

RELATION BETWEEN PRIMARY STABILITY AND BONE DENSITY -A RETROSPECTIVE STUDY

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ABSTRACT

The use of dental implants has gained immense popularity and inside acceptance. A secure implant primary stability is positively associated with a successful implant integration and long-term successful clinical outcome. The aim of this study was to assess the effect of primary stability in success of dental implants. The present retrospective study was conducted among 1263 patients who had undergone implant therapy in the Department of Implantology, Saveetha Dental College and Hospitals, Chennai from June 2019 to March 2020. Data regarding bone type, bone density of the implant site were collected and analysed. In the present study, most of the type of bone density seen commonly was D2 bone and around 42.79% of the patients had D2 type of bone density in the lower posterior region. The next commonly seen bone density was D1 and in the lower posterior and lower anterior region with 8.51% and 2.36% respectively. In association with the gender and the bone density males had more bone density than females. Most of the type of bone density seen was D2 (34.12% in males and 30.58% in females, followed by D1 type of bone density (6.93% in males and 6.62% in females). Positive correlation was obtained between bone density and primary implant stability. The correlation was found to be statistically significant (p=0.000). The present study showed a strong relationship between bone density and the primary implant stability.

Keywords: Bone density; Dental Implants; Osseointegration; Primary stability.

INTRODUCTION

The success rate of osseointegrated implants to treat partially edentulous patients and completely edentulous patients have a predictable outcome and with a success rate of 98% or more. The success of the dental implants depends upon the patient's clinical conditions, the surgical technique and the dental implant design. (Hong and Oh, 2017) Bone quality and quantity majorly determines the procedure and the design, type of dental implant system used. Essential diagnosis, patient history, occlusion, and the To achieve a good result with our implant treatment, a thorough diagnosis is essential, assessment of bone with the help of CBCT has a predictable and good outcome of the success of dental implants. (Herrmann *et al.*, 2005) Bone height and width, the density is well identified with the help of CBCT. Bone density is the key factor in predicting the success of the implant primary stability. Proper technique and stability of the dental implant is in favour of the success of the dental implant. There are many studies which have shown that the survival of the dental implants is based on the quality of the bone which is the bone density. (Jang *et al.*, 2011) Several studies have also shown that there is a better success rate in the implants placed in the

mandible than in maxilla due to the quality of the bone density. (Bergkvist et al., 2010) In few studies in the literature have shown that there is a correlation between the implant success and the bone density, that is there is a high failure rate in the D4 bone. However there are studies which have proven that better success in D1, D2, D3 bone quality. Primary stability and bone density success for dental implants have been proved by many authors in the literature. (Misch et al., 1999)

Assessment of primary stability in any type of bone quality was done by Boronat Lopez et al (Boronat-López et al., 2006) showing that in poor quality of bone the primary stability was lower than the implants placed in denser bone, however the secondary stability is also similar to that of the quality of the bone. A secure primary stability is positively associated with secondary stability. Bone quality and quantity, implant geometry and surgical technique adopted are some of the predominant factors that influence primary stability of the implant. Despite the remarkable progress done in the field of implant dentistry, the bone quantity and quality in maxillary and mandibular arches present a unique challenging condition in rehabilitation. The bone resorption pattern is different in maxilla and mandible. In the maxilla resorption of the alveolar ridge occurs mainly on the buccal aspect and in the mandible resorption occurs lingually in the premolar areas and buccally in the molar segments. (Jacobs et al., 1992) Also, regarding the type of bone, D2 type which is most suitable for implant placement is present primarily in anterior and posterior mandible.

