

## BLOOD SUPPLY AND INNERVATION OF CLAVICLE BONE

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**Abstract:** The clavicle bone is interesting with its horizontal position and with S shaped form. Another fact that makes the clavicle bone to stand out of other bones of axial skeleton is its periosteal ossification. The knowledge of these bone blood supply is really important, because the most frequent choice of implant fixation is open reduction and internal fixation. The surgical procedure is made with plate and screws. If the surgeon makes the perfect reposition and fixation from Biomechanical point of view, but harms the periosteum and blood supply of the bone this will cause a fracture non healing. This research is focused above blood supply and innervation around the clavicle bone. If the operation technique is successful and there is bone healing, which is proved by bone healing seen on X-Rays and there is injury of the supraclavicular nerves, the patient will not be satisfied from the procedure. This investigation focuses on the vessel and nerve supply of the bone to help the practitioner of better understanding, so they can improve their results in the clinical filed. For this research the articles from PubMed are used, and the Anatomy books. All the articles were specially oriented in vessel and nerve anatomy around the clavicle. The results are systemized in two parts: first is oriented on the vessels and nerves around the clavicle bone and the second part is especially for the blood and nerve supply of the bone. Arteria subclavia, Vena subclavia, Plexus brachialis, the blood supply to the clavicle bone, nervi supraclaviculares, the lateral pectoral nerve and subclavian nerve are examined. With clinical value is the position of the supraclavicular nerves, because they are on the way of the surgical approach and easily can be damaged. It is important knowing the surgical anatomy of the clavicle and surrounding structures to provide the successful surgical approach and good outcomes of the surgical procedure and to fulfil the patient's requirements. The distance between the neuro-vascular bundle and the clavicle bone and also the angle they are positioned against each other is from great importance for avoid iatrogenic injury of the neuro-vascular structures during surgical procedures. The surgeon must pay attention not only with the orientation of the drill bit, but also of the penetration of the second cortex of the bone. Another anatomical details that must be taken in mind is the position of nutrition foramen so not disturbed the biology of the bone during osteosynthesis. In the literature the different authors report the different position of the nutritive foramen of clavicle bone. A cadaveric study on embalmed human clavicles concludes that in 94.64% of cases the dominant foramen is located in the middle third. Other based on computed tomography images shows that the nutrient foramen is mostly located closer to the sternal end of the bone. There is need from more evidence-based investigation in this area to clarified the correct information.

**Keywords:** clavicle, anatomy, blood supply, innervation

### 1. INTRODUCTION

The clavicle bone is interesting with its horizontal position and with S shaped form. Another fact that makes the clavicle bone to stand out of other bones of axial skeleton is its periosteal ossification. The knowledge of these bone blood supply is really important, because the most frequent choice of implant fixation is ORIF Open reposition and internal fixation is with plate and screws. If the surgeon makes the perfect reposition and fixation from Biomechanical point of view, but harms the periosteum and blood supply of the bone this will cause a fracture not healing. This research is focused above blood supply and innervation around the bone. If the operation technique is successful and there is bone healing, which is proved by bone healing seen on X-Rays and there is injury of the supraclavicular nerves, the patient will not be satisfied from the procedure. This investigation focuses on the vessel and nerve supply of the bone to help the practitioner of better understanding, so they can improve their results in the clinical filed.

### 2. MATERIALS AND METHODS

For this research the articles from PubMed are used, and the Anatomy books. All the articles were specially oriented in vessel and nerve anatomy around the clavicle.

### 3. RESULTS

The results are systemized in two parts: first is oriented on the vessels and nerves around the clavicle bone and the second part is especially for the blood supply of the bone.

Vital vascular-nervous structures are located directly below the M. subclavius and above the first rib: Arteria subclavia, Vena subclavia, and Plexus brachialis. Some studies show that the neurovascular structures are at a very close distance to the middle third of the clavicle 17.02 mm. The knowledge of their relationship the bone is in big importance for screws placement.(Sinha, Edwin, Sreeharsha, Bhalai, & Brownson, 2011)

**Arteria subclavia** - on the right it starts from the truncus brachiocephalicus, and on the left it is a direct branch of the aortic arch. For this reason, the left subclavian artery is longer than the right. The artery curves around the dome of the pleura, forming an upwardly convex arch. Further, it passes along the upper surface of the first rib along the sulcus arteria subclavia. Passing through a space enclosed by the anterior and middle mm. scaleni. After leaving this space, it passes under the clavicle and, entering the axillary fossa, continues its course as A. axillaris.

