



**Research Article**

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## Evaluation of human temporal bone for loacting favourable site to place longer implant for implant retained auricular prosthesis –a clinicoanatomic study

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### Abstract

**Aim:** To find sites in human temporal bone for placing longer implant **Materials & Methods:** Dry human skull were procured from the anatomy department. External acoustic meatus(EAM) was taken as reference point from that point five arcs of radius 15mm, 20mm, 25mm, 30mm, 35 mm were drawn over the temporal bone. The temporal bone removed from the skull and the bone is removed from the outer most point towards the EAM. The thickness of the bone at 1oClock and 4o Clock position and 8oClock and 11o Clock position over the left and right side of the temporal measured using digital Vernier calliper. The temporal bone is thicker at the 3oClock on the left and 9oClock on the right side. The thickness at the new position also measured. **Result:** The mean bone thickness at 15mm, 20mm, 25mm ranges from 3.92 to 12.08mm. The mean bone Thickness at the 3oclock and 9 o clock position at the distance of 20mm from EAM ranges from 8.21 to 8.50mm. The Statistical significance within the group were analysed using paired t test and found to be statistical significant at P value less than .05. **Conclusion:** The external surface of temporal bone at the 3oClock on the left and 9oClock on the right side denser and thicker. The bone availability is also more favours for placing longer implant.

**Keywords:** Implants, auricular prosthesis, maxillofacial prosthesis

### INTRODUCTION

The success of any maxillofacial prosthesis depends on the colour matching with the adjacent skin and the method of retention used to retain the prosthesis. Three main extra oral prosthesis are Auricular prosthesis, Nasal prosthesis and Orbital prosthesis. Auricular defects is the most common compared to the other two [1]. The main cause for the auricular defects are congenital, trauma and cancer [1]. Implant provide more reliable treatment option in retaining the auricular prosthesis, success rate of implant retained auricular prosthesis is 97.3% [2]. Implant used to retain the maxillofacial prosthesis differs from the one used for intraoral implant. The length of the implant is less with a flange on the top [3]. The location for placing the implant in the temporal bone depends on the available bone and the close proximity of the anatomical structure. The ideal location of the placing the implant is 20mm distance from the external acoustic meatus. The position for placing the implant on the right side is 8o'Clock and 11o'Clock and over the left side and 1o' Clock and 4o'Clock. The distance between the cranial and caudal implant is 15mm<sup>4</sup> (Fig 1). The most challenging aspect in the implant placement is, placing the shorter implant as the bone availability range from 5 – 7mm, treatment planning will be easy if there are any other area where the bone availability will be more to favour placement of longer implant. This anatomical study is planned to find out any other region where the bone availability is more by exploring the temporal bone directly at the specified position in the dry human skull. The aim and objectives of the study are: To find out any other site in the temporal where longer implant can be placed by direct evaluation of the temporal bone.

**Background of the study:** The bone availability in the human temporal bone for placing the implant were assessed by direct measurement. The quantity of the bone in the conventional position (Fig 1), were measured and found to be average of 5-7mm. The temporal bones were further evaluated for more bone availability in any other regions. The bone availability at the

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3o' Clock position on the left side and 9 o'Clock position over the right side were more and dense when compared to the other area (Fig 2). The lateral surface of the temporal bone corresponding to the 3o' Clock position and 9 o'Clock shows a bone elevation because of this feature the bone availability in this region is more and more favourable for placing longer implant (Fig 3). This background idea is considered for pursuing this study.

### Anatomy of temporal bone

Temporal bone is formed by fusion four parts squamous part, tympanic part, styloid process and petromastoid part. The squamous part forms the lateral aspect of the temporal bone. The three process which forms the squamous part are Zygomatic process, Mastoid process and styloid process. External acoustic meatus present in the squamous part through which sound waves reach the internal ear. Glenoid fossa present in the squamous part gives space for the accommodation of the tempromandibular joint. The squamous part contain a bony groove which houses the middle meningeal artery. The structures of the inner ear such as, Cochlea and Semi circular canals were present in the petromastoid part. Internal acoustic meatus present in the petromastoid part through which facial nerve and vestibule cochlear nerve passes. The petromastoid part has fallopian canal for facial nerve and mastoid air cells. Tympanic part is the bony passage from the auricle the external acoustic meatus [5]. Styloid process is a pointed bone present in the temporal bone which gives attachment to muscle and ligaments.

