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"A HISTOMORPHIC STUDY OF IMPLANT DENTISTRY ON THE ALVEOLAR SPONGIOSA OF HUMAN DRY SKULL."

Dr. Ashish Singh[1*]

[1*]Professor Department of Oral and Maxillofacial Surgery Maharana Pratap College of Dentistry and Research centre Gwalior, Madhya Pradesh

Corresponding Author: Dr. Ashish Singh
[*]Professor Department of Oral and Maxillofacial Surgery Maharana Pratap College of Dentistry and Research centre Gwalior, Madhya Pradesh

ABSTRACT
Alveolar bone is the part of the maxilla and mandible that supports the roots of the teeth. It is functionally divided into – alveolar bone proper and supporting bone which comprises of outer cortical plates and spongiosa.
The aim of the study was to evaluate- Trabecular width and its characteristics and shape and size of marrow spaces and their distribution throughout the alveolar bone.
The study was conducted on 150 samples derived from 12 dried human jaw bones. Each sample comsisted of interdental alveolar bone. The samples were processed for optical microscopy to evaluate the dimensional characteristics of trabecular width and marrow space. The present study revealed the trabecular width different at its coronal, middle and apical locations. It has been observed that the trabecular width decreases from the coronal zone (1.08 mm) to the apical zone (0.34 mm). The dimension of the marrow space has been seen to be different at it's coronal, middle and apical zones. It increases from the coronal zone (0.26 mm) to the apical zone. (1.05 mm). it is interesting to note that in a particular locality, the greater the trabecular width, the lesser is the marrow space size. It is clear that the trabecular width is inversely proportional to the size of the marrow space at any location from the coronal to the apical zone.
The statistical analysis of the data reveals that for trabecular width, the average coronal reading is highest followed by the middle and apical reading and student's 't' test reveals that the differences are all highly significant ($p<0.001$). With respect to the size of marrow space the average apical reading is highest (1.05 mm), next to it, the middle average reading (0.49 mm) and the lowest average reading is that of the coronal zone (0.26 mm). The differences are all statistically significant ($p<0.001$). Since in the cononal area, the trabecular width is more, the marrow space becomes smaller. Conversely in the apical area, the trabecular width is lesser and the marrow space becomes bigger. The results of the study is helpful in determining the potential micro-anatomical factors for dental implants. This study, therefore seems to the first of it's own kind.

KEY WORDS: Alveolar spongiosa, trabecular width, marrow space. Interseptal bone, Ocular micrometer.

INTRODUCTION:

Alveolar bone is that part of the maxilla and mandible which supports the roots of the teeth. It is first formed around the developing tooth germs to construct the protective crypt. During the eruption of the teeth, the crypts are modified by further apposition of bones to form the sockets or alveoli which surround the roots of the functional teeth. The alveolar bone, therefore surmount the basal bone of the jaw and transmits forces between the teeth and basal bones. Alveolar bone is indistinguishable from basal bone, histologically and biochemically Anatomically the alveolar process is regarded as the alveolar bone functionally it is divided into

1. Alveolar bone proper (Cribriform plate).
2. Supporting bone which comprises of outer cortical plates and spongiosa.

The spongiosa consists of a honeycomb of bone trabeculae which buttress the outer cortical plate and the alveolar bone proper.

There is certainly a void area of study on alveolar spongiosa with regard to it's distribution, shape and size. Similarly, the measurements of the trabecular width all along the alveolar spongiosa with special emphasis to the interdental septum, has not been studied. The knowledge of this aspect of periodontology is greatly in need of as available literature does not provide much information.

In view of the above perspective and inadequacy of information, the present study has been undertaken to evaluate:-

(1) Trabecular width and it's characteristics.
(2) Shape and size of marrow spaces and it's distribution throughout the alveolar bone.

REVIEW OF LITERATURE

The alveolar process is an integral part of the maxilla and mandible. It is not separated from the jaw bone by any obvious boundary such as a suture and as a result a junction between the two cannot be identified. It envelops the roots of the teeth, extending between them and covering their interproximal vestibules, oral and apical surfaces [1,2,3]. Weinreb et al in 1967[4] observed that the alveolar bone may exert some influence on developing teeth. The alveolar process is recognized as an entity because its existence depends on the presence of erupted teeth, development of it is associated with eruption of the teeth and loss of teeth precipitates its resorption.