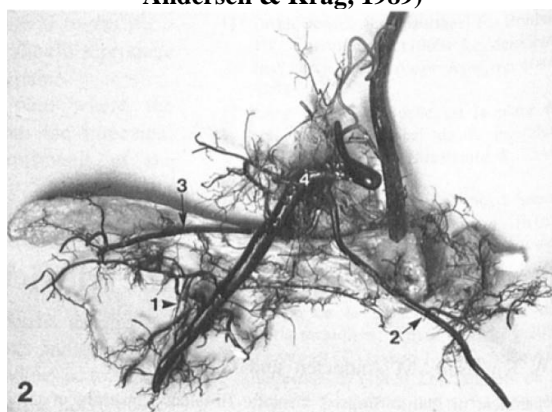
**Vena subclavia** – each subclavian vein is a continuation of the Vena axillaris and moves along the upper surface of the first rib, along the medial edge of M. scalenus anterior. It then continues its course merging with the internal jugular vein and forming the Vena brachiocephalica. The subclavian vein runs parallel to the subclavian artery throughout its length. The two vessels are separated by the insertion of the M. scalenus anterior. Thus, the Vena subclavia lies in front of the M. scalenus anterior, while the Arteria subclavia is located on its posterior surface and in front of the M. scalenus medius. The left Vena subclavia, in addition to venous outflow, it also drains lymphatic outflow.

**Plexus brachialis** - it is located between the anterior and middle scalene muscles (spatium interscalenum) in the supraclavicular space. Entering below the clavicle, it remains on the upper-posterior side of the Arteria subclavia and is crossed anteriorly by the lower abdomen of m. omohyoideus. With its lower part, it lies in the axillary fossa (Fossa Axillaris), where its three bundles are located on the back, lateral and medial sides of the Arteria axillaris. According to its location, the plexus is divided into two parts: supraclavicular Pars supraclavicularis and subclavian Pars infraclavicularis.

#### **Blood supply to the bone**

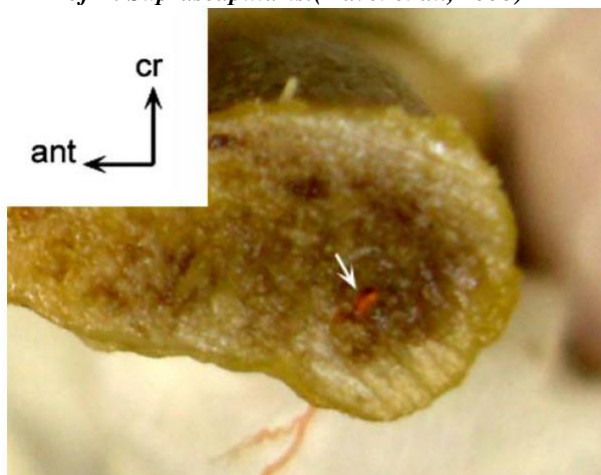
Most Anatomy textbooks describe the blood supply to the clavicle as primarily periosteal. According to an anatomical study by Knudsen, Arteria Suprascapularis provides the main blood supply to the clavicle except for the sternal 1/5. (FW Knudsen, Andersen & Krag, 1989) (Fig.1) Relative to the clavicle, it is positioned on the postero-inferior surface and enters through a main nutritive foramen. Other arteries that contribute to the bone's blood supply are Arteria thoracoacromialis, which provides blood supply to the lateral 4/5, located on the inferior-anterior surface of the clavicle.(FW Knudsen, Andersen & Krag, 1989) Many variations are observed in the terminal branches. However, the blood supply area is always constant. Mamilaris gives a branch for the sternal end.

**Fig.1 A Thoracoacromialis; 2 A. mamilaris; 3. A. Suprascapularis; 4. Truncus thyrocervicalis;(FW Knudsen, Andersen & Krag, 1989)**

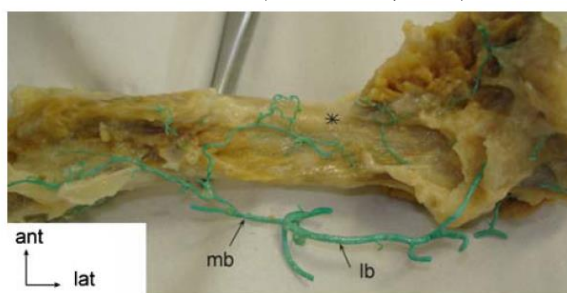


Another anatomical study by Eric Havet (Havet, Duparc, Muller, Delas, & Fréger, 2008)(Fig 2,3,4) reported similar results. He proved that the main blood supply in the diaphyseal part of the bone is periosteal. It is carried out by two main branches - a. thoracoacromialis, with its two branches (medial and lateral) and A. suprascapularis, which gives one periosteal branch and one branch that supplies blood to the sternal end of the bone. A. Suprascapularis enters the bone through a dominant nutritive foramen. In the same study, the presence of an intraosseous artery was reported in only 4 of 17 cases.