The primary stability is also influenced by the surgical techniques and the morphology of the bone (cortical) and the diameter. Wider diameter will increase in the success of the primary stability by contacting the cortical bone. Likewise the design of the dental implants contribute in achieving the primary stability. Tapered dental implant designs have more primary stability than cylindrical dental implants. (Steigenga et al., 2003)

Previously our team had conducted various studies pertaining to the factors associated with the success and failure of dental implant therapy over the past 5 years. (Ashok et al., 2014; Venugopalan et al., 2014; Ashok and Suvitha, 2016; Ganapathy et al., 2016; Selvan and Ganapathy, 2016; Subasree, Murthykumar and Dhanraj, 2016; Vijayalakshmi and Ganapathy, 2016; Ajay et al., 2017; Ganapathy, Kannan and Venugopalan, 2017; Jyothi et al., 2017; Ranganathan, Ganapathy and Jain, 2017; Ariga et al., 2018; Basha, Ganapathy and Venugopalan, 2018; Kannan and Venugopalan, 2018; Duraisamy et al., 2019) The present study aims to assess the effect of bone density and primary stability in a private dental hospital.

MATERIALS AND METHODS

The present retrospective study was conducted among 1263 patients who had undergone implant therapy in the Department of Implantology, Saveetha Dental College and Hospitals, Chennai from June 2019 to March 2020. Data regarding bone type, bone density of the implant site were collected from patient's records. The study protocol was approved by the Institutional ethical and review board, Saveetha Dental College and Hospitals, Chennai.

A single centre retrospective study was done in an institutional setting. The ethical approval was received from the institution's ethical committee. The necessary approvals in gaining the data were obtained from the institutional ethical committee (SDC/SIHEC/DIASDATA/0619-0320). The study involved selected patients data who had undergone dental implant placement.

Selection of subjects:

The patients who had undergone implant placement from the time period of June 2019 to April 2020 were selected for this study. There were three people involved in this study (guide, reviewer, and researcher). All available data were taken into consideration and there was no sorting process.

Data collection:

The patient's details were retrieved from the institution's patient record management software. Data regarding patients age, gender, implant site, bone density and primary stability were taken into consideration for this study. Cross verification of the data was done with the help of photographs and radiographs. The data was manually verified, tabulated and sorted.

Inclusion Criteria:

All patients with implant placement and all age groups were taken into account

Exclusion Criteria:

Patients' records that were incomplete were removed from the study. Repetitive entries were excluded as well.

Statistical Analysis:

The tabulation of data was analysed using SPSS software. (IBM SPSS Statistics 26.0) The method of statistical analysis that was used in this study was Chi Square Test to compare two proportions. The analysis was done for Region and Bone density, Gender and bone density, Age and bone density, Primary stability and bone density.

A total of 1263 was the sample size based on the inclusion and exclusion criteria.

RESULTS AND DISCUSSION

The study sample consisted of 1263 subjects who had undergone implant therapy. The association between bone density and primary stability was assessed. The results of the present study shows that out of 1263 patients who had undergone dental implants, most of the patients had D2 type bone density. In association between the primary stability and bone density, most of the good stability achieved had good bone, that is 4.18% of the patients who had D1 bone density had a primary stability of 40- 50 Ncm, 14.03% of the patients who had D2 bone density had a primary stability of 40- 50 Ncm, 4.65% of the patients who had D3 bone density had a primary stability of 40- 50 Ncm, and 0.08% of the patients who had D3 bone density had a primary stability of 40- 50 Ncm. 7.57% of the patients who had D1 bone density has a primary stability of 30-40 Ncm, 39.40% of the patients who had D2 bone density has a primary stability of 30-40 Ncm, 8.43% of the patients who had D3 bone density has a primary stability of 30-40 Ncm, 0.87% of the patients who had D4 bone density has a primary stability of 30-40 Ncm. 1.26% of the patients who had D1 bone density has a primary stability of 20-30 Ncm, 8.43% of the patients who had D2 bone density has a primary stability of 20-30 Ncm, 4.26% of the patients who had D3 bone density has a primary stability of 20-30 Ncm, 0.55% of the patients who had D4 bone density has a primary stability of 20-30 Ncm. 0.55% of the patients who had D1 bone density has a primary stability of 15 -20 Ncm, 2.84% of the patients who had D2 bone density has a primary stability of 15 -20 Ncm, 2.90% of the patients who had D3 bone density has a primary stability of 15 -20 Ncm, 0.63% of the patients who had D4 bone density has a primary stability of 15 -20 Ncm. (Figure 1 and Table 1)

