Original article:

An osteological study of the nutrient foramina of human clavicle

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Abstract:

Our study comprised of 54 dry human clavicles collected irrespective of age and sex obtained from North Bengal Medical College, Murshidabad Medical College.There were 30 (55.56%) left sided clavicle and 24 (44.44%) were right sided clavicle. The aim of our study was to observe macroscopicallythe number, location and direction of nutrient formina. Forminal index was calculated using Hughes formula. In our present study single foramina was present in 53.70% clavicles. Maximum number was present in the middle third and on the posterior surface (59.76 %). The average forminal index was 47.65. Majority of the formina were directed towards the acromial end which showed that sternal end of the clavicle was the growing end and followed the laws of ossification. Only two foramina were directed towards sternal end. The knowledge of the nutrient foramina is essential in some surgical procedures like placement of internal fixation, in vascularised bone graft and also to preserve arterial supply during radiation therapy.

Key words: Nutrient foramina, clavicle, Foraminal index, bone grafting.

Introduction:

Human beings are bestowed with the power of bipedal locomotion and the clavicle acts as a strut to allow the free movement of the upper limb away from the chest wall[1]. The clavicle (the Latin word which means 'small key'[1]meets the axial skeleton at the sternoclavicular joint[2]. It is like the letter 'f' and its curvature is such that its medical two-third is convex forward (antecurve) and lateral third is concave forward (retrocurve)[3].The clavicle transmits forces from upper limb through the coracoclavicular ligament and medial two third of the bone to the axial skeleton[4].It has no homologue in pelvic girdle[4]. The clavicle or collar bone has some unique features in that it is the first bone to ossify in membrane and completes its ossification by about 25 years[5]. It is said to be a modified long bone as it has no medullary cavity, it placed horizontally and is membranous in ossification. It was described, that a small foramen present in the middle third of the clavicle and it transmits nutrient artery, branch of suprascapular artery. In contrast Knudsen et al repoted that clavicle is supplied by periosteal arteries [6]

Aim of the study:

To study the number, direction, position of the nutrient foramina of dry human clavicle and correlate them with surgical procedures and in some therapeutic procedures like radiation therapy where there is need to preserve the arterial supply.

Materials and Methods:

The materials required were dry human clavicles, magnifying glass, thread, scale, stiff wire. The dry human clavicles of unknown age and sex were collected from Department of anatomy of North Bengal Medical College, Murshidabad Medical College. The damaged and deformed bones were excluded from the study. With the aid of magnifying glass and stiff wire the number position and direction of the nutrient foramina were determined.

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A measuring scale was used to measure the total length of the clavicle (L) and the distance from the sternal end and measured (D) to determine the foraminal index by applying Hughes formula [7]

Forminal index = D/L X100

Data was recorded in tabulated sheets and analysed.

Results: In our study, maximum length of the clavicle is 16cm. Minimum length of clavicle 10.8cm. Maximum length of the foramina from sternal end is12cm, minimum length of the foramina from sternal end is 1.3cm. In our present study average length of the clavicle was 13.53cm, average distance of the foramen form the sternal end was 6.46cm and mean forminal index was 47.65. Single foramen was present in 53.70% cases, double in 40.74% cases and more than two in 5.56%. Maximum number of foramina was present on the posterior surface (59.76%) and in the middle third of the clavicle. Majority of the nutrient foramina were directed towards the acromial end which followed the 'growing end theory' and hence the sternal end was regarded as the growing end[5]. 3.70% of the nutrient foramina were present towards the sternal end. Nutrient foramina were present in all the clavicles. Our study depicts the foramina on the posterior surface which contradicts the classical presentation on the inferior surface.

TALBE 1 NUMBER OF NUTRIENT FORAMINA

Number of Foramina	Number of Clavicles	Percentage
0	Nil	0%
1	29	53.70%
2	22	40.74%
3	3	5.56%

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TALBE II SURFACE OF LOCATION OF NUTRIENT FORAMINA

Surface	Number of Nutrient Foramina	Percentage
Superior	4	4.88%
Inferior	25	30.49%
Posterior	49	59.76%
Anterior	4	4.87%

TALBE III LENGTHWISE DISTRIBUTION OF NUTRIENT FORAMINA

Part of Clavicle	Number of Foramina	Percentage
Medial	14	17.07%
Middle	61	74.39%
Lateral	7	8.53%

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TALBE IV FORAMINAL INDEX

Number of clavicles	Length from Sternal end (D)	Total Length of Bone (L)	Foramen Index D _____X100 L
1	a) 7cm	12.5cm	a) 56
	b) 9.3cm		b) 74.4
2	8cm	15cm	53.33
3	7.5cm	13.5cm	55.55
4	a) 5cm	13.2cm	a) 37.88
	b) 8cm		b) 60.61
5	a) 8.2cm	13cm	a) 63.08
	b) 2.5cm		b) 19.23
6	7cm	13.5cm	51.85
7	8cm	12.2cm	65.57
8	a) 5.1cm	13.3cm	a) 38.35
	b) 7cm		b) 52.63
9	4.1cm	12cm	34.17
10	a) 7.2cm	11.2cm	a) 64.29
	b) 1cm		b) 08.93
11	7.3cm	12.3cm	59.35
12	a) 4.1cm	11.9cm	a) 34.45
	b) 7cm		b) 58.82
13	a) 6cm	11.4cm	a) 52.63
	b) 4.9cm		b) 42.98
14	a) 8cm	13cm	a) 61.54
	b) 4.5cm		b) 34.62
15	6.2cm	13.8cm	44.93
16	6cm	10.8cm	55.56
17	a) 17.2cm	13.2cm	a) 54.55
	b) 6.6cm		b) 50.00
	c) 4.2cm		c) 31.82
18	a) 4.5cm	13.5cm	a) 33.33
	b) 7.5cm		b) 55.56
19	a) 2cm	14cm	a) 14.29
	b) 2cm		b) 14.29
20	55.5cm	11.5cm	47.83
21	7.5cm	14cm	53.57
22	a) 10.5cm	14.5cm	a) 72.41cm