During embryological development, the temporal bone undergo ossification from eight centres. One for the tympanic part and another one for zygomatic part, two for the styloid process and four for the petrous and mastoid part. The squamous and tympanic parts undergo intramembranous ossification. Petrous part and the styloid part undergo endochondral ossification. The mastoid process is absent in the new born and develops with the traction force of the sternocleidomastoid muscle [5].

### METHODOLOGY

Dry human skull will be procured from the anatomy department Government Stanley Medical College and Hospital, Chennai. Ethical committee clearance obtained to use the dry skull for the study.

**Inclusion criteria:** Skulls with intact cranial vault, cranial and facial bones are included in the study

**Exclusion criteria:** There are no particular exclusion criteria. Damaged, fractured, skulls are not included in the study.

**Sample size :** Number of skulls assessed - 20

### Methodology for measuring the available bone

Temporal bone was removed from the skull using steel carbide bur (702 surgical straight carbide bur ). The external acoustic meatus is taken as reference point, a line was drawn posterior and superior margin of the external acoustic meatus and the intersecting point was taken as reference for marking the various radius (Fig 4).The reference was taken as centre and five arcs of radius 15mm, 20mm,25mm,30mm,35 mm were drawn over the temporal bone and separated from the skull (fig -5). In the separated temporal bone the clock positions from 6 ° clock to 12 ° clock for the right side and 1 ° clock to 6 ° clock for the left side were marked as lines intersecting the arcs (fig-6). The ideal location for the implant over the right side is 8° clock and 11 ° clock positions with a distance of 20mm from the external acoustic meatus and over the left side is 1 °clock and 4 ° clock position with a distance of 20 mm from the external acoustic meatus. The potential two implant sites were simple to identify because of the previously drawn arcs and clock positions. The bone thickness is to be measured at a total of six intersecting points of

the 8 ° clock and 11 ° clock lines with 25mm, 20mm, 15mm arcs, and these were highlighted. The available bone at the marked site were measured using digital Vernier calliper (fig -4). The same procedure was repeated for the left side, but on the 1° clock to 4 ° clock lines. The readings were shown in table 1.The bone thickness at the 3 ° clock and 9 ° clock position at the left and right side 20mm from EAM was measured and the data are shown in table II.

### RESULTS

The collected data were analysed with IBM.SPSS statistics software 23.0 Version. To describe about the data descriptive statistics mean & S.D were used. To find the significant difference between the bivariate samples in Paired groups the Paired sample t-test was used. In the above statistical tool the probability value. 05 is considered as significant level. The comparison of Right and left side at the cranial (CRA) and caudal (CRU) position at 15mm, 20mm, 25mm were analysed using paired t Test shown in table III. The statistical analysis of the bone availability at 3 ° clock on the left and 9 ° clock position at the right side is also shown in table IV. The mean bone thickness at 15mm, 20mm, 25mm ranges from 3.92 to 12.08mm. The mean bone Thickness at the 3°clock and 9 ° clock position at the distance of 20mm from EAM ranges from 8.21 to 8.50mm.The mean bone thickness at 15,20,25mm from EAM is shown in the bar diagram (Fig 7).The mean bone thickness at 3°Clock on the left and 9°clock on the right is shown in the bar diagram (fig 8).

### Discussion

The loss of ear is one of the common maxillofacial defects. The cause for the ear defects is due to the congenital defects, carcinoma and trauma of which, the congenital defect is the major cause of the ear loss. Congenital defects is one of the common cause compared to the others [6]. The treatment options for the rehabilitating the ear defects by implant is one of the reliable and predictable treatment option<sup>3</sup>.The challenging aspect in placing the implant is the limited bone availability and close proximity to the anatomical structures forces to use a short implant of 3-5mm length. Two implants were required to retain the auricular prosthesis one placed in the cranial and the other at the caudal. The cranial part of the bone is thin, on the other hand caudal has the mastoid air cells making the treatment planning difficult in selecting the longer implant.

