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MAPPING THE MORPHOLOGY OF NUTRIENT FORAMEN IN CLAVICLES OF ADULT HUMANS

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ABSTRACT

Introduction: The clavicle helps in weight transmission from the upper limb to the skeleton and is a long bone. The nutrient foramen is characteristic of long bones through which the nutrient artery pass which is the main blood supply source in fetal life, the ossification phase, and the active growth period. The nutrient foramen is at the lateral end of the subclavian groove and runs in the lateral direction.

Aims: To assess the direction, number, and location of the nutrient foramen in the clavicles of adult humans.

Materials and Methods: 100 adult human clavicles from cadavers of unknown age and gender from the Anatomy department were assessed to note the direction, number, and position of the nutrient foramen using the magnifying lens. The data were assessed to form the results.

Results: The included 200 clavicles were 100 from the left and 100 right sides and nutrient foramen was seen in 194 clavicles where 96 were from the left side and 98 from the right side. One single foramen was noted in 160 subjects including 78 on left and 82 on the right side. Two foramina were seen in 34 clavicles with 18 from the left and 16 from the right-side clavicle. No nutrient foramen was seen in 6 clavicles where 4 were constituted by the left side and 2 from the right side. All noted nutrient foramen were towards the acromial end.

Conclusion: The understanding of nutrient foramen variations in human clavicles is vital during surgical modalities including microsurgical vascularized bone transplantation and the use of bone grafting.

Keywords: Bone Graft, human clavicle, nutrient canal, Nutrient Foramen.

INTRODUCTION

The human clavicle is a long bone that is a modified bone. The clavicle is the only long bone that has horizontal placement and is subcutaneous at the neck root.[1] The clavicle helps in transmitting the weight from the upper limb to the axial skeleton. In all the long bones, the nutrient foramen is the largest of all foramen allowing the passage of nutrient arteries through it. The structures passing through the nutrient foramen are the nutrient foramen artery and occasionally the supraclavicular nerve.[2]

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The principal media for blood supply to the long bones is the nutrient artery. The nutrient artery plays a vital role in providing blood supply to the long bones during fetal and embryo life, the early phase of ossification, and the active growth period of the bone.[3]

The clavicle has a shaft, which is a cylindrical part of the bone seen at two ends of the bone namely medial and lateral. The shaft of the clavicle is divided into medial two-thirds and lateral one-third parts.[4] A subclavian groove is present on the inferior surface of the shaft of the clavicle and the nutrient foramen is present on the lateral end of the subclavian groove. The nutrient foramen runs in the lateral direction.[5]

A comprehensive understanding of the nutrient foramen is vital during surgical modalities including the placement of internal fixation devices, bone transplantation, and free vascularized bone grafts. It is also clinically vital to understand the neurovascular foramina of the human clavicle as these have a role in supraclavicular nerve entrapment syndrome.[6,7] The present study aimed to assess the variations in direction, number, and position of the nutrient foramen in human adult clavicles.

MATERIALS AND METHODS

The present study aimed to assess the variations in direction, number, and position of the nutrient foramen in human adult clavicles. The present study was carried out at the Department of Human Anatomy of the Institute.

For the present study, 200 clavicles were collected from the Department of Anatomy. The collected clavicles were from an unknown gender and age. After collection, the clavicles were assessed for gross evaluation to detect any notable pathology or deformity in the clavicle that could have masked or affected the nutrient foramen.

After the final inclusion of the clavicle, they were assessed macroscopically for the direction, number, and position of the nutrient foramen. To evaluate the nutrient foramen in the included clavicles, a magnifying glass was used. The data gathered were analyzed statistically and tabulated to form the results.

RESULTS

The included 200 clavicles were 100 from the left and 100 right sides and nutrient foramen was seen in 194 clavicles. Nutrient foramen was seen in 194 clavicles where 96 were from the left side and 98 from the right side. One single foramen (Figure 2) was noted in 160 subjects including 78 on left and 82 on the right side. Two foramina (Figure 1) were seen in 34 clavicles with 18 from the left and 16 from the right-side clavicle. No nutrient foramen (Figure 3) was seen in 6 clavicles where 4 were constituted by the left side and 2 from the right side. All noted nutrient foramen were towards the acromial end as shown in Table 1.

It was seen that in the nutrient foramen of the right side, in the lateral 1/3rd 90 foramina were in the posterior part (Figure 5), and none on the inferior or superior part (Figure 4), and the medial 2/3rd surface, 8 foramina were on the inferior part and none on superior or anterior part (Figure 6) making a total of 98 foramina on the right side. Concerning the nutrient foramen on the left side, on the lateral 1/3rd, 80 foramina were seen on the posterior part, none on the superior, and 2 on the inferior part (Figure 7).. However, on the medial 2/3rd, 22 foramina were seen on the inferior surface and none on the anterior or superior surface. For the total foramina, on the lateral 1/3rd part, 170 foramina

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were seen on the posterior part and 2 on the inferior part, whereas, on the medial 2/3rd surface, 22 foramina were seen on the inferior part as depicted in Table 2.