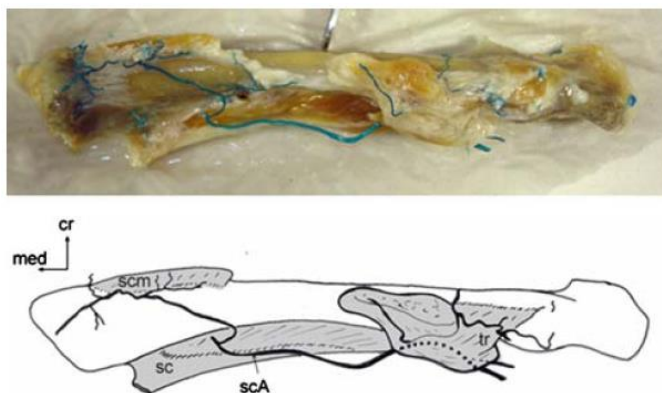
**Fig.2 Left clavicle osteotomized 5 mm lateral to the nutritive foramen well demonstrating the inside bone branch of A. Suprascapularis.(Havet et al., 2008)**



**Fig.3 Anastomosis between the medial and lateral branch of a thoracoacromialis. Mb – medial branch, lb = lateral branch.(Havet et al., 2008)**

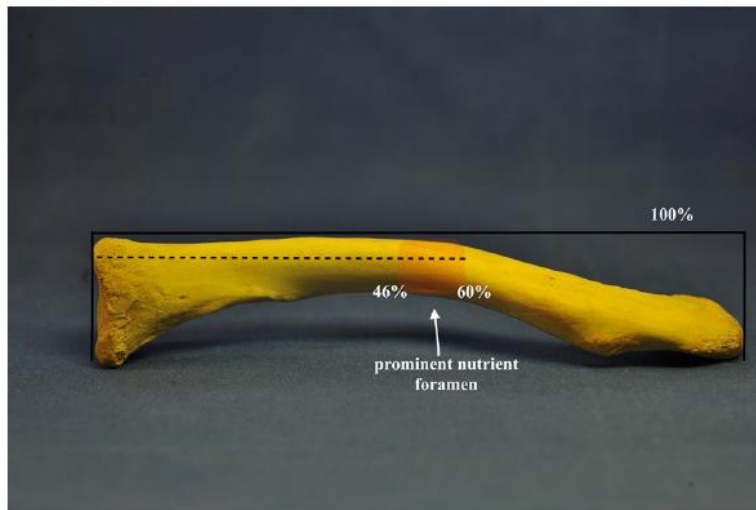


**Fig.4 Photograph of the left clavicle showing the periosteal branch of the suprascapular artery moving to the attachment sites of m. cleidosternomastoideus and m. trapezius.(Havet et al., 2008)**



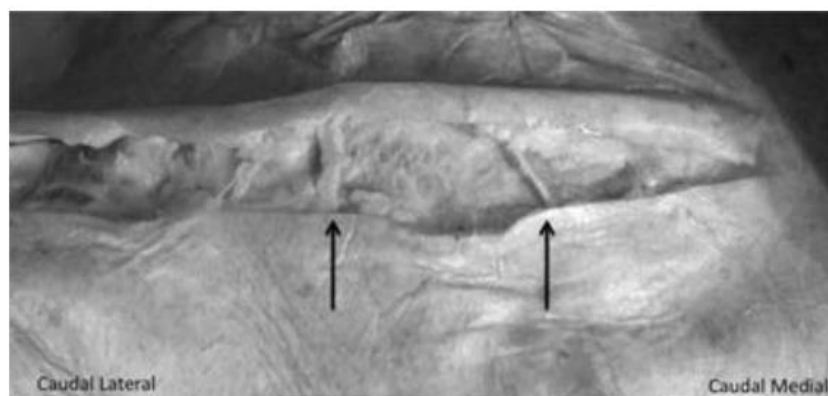
In a study by Tim Leschinger (Leschinger et al., 2018), a dominant foramen was found in the majority of cases, 300 of 317 (94.64%). In 287 out of 300 (95.7%) it is located in the middle third. In the same study, a topographic orientation is given for the area where the nutritive foramen is located Fig.5.

