathy Scapular dyskinesia
Median Nerve	Insertions of the Gantzer muscle in the flexor digitorum superficialis and the braquialis fascia. Anomalous Innervation of the median nerve in the arm : the absence of the musculocutaneous nerve. Origin of the anterior interosseous nerve in the space between the arc of the flexor digitorum superficialis and the teres pronator and proximal to this point. Gantzer muscle. Accessory brachialis muscle. Palmaris profundus muscle. A biventred first lumbrical extending into the carpal tunnel combined with bilateral fifth superficial flexor digitorum tendon regression. Pronator teres distal insertions. Struthers' ligament Gantzer muscle Axillary Arch Supracondylar Process	Carpal tunnel syndrome. Flexor paralysis of the arm or sensory loss in the lateral forearm. Nerve entrapment syndromes of the anterior interosseous nerve. Median or anterior interosseous nerve entrapment. Median nerve entrapment Neuropathy of the median nerve Carpal tunnel syndrome Median nerve entrapment Median nerve entrapment Median or anterior interosseus nerve entrapment Median nerve entrapment Median nerve entrapment
Radial Nerve	Accessory head of the extensor carpi radialis longus muscle merging with the extensor carpi radialis brevis muscle. Aberrant course of superficial radial nerve in the forearm that perforates the brachioradialis tendon to become subcutaneous. Muscular elevator of the latissimus dorsi tendon. Axillary Arch	Radial syndrome and epicondylalgia. Waterberg syndrome. Radial Nerve entrapment  Radial nerve entrapment
Musculocutaneous Nerve	Four-headed biceps brachii.	Musculocutaneous nerve entrapment
Ulnar Nerve	Epitrochlear anconeus. Accessory Abductor Digiti Minimi. Epitrochlear anconeus. Accessory extensor digitorum brevis. Accessory abductor minimidigitimanus muscla. Accessory belly of the flexor digitiminimi.	Ulnar nerve entrapment. Compressive neuropathy of the ulnar nerve. Ulnar nerve entrapment. Guyon tunnel syndrome Guyon tunnel syndrome Ulnar nerve entrapment
Axillary Nerve	Muscular elevator of the latissimus dorsi tendon	Axillary nerve entrapment
Other nerve root/trunks structures entrapments	Cervical Rib Axillary Arch	Thoracic Outlet Syndrome Thoracic Outlet Syndrome





Fig. 1 Photos of the scapulae showing the types of suprascapular notch<sup>107</sup>.

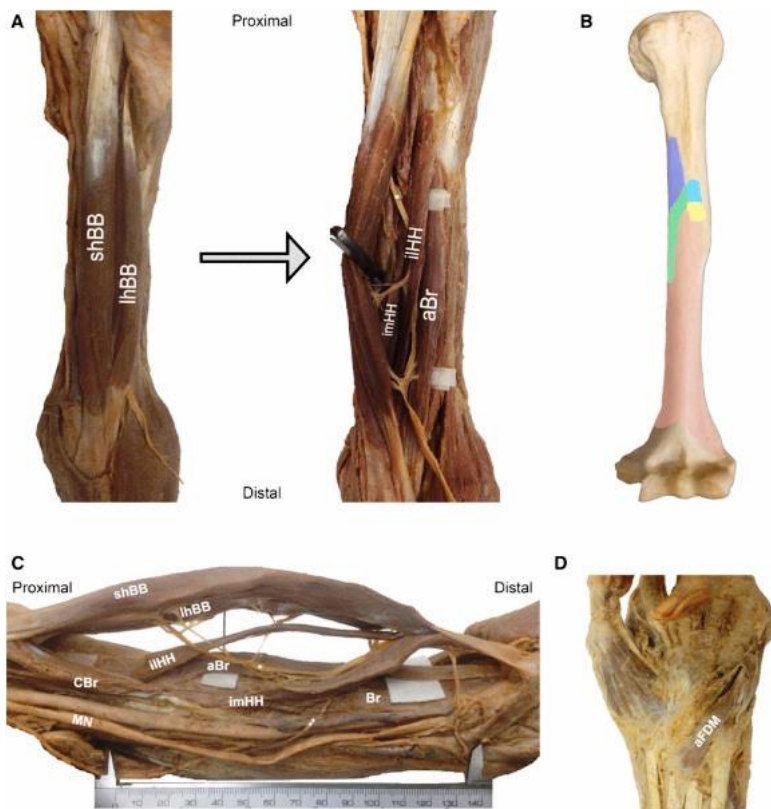


Fig. 2 Cadaveric upper limb depicting the four-headed biceps brachii and other variant musculature identified in the arm and hand. a Reflection of the short (shBB) and long (lBB) heads of the biceps brachii exposing the infero-medial (imHH) and infero-lateral (ilHH) humeral heads of the biceps brachii and the accessory brachialis (aBr), b Spatial relationships of the variant musculature (aBr yellow, imHH green, ilHH light blue) with respect to the brachialis origin (Br pink) and coracobrachialis insertion (eBr dark blue). c Variant innervation pattern consisting of a communication branch between the median (MN) and musculocutaneous (MIN) nerves. d Accessory flexor digiti minimi brevis (aFDM) located in the palm<sup>47</sup>.



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