The cancellous bone varies from place to place[1] . The maxilla has more cancellous bone than the mandible. The spongiosa is more on the lingual aspect than on the buccal part. Interradicular and interdental septae contain entirely of spongy bone. Most of the facial and lingual portions of the sockets are formed by compact bone alone. The cortical plate of alveolar bone is continuous with cortical plate of basal bone. At the mouth of the tooth sockets, the surface cortical bone is continuous with alveolar bone proper. It is thicker in maxilla than in mandible. The interdental septum consists of cancellous bone bordered by the socket walls of approximately teeth and the facial and lingual cortical plates. If the interdental space is narrow the septum may consist of only lamine dura[1]. The spongiosa consists of a honeycomb of bony trabeculae, between which lies red hematopoietic marrow in young subjects and yellow marrow in older ones [1,2,5] . Over the past several decades, the mechanical properties and the microscopic histometrical and mineral properties of cancellous bone have been rigorously studies.

In a study conducted by Bachus, Bloebaum and Hofmann in 1990[6] on human cadaveric tibias the limits of the load carrying capabilities of cancellous bone was evaluated by comparing the strength, stiffness, mineral volume, the minimum trabecular thickness and the fracture site trabecular thickness. It was seen that the minimum trabecular thickness correlated extremely well to the fracture site. It was concluded that future investigation of cancellous bone should document the changes associated with the minimum trabecular thickness since then appears to be a structurally limiting region of the trabeculae.

MATERIAL AND METHODS

This study was carried out using interseptal bone of maxilla and mandible from 12 dried skull bones, the sample number being 150.

Since the interseptal bone is rich in the cancellous variety as compared with the buccal and lingual parts, this study selected interseptal bone as it's study material. The interseptal bone was obtained by sectioning the jaw bone along it's length by a saw machine and the sample obtained by cutting with a hand saw below the apical most part of the socket to consist now of alveolar bone. The samples were processed by the routine standard methods for optical microscopy. The sections prepared of 5 microns thickness was stained with Marriss haematoxylin and eosin and mounted with DPX (Dissolved Polysterine in Xylol) and placed on glass slides for observation.

For the recording of the trabecular width and size of marrow space the ocular micrometer was used. The ocular micrometer has within it a glass disk on which is extended a graduated scale and it is placed in the tube of he microscope. The standardisation of occular micrometer was made by using the counting slide of a haemocytometer and division of haemocytometer chamber and ocular micrometer was adjusted 10 times. Each ocular micrometer was adjusted as 64.4 microns counting in 6 x ocular. A high power objective (40) with numerical aperture 0.65 was selected under which the sample was focused for recording of the measurements of trabecular width and marrow space from coronal to apical direction. Ten readings for each anatomical zone were taken and the mean values were then recorded in teams of divisions by ocular micrometer, which was multiplied by 65.4 microns and result divided by 1000 to be expressed in millimeters. Statistical analysis was done for both trabecular width and marrow space readings to test the significance of the differences in the average readings of each anatomical zone.

RESULTS:

It was observed that in the coronal zone, there was more calcified structure within which marrow spaces were situated wide apart, smaller in dimension and seanty in number.

The calcified part between the two marrow spaces considered to be the trabeculum seemed to have no special characteristic for descriptive purposes. On the contrary, a well-delineated trabeculum was observed in both the middle and apical zones, with the trabeculum seen in the middle zone being wider than that observed in the apical zone. In the coronal zone, the marrow spaces are also smaller in size and round in shape. In the middle zone,the marrow spaces were moderate in number, placed little closer, irregular i.e. oval and elongated in shape. In the apical zone, the highest number of marrow spaces were observed, placed very close to each other, round and oval in shape (Table No. 1)

The trabecular width of coronal middle and apical zones were found to be 1.08 mm 0.63 mm and 0.34 mm respectively (Table No. 2).

The size of the marrow space was found to be 0.26 mm, 0.49 mm and 1.05 mm respectively for coronal, middle and apical zone (Table No.3).

The statistical analysis of the data reveals along with the student's test that the difference in the readings of the different anatomical zones for both trabecular width and marrow space are all statistically significant.