*Fig.5 Red zone is the place where is situated the nutritive foramen.(Leschinger et al., 2018)*



**Nervi supraclaviculares**- they start from the nerve roots of C3, C4. They separate from a common truncus which runs on the posterior border of M. sternocleidomastoideus. Normally they are 3 branches-anterior, middle and posterior.(Nathe, Tseng, & Yoo, 2011) They cross the clavicle on the front surface and are at great risk, because are on the way of the surgical approach to the clavicle. Injury of these nerves can cause an area of numbness on the anterior chest wall. An unpleasant complication is also the formation of painful neurinomas. For this reason, during soft tissue dissection, it is recommended to identify these nerves and preserve them. Some authors describe a safe zones on the two ends of the bone where the never appear and can't be affected during operations.(Nathe et al., 2011)(Fig.6). (Lorsuwannarat & Jirangkul, 2023). Clinical studies conclude than sparing the nerves result in significantly less numbness following clavicle ORIF but does not affect patient reported functional outcomes.(Huang et al., 2021)(Hu, Su, & Chien, 2023). An anatomic variation in which the nerves pass through osseous tunnels in the clavicle must also be considered.(Natsis, Totlis, Chorti, & Karanassos, 2015)

*Fig.6 Demonstrates the position of the supraclavicular nerves on the path of surgical approach (cadaveric study)(Nathe et al., 2011)*

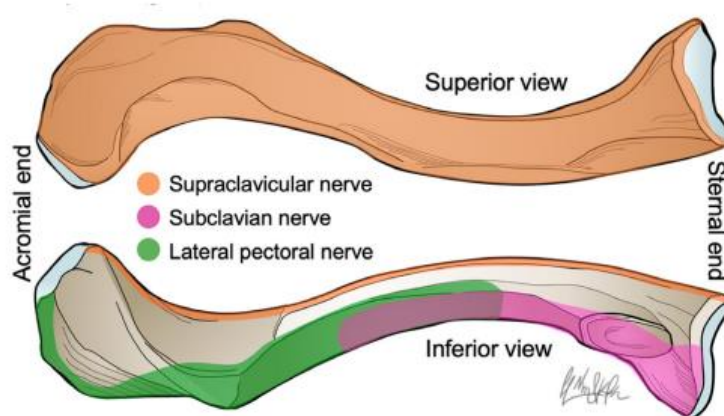


The **lateral pectoral nerve** (C5, C6, C7) typically arises as the most proximal branch of the lateral cord of the **brachial plexus**, immediately above or deep to the **clavicle**. From its origin, the nerve runs anteriorly across the **axillary artery** and **vein** towards the pectoral muscles. Shortly after emerging from the **lateral** cord, the lateral pectoral nerve sends a communicating branch to the **medial pectoral nerve**. This communicating branch forms a loop known as **ansa pectoralis**, which runs anterior to the first part of the axillary vessels, contributing nerve fibers that supply the

pectoralis minor muscle. The lateral pectoral nerve supplied the caudad aspect of the clavicle (middle and lateral thirds)(Leurcharusmee et al., 2021)

The **subclavian nerve (C5, C6)** also known as the **nerve to subclavius** is a small branch from the upper trunk of the brachial plexus that arises from the point of junction of the fifth and sixth cervical nerves. (Fig.7) The subclavian nerve descends anterior to the brachial plexus and subclavian vessels to innervate the subclavius muscle. Subclavian nerve innervates caudal and dorsal aspects of the clavicle(middle and medial thirds).(Leurcharusmee et al., 2021)

**Fig.7 Areas of the clavicle innervated by the supraclavicular (orange), subclavian (pink) and lateral pectoral (green) nerves.(Leurcharusmee et al., 2021)**



#### 4. DISCUSSION

In the literature the different authors report the different position of the nutritive foramen of clavicle bone. A cadaveric study on embalmed human clavicles conclude that in 94.64% of cases the dominant foramen is located in the middle third.(Leschinger et al., 2018) other based on computed tomography images shows that the nutrient foramen is mostly located closer to the sternal end of the bone.(Vatansever & Demiryürek, 2020) There is need from more evidence-based investigation in this area to clarified the correct information.

#### 5. CONCLUSION

It is important knowing the surgical anatomy of the clavicle and surrounding structures to provide the successful surgical approached and good outcomes of the surgical procedure and to fulfil the patient's requirements. In the literature the different authors report for the different position of the nutritive foramen of clavicle bone. There are need from more evidence-based investigation in this area to clarified the correct information.

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