In association between the region and the bone density, lower posterior had good bone density than the other sites. Most of the type of bone density seen commonly was D2 bone and around 42.79% of the patients had D2 type of bone density in the lower posterior region. The next commonly seen bone density was D1 and in the lower posterior and lower anterior region with 8.51% and 2.36% respectively. (Figure 2)

In association with the gender and the bone density males had more bone density than females. Most of the type of bone density seen was D2 (34.12% in males and 30.58% in females, followed by D1 type of bone

density (6.93% in males and 6.62% in females). D3 type of bone density (12.92% in males and 6.70 % in females), D4 type of bone density (1.26% in males and 0.87% in females). (Figure 3)

In association with the age group and bone density, D2 type of bone density was more commonly seen in all the age groups but more common in the age group between 41-59 years. D1 type of bone density - 3.07% in 18-30 years, 4.26% in 31- 40 years, 4.65% in 41- 59 years, 1.58% in above 60 years. D2 type of bone density - 12.45% in 18-30 years, 17.57% in 31- 40 years, 26.32% in 41- 59 years, 8.35% in above 60 years. D3 type of bone density - 4.49% in 18-30 years, 4.10% in 31- 40 years, 8.90% in 41- 59 years, 2.13% in above 60 years. D4 type of bone density - 0.71% in 18-30 years, 0.16% in 31- 40 years, 1.26% in 41- 59 years, 2.13% in above 60 years.

Bone density and implant stability are important factors for implant osseointegration, which has been widely demonstrated by several authors. (Davies, 1998; Beer *et al.*, 2003) Bone density seems to be of great importance not only in primary implant stability but also in the predictability of oral implant outcome. Jaffin RA *et al* (Jaffin and Berman, 1991) and Herrmann I *et al* (Herrmann *et al.*, 2005) stated that poor bone quantity and especially poor bone quality are the main risk factors for implant failure.

Farre-Pages N *et al* (Farré-Pagès and Augé-Castro, 2011) demonstrated a strong relationship between the bone density values and the primary stability of dental implants. Also, Huang HM *et al* (Huang *et al.*, 2002) suggested that the primary stability increases as the bone density increases. Turkyilmaz I *et al* (Turkyilmaz and McGlumphy, 2008) conducted a clinical study with 158 implant sites from 85 patients and reported a strong correlation between bone density and primary implant stability.

Furthermore, Friberg B *et al*, (Friberg *et al.*, 1999) Norton MR *et al*, (Norton and Gamble, 2001) Shahlaie M *et al* (Shahlaie *et al.*, 2003) reported a strong relationship between bone density values and primary implant stability. Our findings are in accordance with previous studies, as the bone density increases; the primary stability increases. Also, in the present study the correlation between bone density and primary stability was found to be statistically significant ($p=0.000$).

The present study assessed the association between age and bone density and found 66.5% of individuals aged between 31-40 years presented with D₂ bone type and 23.7% of individuals above 60 years presented with D₃ bone type. Our findings are in agreement with previous studies by Ozdemir F *et al* (Ozdemir, Tozlu and Germec Cakan, 2014) and (Aranyarachkul *et al.*, 2005) as these authors reported that the majority of individuals with D₂ type bone aged below 40 years. However, to confirm these findings further multi-centered studies need to be conducted among a large population. Also, individual bone density needs to be correlated with the success of implant therapy.

CONCLUSION

Within the limitations of the study, there is a strong relationship between the bone density and primary stability. D2 bone density was more commonly seen in males than in females. D2 bone density was more commonly seen in lower posteriors than other regions and 41- 59 years of age group had better bone density than other age groups.