The position for placing the implant on the right side is 8o'Clock and 11o'Clock and over the left side and 1o' Clock and 4o'Clock. The distance between the cranial and caudal implant is 15mm<sup>4</sup>.The amount of bone availability in this region will be in the range of 3-5 mm. A study on Japanese cadaver was done to find out the bone quantity at potential implant sites in temporal bone, orbital margin and maxilla in the facial bone to retain the prosthesis. The amount of temporal bone at the conventional position were only measured. The average amount of bone at 15mm,20mm, 25mm were 3.0 ±1.0, 2.7±1.0, 3.0 ±0.9 respectively [7]. There are no studies to find out the bone availability in the regions other than the conventional position, hence this study was planned to explore areas where the bone availability is more to place longer implant.

The temporal bone thickness at the 3°Clock and 9°Clock position shown in Fig 2 reveals the amount of bone is more and also dense. The amount of bone at the inferior position is also more but the quality is compromised because of mastoid air cells (Fig2). Examination of temporal bone at the external surface reveals a dense and elevated suggestive of more dense bone. This findings are supportive for the alternate position for placing the implants. The conventional and new position for placing the implant to retain the implant retained auricular prosthesis is shown in Fig 5,6.

The mean bone Thickness at the 3°clock and 9 ° clock position at the distance of 20mm from EAM ranges from 8.21 to 8.50mm favourable for

placing a longer implant. The statistical data were analysed and found to be significant.

at 3°Clock and 9°Clock position over the left and right side respectively  
The caudal implant can be placed in the conventional position.

## CONCLUSION

The major problem in implant placement at the temporal bone is the limited bone thickness. This study concludes for placing longer implant

## Conflict of Interest

The author reports no conflicts of interest.

**Table I:** bone availability in the temporal bone at the conventional position for placing the implant

S.No	Skull No	Bone quantity 15mm from EAM Right side		Bone quantity 20 mm from EAM Right side		Bone quantity 25mm from EAM Right side		Bone quantity 15mm from EAM left side		Bone quantity 20mm from EAM left side		Bone quantity 25mm from EAM left side	
		Cra	Cau	Cra	Cau	Cra	Cau	Cra	Cau	Cran	Cau	Cran	Cau
1.	S-1	4.1mm	6.4mm	0.6mm	5.4mm	4.5mm	0.6mm	3.8mm	9.6mm	0.8mm	1.8mm	3.7mm	0.4mm
2.	S-2	7.6mm	8.2mm	4.6mm	3.8mm	3.1mm	4.0mm	7.7mm	8.3mm	8.4mm	6.7mm	4.2mm	4.8mm
3.	S-3	4.1mm	12.4mm	6.2mm	9.6mm	3.5mm	6.3mm	3.7mm	10.4mm	8.5mm	5.0mm	4.4mm	7.8mm
4.	S-4	11.1mm	24.3mm	8.4mm	14.8mm	2.6mm	3.7mm	6.6mm	17.8mm	5.6mm	14.3mm	4.9mm	9.2mm
5.	S-5	7.1mm	11.3mm	4.8mm	9.4mm	6.7mm	7.1mm	6.2mm	11.8mm	6.7mm	10.2mm	6.4mm	4.9mm
6.	S-6	9.2mm	10.4mm	2.8mm	7.0mm	2.3mm	4.4mm	4.5mm	17.1mm	9.4mm	11.7mm	3.6mm	5.9mm
7.	S-6	7.8mm	14.1mm	8.3mm	12.0mm	1.1mm	8.3mm	4.9mm	11.3mm	3.3mm	9.8mm	3.0mm	7.1mm
8.	S-7	1.3mm	9.5mm	1.9mm	8.7mm	3.5mm	6.3mm	10.1mm	14.1mm	6.5mm	11.0mm	5.6mm	6.5mm
9.	S-8	5.5mm	24.8mm	4.6mm	7.6mm	2.2mm	5.6mm	6.0mm	18.2mm	7.4mm	7.0mm	4.8mm	4.3mm
10.	S-9	6.7mm	8.5mm	6.4mm	7.3mm	5.0mm	2.3mm	5.9mm	7.3mm	5.8mm	6.1mm	5.4mm	2.9mm
11.	S-10	6.7mm	5.9mm	2.8mm	4.3mm	4.0mm	2.4mm	5.7mm	5.1mm	2.7mm	3.5mm	2.7mm	3.3mm
12.	S-11	7.5mm	11.00mm	4.0mm	4.6mm	3.8mm	6.7mm	7.6mm	10.8mm	6.7mm	5.2mm	3.7mm	5.6mm
13.	S-13	7.6mm	13.5mm	4.8mm	10.7mm	3.0mm	6.7mm	9.5mm	13.9mm	7.2mm	11.6mm	2.6mm	10.2mm
14.	S-14	5.1mm	13.1mm	7.7mm	13.1mm	6.9mm	9.4mm	10.7mm	12.8mm	9.9mm	11.1mm	10.4mm	9.1mm
15.	S-15	2.4mm	7.6mm	0.4mm	2.1mm	1.3mm	8.2mm	5.2mm	8.4mm	5.0mm	6.0mm	6.3mm	8.5mm
16.	S-16	9.4mm	9.9mm	4.5mm	9.8mm	3.3mm	5.7mm	7.3mm	10.7mm	5.7mm	8.0mm	3.9mm	5.8mm
17.	S-17	4.4mm	9.8mm	12.3mm	20.3mm	3.9mm	8.1mm	6.9mm	12.9mm	11.5mm	13.6mm	8.6mm	6.8mm
18.	S-18	7.8mm	6.8mm	7.6mm	8.6mm	5.5mm	6.8mm	9.0mm	8.1mm	7.2mm	4.6mm	4.3mm	3.4mm
19.	S-19	9.4cm	17.9mm	37.4mm	30.1mm	6.7mm	6.5mm	10.3mm	15.2mm	17.8mm	17.5mm	4.2mm	8.4mm
20.	S-20	12.5mm	16.1mm	15.4mm	15.7mm	5.4mm	6.5mm	9.1mm	15.9mm	15.4mm	15.0mm	7.6mm	10.3mm