Table No. 4, the apical readings are compared with middle and coronal readings for trabecular width and size of marrow spaces. Student's 't' test were adopted to compare the averages. It would be seen from Table No.2 that for trabecular width the average coronal reading is highest followed by middle and apical readings and student's 't' test reveals that the differences are all highly significant (p<0.001). In respect of the size of marrow space, the average apical readings is highest (1.05 mm) next to it the middle average reading (0.49 mm) and the lowest average reading is that of coronal (0.26 mm). It is also seen that the differences are all satistically significant (p<0.001).

$$t_v = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{Se_1^2 + Se_1^2}}$$

where Se_1 and Se_2 are the two standard errors of the two average readings.
v = degrees of freedom, which is 298 in this case.
' t 'values thus competed are found to be far greater that the critical value of ' t ' at 0.001 probability level. (Table No. 4)

Table No: 1 Morphological Characteristics of Trabeculum and marrow space

	Coronal	Middle	Apical
Nature & Pattern of trabecular width Nature & shape Of Marrow space	Widest, no special characteristic Scanty in number wide apart, smaller in size and round in shape	Wide, well delineated Moderate in number, placed, little closer, Irregular (oval and elongated in shape)	Narrow, Irregular but Well-delineated Highest in number placed very close to each other, round and oval in shape

Table no. 2 Average values of trabecular width (with standard error) in coronal, middle and apical zones.

	Coronal Zone	Middle Zone	Apical Zone
Average	1.08	0.63	0.34
Standard deviation	0.095	0.060	0.0546
Standard error	0.0078	0.0055	0.00446

Table no. 3 Average values of marrow space (with standard error) in coronal, middle and apical zones.

	Coronal Zone	Middle Zone	Apical Zone
Average	0.26	0.49	1.05
Standard deviation	0.0485	0.096	0.175
Standard error	0.004	0.00787	0.0143

Table no. 4 Statistical Analysis To Test Significance Of Differences In The Average Reading

ITEMS	CORONAL AND MIDDLE			CORONAL AND APICAL			MIDDLE AND APICAL		
	Difference	't'value	P value	Difference	't' value	P value	Difference	't' value	P value
Trabecular Width	0.442	46.24	<0.001	0.73	81.37	<0.001	0.288	40.58	<0.001
Size of Marrow Space	0.23	26.06	<0.001	0.787	52.97	<0.001	0.557	34.09	<0.001