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	b) 7cm		b) 48.28
23	6cm	13.5cm	44.44
24	6.5cm	12.5cm	52.00
25	8cm	14cm	57.14
26	7.5cm	12.5cm	60.00
27	7cm	13cm	53.85
28	7.6cm	14cm	54.28
29	a) 2.3cm	15.2	a) 15.13
	b) 8.7cm		b) 57.23
30	a) 7.7cm	14.7	a) 52.38
	b) 1.6cm		b) 10.88
31	a) 5.9cm	14.7cm	a) 40.13
	b) 2.3cm		b) 15.64
32	4.9cm	12.6cm	38.88
33	8.1cm	14.6cm	55.47
34	8.1cm	12.7cm	63.77
35	a) 9.2cm	14.5cm	a) 63.45
	b) 5.5cm		b) 37.93
36	a) 1.3cm	14.8cm	a) 08.78
	b) 11.5cm		b) 77.70
	c) 12cm		c) 81.08
37	6cm	15cm	40.00
38	a) 8cm	16cm	a) 50.00
	b) 12cm		b) 75.00
39	8.5cm	13cm	65.38
40	9.5cm	15.3cm	62.09
41	7.5cm	13cm	57.69
42	7.6cm	14cm	54.28
43	a) 2.3cm	15.2cm	a) 15.13
	b) 8.7cm		b) 57.23
44	a) 7.7cm	14.7cm	a) 52.38
	b) 1.6cm		b) 10.88
45	a) 5.9cm	14.7cm	a) 40.13
	b) 2.3cm		b) 15.64
46	4.9cm	12.6cm	38.88
47	8.1cm	14.6cm	55.47
48	8.1cm	12.7cm	63.77
49	a) 5cm	13cm	a) 38.46
	b) 7cm		b) 53.85

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50	a) 3.5cm	15.4cm	a) 22.73
	b) 9cm		b) 58.44
51	a) 7.4cm	12.9cm	a) 57.36
	b) 6cm		b) 46.51
	c) 9.7cm		c) 75.19
52	9.5cm	13.5cm	70.37
53	6.6cm	13.8cm	47.83
54	a) 8.3cm	14.5cm	a) 57.24
	b) 4.2cm		b) 28.96

Discussion:

Nutrient foramina as the name implies are vital need for the growth of the bone. A knowledge of the position direction surface of nutrient foramina is essential and its variations should be noted as it may account for the altered growth of the bone. Nutrient foramina were present in all the clavicles we studied. In 54 clavicles that we studied we got 82 foramina. Out of these 82 foramina 74.39% of the foramina was in the middle third of the clavicle which is about 92.3% by Pushpalata M et al[8] and 84 foramina in the middle third out of 142 foramina in clavicle studied by Ojaswini Malukar et al[9]. Patel H G reported 82.29 % foramina were in middle third of clavicle [10].The middle third of the clavicle is the region most prone to fracture and trauma and periosteal arterial supply in this region should be preserved in case of fracture or trauma otherwise bone grafting may be needed [8].

All the foramina were directed towards the acromial end. But in 2 cases we found the direction of nutrient foramina towards sternal end (Fig-2). In our study, 3.70% of the nutrient foramina were towards the sternal end defied the growing end theory. Pushpalata M et al also reported 96% of foramina towards acromial end and 4% had the medially directed foramina.[8] . Ojaswini Malukar et al reported that all the foramina were directed away from growing end. [9]Single foramen was maximum in our study (53.70%), the value in the previous study by Ojaswini Malukar et al where it was 68%.[9] But single foramina observed was only 38.5% clavicle in the study by Pushpalata M et al. [8] The mean foraminal index in our study is 47.65 . Rahul rai et al reported , that the mean foraminal index is 48.01. [11] 59.76% of the foramina in the present study is on the posterior surface while Ojaswini Malukar et al found it to be 56.3% [9]and Pushpalata M et al found it to be 69.2% [8]. The presence of a large number of cases having nutrient foramina in the posterior surface contradicts the classical presentation on its inferior surface[3].

Conclusion:

In our present study we can conclude from the 54 bones studied the nutrient foramina was present in the middle one third and on the posterior surface. Knowledge about the 'Nutrient foramina and its variations is essential for the maintenance of vascularity and survival of osteoblasts and osteocytes in surgical procedures like internal fixation and vascularized bone grafts. To preserve the vascularity during radiation therapy also a knowledge of the nutrient foramina is essential.

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Figure 1: showing 2 foramina on posterior surface of clavicle.

Figure 2 : showing nutrient foramen directed towards sterna end.

Figure 3: showing 2 nutrient foramina directed towards acromial end.

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