**Table 2:** Bone availability at the 9' o clock and 3' o clock position

S.No	Skull. No	Right side 20 mm from EAM at 9'o clock position	Left side 20mm from EAM at 3' o clock position
1.	S-1	8.1mm	6.2mm
2.	S-2	7.3mm	8.5mm
3.	S-3	7.6mm	6.7mm
4.	S-4	10.6mm	9.1mm
5.	S-5	8.5mm	8.4mm
6.	S-6	6.3mm	9.4mm
7.	S-7	11.2mm	7.6mm
8.	S-8	9.5mm	8.4mm
9.	S-9	12.3mm	10.3mm
10.	S-10	7.1mm	7.1mm

11.	S-11	6.1mm	6.1mm
12.	S-12	6.5mm	7.1mm
13.	S-13	7.2mm	8.3mm
14.	S-14	10.2mm	9.3mm
15.	S-15	7.4mm	8.5m
16.	S-16	9.1mm	8.2mm
17.	S-17	7.8mm	8.3mm
18.	S-18	9.7mm	8.4mm
19.	S-19	7.1mm9	9.6mm
20.	S-20	10.3mm	8.6mm

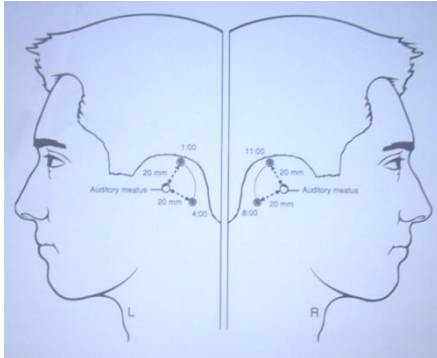


Figure 1: Guidelines for placing the implant



Figure 4: The intersecting line from the posterior and superior margin of external acoustic meatus



Figure 2: The bone availability at the 3 o' Clock and 9 o'Clock position

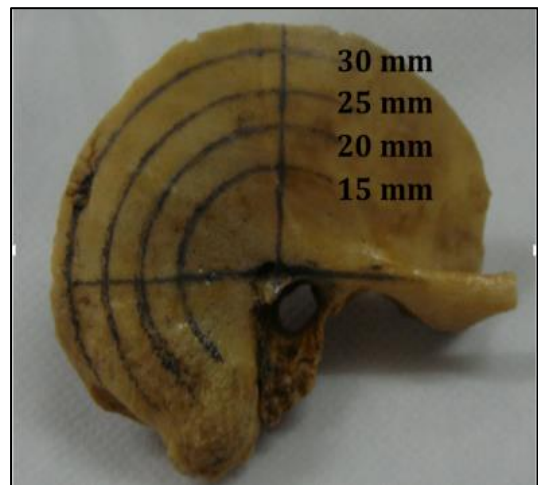


Figure 5: The arc drawn on the temporal bone



Figure 3: The lateral surface of the temporal bone at 3o' Clock position shows elevation