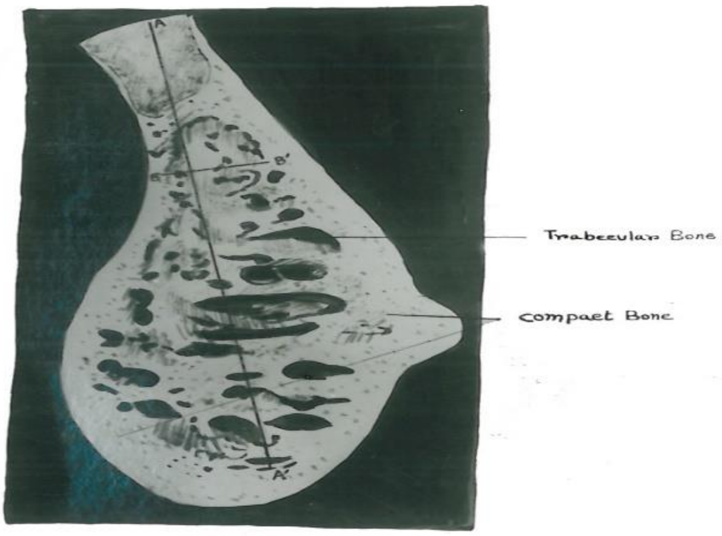

Fig . 1: Section of lower jaw

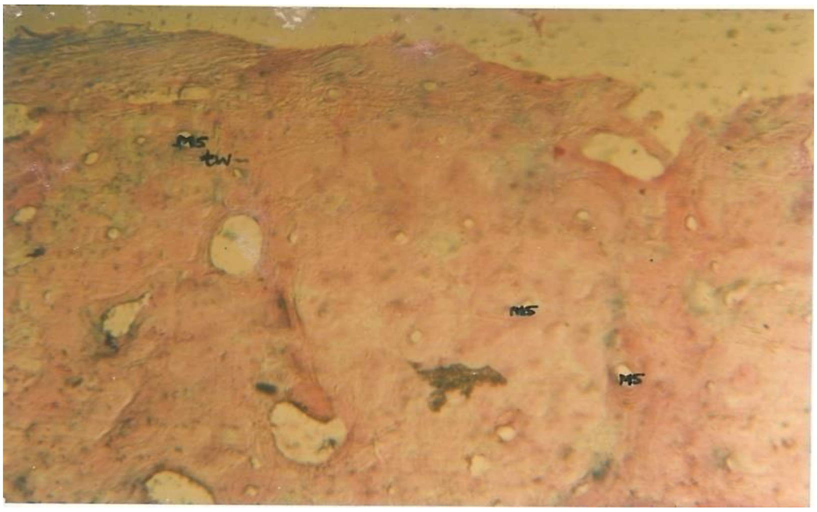

Fig. 2 : Photomicrograph of the conal part of the alveolar spongiosa showing distinct marrow spaces ms (small, round) and wide trabecular width tw Haematoxylin and eosin x 30

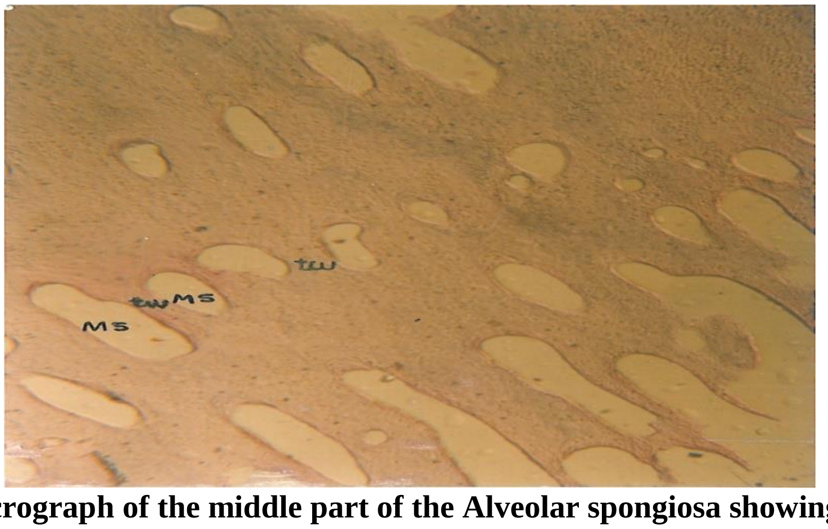

Fig. 3 : Photomicrograph of the middle part of the Alveolar spongiosa showing marrow spaces ms (oval, elongated) and wide, well-delineated trabecular width tw Haematoxylin and eosin x 30

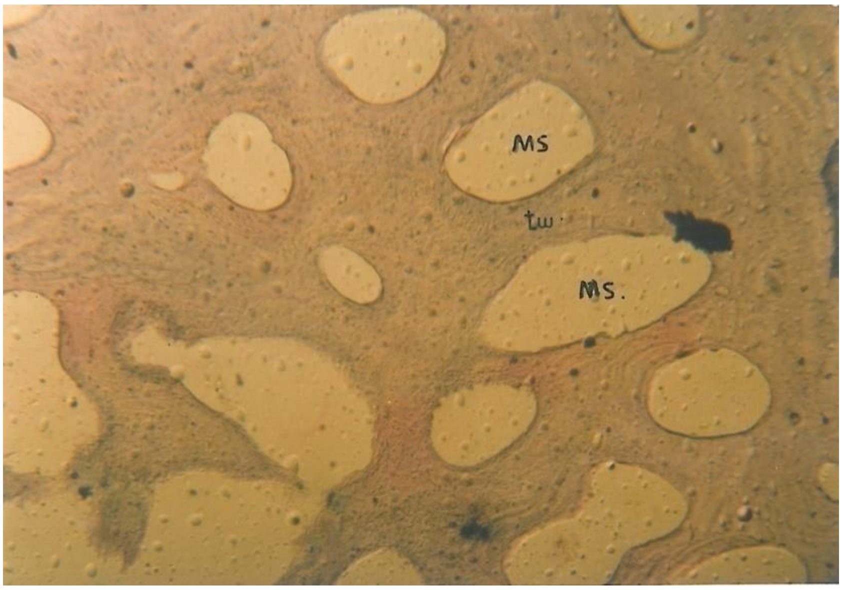

Fig. 4 : Photomicrograph of the apical part of the alveolar spongiosa showing marrow spaces ms (round oval) and narrow trabecular width tw Haematoxylin and eosin x 30