DISCUSSION

In the long human bones, the nutrient foramen is considered the largest foramen which is located on the shaft of the long bones. The structure passing through the nutrient foramen is the nutrient artery that plays a vital role in providing nutrition to growing bones in fetal life and the growth and ossification phase. The blood supply via nutrient artery also helps in the healing of the fractures in the long bones as reported by pioneer studies of Johnson W[8] in 1927. The nutrient foramen marks the external opening of a canal known as the nutrient canal. The location of the nutrient canal and its opening, the nutrient foramen is particular for each bone and anatomic and morphologic variations can be seen in their location as suggested by Murlimanju BV[9] in 2011.

Chatrapathi DN[10] in 1965 reported that the main source of blood supply to the long bones is the nutrient artery and has a vital role in the growth of the long bones especially during the early phases of bone ossification and during the active growth period of the long bones. Henderson RG[11] in 1978 suggested that in mammalian bones the nutrient arteries pass through the nutrient foramen. However, the passage of nutrient arteries through the nutrient foramen has varied locations and routes which can change during the growth process.

The results of the present study showed that Nutrient foramen was seen in 194 clavicles where 96 were from the left side and 98 from the right side. One single foramen was noted in 160 subjects including 78 on left and 82 on the right side. Two foramina were seen in 34 clavicles with 18 from the left and 16 from the right-side clavicle. No nutrient foramen was seen in 6 clavicles where 4 were constituted by the left side and 2 from the right side. All noted nutrient foramen were towards the acromial end. These results were consistent with the previous study of Dinesh K et al[12] in 2017 where the authors reported results similar to the present study.

It was also noted from the results of the present study that in the nutrient foramen of the right side, in the lateral 1/3rd 90 foramina were in the posterior part, and none on the inferior or superior part, and the medial 2/3rd surface, 8 foramina were on the inferior part and none on superior or anterior part making a total of 98 foramina on the right side. Concerning the nutrient foramen on the left side, on the lateral 1/3rd, 80 foramina were seen on the posterior part, none on the superior, and 2 on the inferior part. However, on the medial 2/3rd, 22 foramina were seen on the inferior surface and none on the anterior or superior surface. For the total foramina, on the lateral 1/3rd part, 170 foramina were seen on the posterior part and 2 on the inferior part, whereas, on the medial 2/3rd surface, 22 foramina were seen on the inferior part. These results were in agreement with the previous studies of Rai R[13] in 2014 and Maitrayee M et al[14] in 2017 where authors also reported the most common location for nutrient foramen as the posterior surface which was also seen in the results of the present study.

The clavicle is the main source of harvesting the bone in cases needing the bone graft procedure, it is vital to have an understanding and knowledge to localize the nutrient foramen to avoid any compromise to the circulation to the bone. In the present study, maximum nutrient foramina were seen on the medial 2/3rd part of the clavicle which was comparable to the results of the study by Prasad KRS et al[15] in 2016 where the authors confirmed the findings of the present study. In all the

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clavicles assessed for the present study, nutrient foramen was directed towards the acromial end. This was in line with the studies of Malukar O et al[16] in 2011 where the assessed nutrient foramen was directed towards the acromial end. However, these results were in contrast to the study of Maitrayee M et al[14] in 2017where the direction of the nutrient foramen was found towards the sternal end in nearly 4% of the clavicles.

CONCLUSION

Considering its limitations, the present study concludes that in most of the clavicles, the nutrient foramen is single and is located on the posterior surface. All nutrient foramina are directed towards the acromial end suggesting that the sternal end is the growing end. It is vital to have a comprehensive knowledge and understanding concerning the anatomical variations of a nutrient foramen in clavicles as it is of importance in surgical interventions including microsurgical vascularized bone transplantation and/or bone grafting.

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TABLES

S. No	Number of foramina	Left	Right	Total
1.	**Two**	18	16	34
2.	**One**	78	82	160
3.	**None**	4	2	6

Table 1: Number of nutrient foramina in the clavicles of study participants

S. No	Clavicle side	Lateral 1/3rd			Medial 2/3rd			Total
		Posterior	Superior	Inferior	Superior	Inferior	Anterior	
1.	**Right**	90	-	-	-	8	-	98
2.	**Left**	80	-	2	-	14	-	96
3.	**Total**	170	-	2	-	22	-	194

Table 2: Position of nutrient foramina in the clavicles of study participants

ATLAS

Figure 5: Nutrient foramen on posterior clavicle

Figure 6: Nutrient foramen on anterior clavicle

Figure 7: Nutrient foramen on inferior surface of clavicle