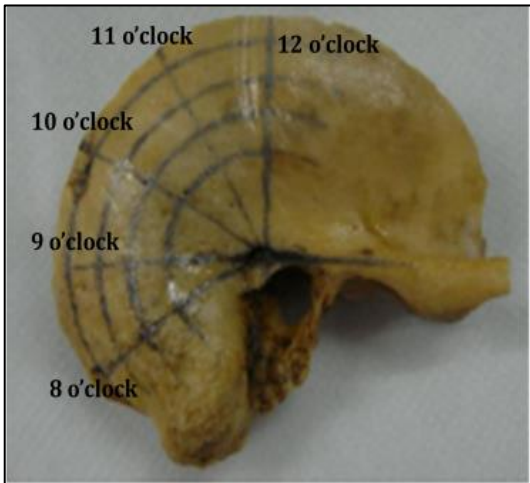


Figure 6: The Clock position marked on the temporal bone



Figure 7: Measurement done using digital Vernier calliper

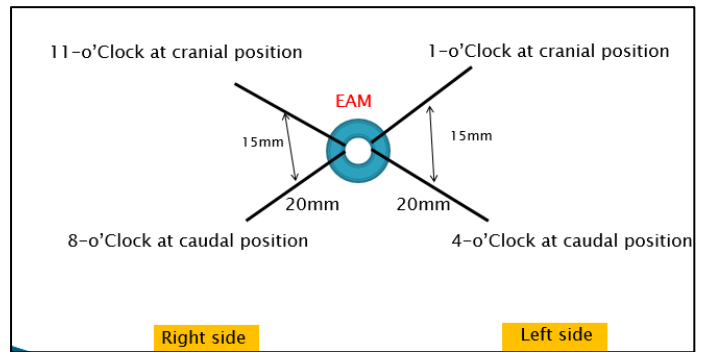


Figure 8: Conventional implant position at temporal bone for implant retained auricular prosthesis