DISCUSSION

This study was conducted on 150 samples consisting of alveolar bone which entails the buccal and lingual cortical plates on the outer part and trabecular bone in the inner part lined by alveolar bone proper (cribriform plate) from 12 dried jaw bones. Each of the specimen, prepared through proper methodology was studied under the microscope to see the characteristics of trabecular width and marrow space.

The present study revealed the trabecular width different at it's coronal, middle and apical locations. It has been observed that the trabecular width decreases from the coronal zone (1.08 mm) to the apical zone (0.34 mm). The dimension of the marrow space has been seen to be different at it's coronal, middle and apical zones. It increases from the coronal zone (0.26 mm) to the apical zone (1.05 mm). It is interesting to note that in a particular locality, the greater the trabecular width, the lesser is the marrow space size. The trabecular width is inversely proportional to the size of the marrow space at any location from the coronal to the apical zone. The statistical analysis of the data reveals that for trabecular width, the average coronal reading is highest followed by the middle and apical readings and student's 't' test reveals that the differences are all highly significant ($p< 0.001$). With respect to the size of marrow space the average apical reading is highest (1.05mm) next to it, the middle average reading (0.49mm) and the lowest average reading is that of the coronal zone (0.26 mm). The differences are all statistically significant.

The root of a tooth is embedded within the jaw bone, which in turn, gives support to the tooth in it's masticatory function. The coronal area of the jaw bone is structurally less voluminous than of course the apical area. It is conceivable that to adjust with the less voluminous part of the jaw bone, the internal constituting trabeculae is automatically thicker. In the apical area, the jaw bone is considerably voluminous and the need of increased trabecular width is minimal. This conceptual hypothesis has been derived from the present study.

The marrow space has to be designed, as per the space left for it. Since in the coronal area the trabecular width is more, the marrow space becomes smaller. Conversely in the apical area the trabecular width is lesser and marrow space becomes bigger. The results of the study is helpful in determining the potential micro-anatomical factors for dental implants.

The purpose of the study was to determine the trabecular width at various levels of the spongy bone into which the larger part of the implant body remains embedded. As we know of the two types of bone architecture-cortical and cancellous , the cancellous bone with its trabeculae and marrow come into contact with most part of the implant body. The bone implant contact (BIC) is responsible for the success of an implant. BIC is better achieved by cortical bone but if there is insufficient cortical bone, cancellous bone provides bone to implant contact in such cases. BIC is achieved through the mocro-anatomical component of trabecular bone to the implant surface. The trabecular thickness with its mineral components is instrumental in providing the initial stability of the dental implant soon after its insertion.

No specific study has so far been reviewed, so that the present data can be compared. This study, therefore seems to be the first of it's own kind.

CONCLUSION

The trabecular width of the coronal, middle and apical zones were 1.08 mm, 0.63 mm and 0.34 mm respectively and diameter of marrow space of the same were 0.26 mm, 0.49 mm and 1.05 mm respectively.

From the present study, the conclusious drawn are that this study model comprising of human dried jaw bones is effective, easy and reproducible. Throughout the length of the alveolar bone, the trabeculae have been found to be widest in the coronal zone (1.08 mm) and thinnest in the apical zone (0.34 mm) and throughout the length of the alveolar bone, the diameter of marrow space has been found to be smallest in the coronal zone (0.26 mm) and largest in the apical zone (1.05 mm). It is observed that greater the trabecular width, the lesser is the marrow space size and conversely, the bigger the marrow space, the thinner is the trabecular width.

Finally, there is a distinct inverse relationship of trabecular width and marrow space, throughout the length of alveolar bone. Since this study seems to be the first of it's own kind future research is recommended pertaining to this context.

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Conflict of interest: None declared.

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