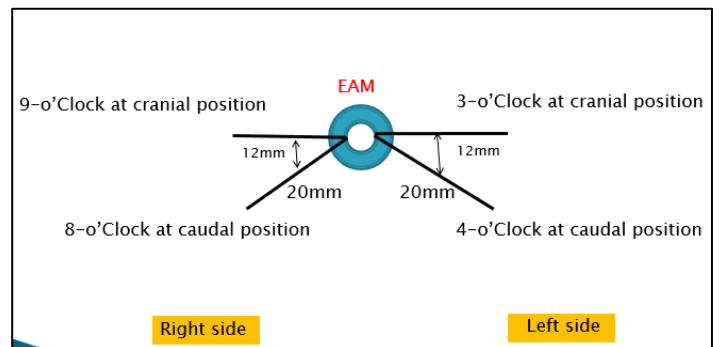


Figure 9: New implant position for implant retained auricular prosthesis

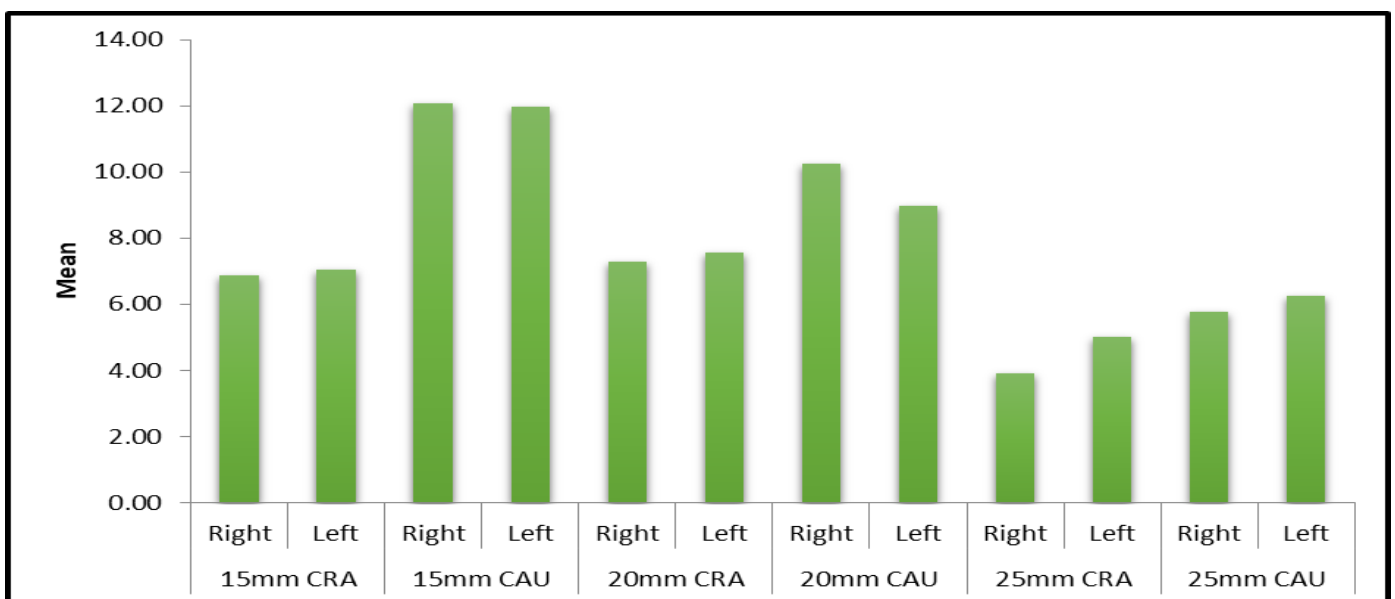
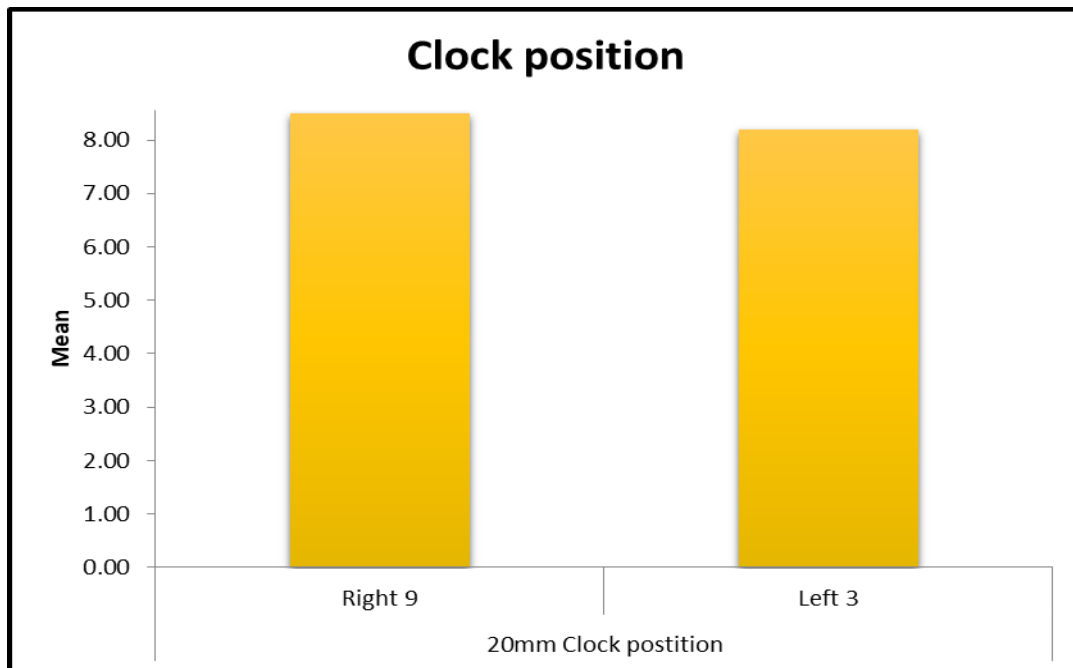


Figure 10: Bar diagram for mean bone thickness at 15mm,20mm,25mm at Cranial (CRA) & Caudal (CAU) sites



**Figure 8:** Bar diagram for mean bone thickness at Right 9° clock and left 3° clock position

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