AUTHORS CONTRIBUTIONS

Thanish Ahamed S carried out the retrospective study, participated in the sequence alignment, statistical analysis and drafted the manuscript. Subhashree. R and Mebin George Mathew conceived the study, participated in its design and coordinated and provided guidance to draft the manuscript. All the authors had equally contributed in developing the manuscript.

CONFLICT OF INTEREST

There were no conflicts of interest as defined by the authors.

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Table and Graphs:

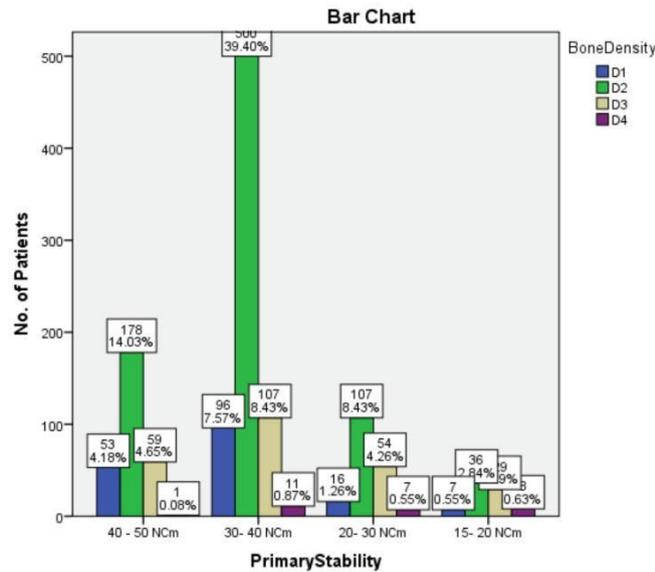


Figure 1: Bar graphs showing the association of primary stability and bone density. X axis represents the Primary stability and Y axis represents the no of patients. The types of bone density are D1 bone density (blue), D2 (green), D3 bone density (beige) and D4 bone density (purple). Chi square association was done and found to be significant, (Chi square value: 78.215, df: 9, p value: 0.000 (< 0.05), hence proving that D1 and D2 bone density has higher primary stability than other types of bone density.

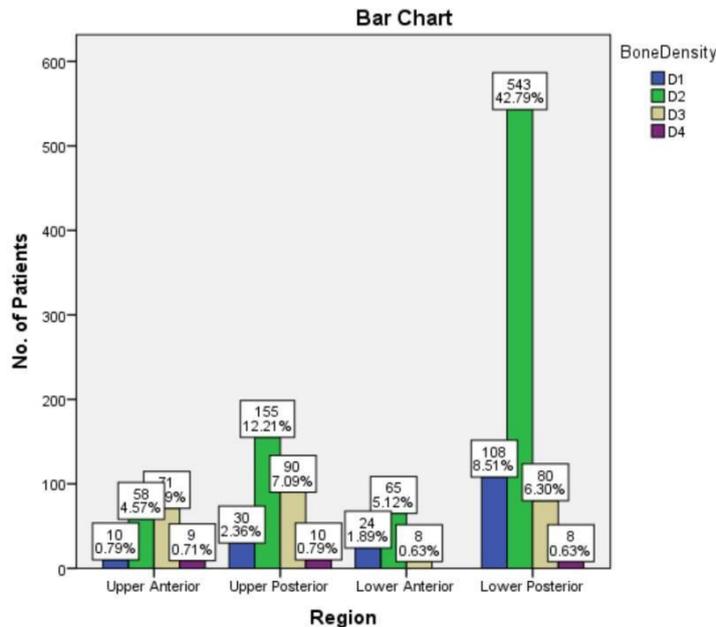


Figure 2: Bar graphs showing the association of the region and bone density. X axis represents the Primary stability and Y axis represents the no of patients. The types of bone density are D1 bone density (blue), D2 (green), D3 bone density (beige) and D4 bone density (purple). Chi square association was done and

found to be statistically significant, Chi square value: 181.214, df: 9, p value: 0.000 (< 0.05), hence proving that the lower posterior region had more density than other regions.

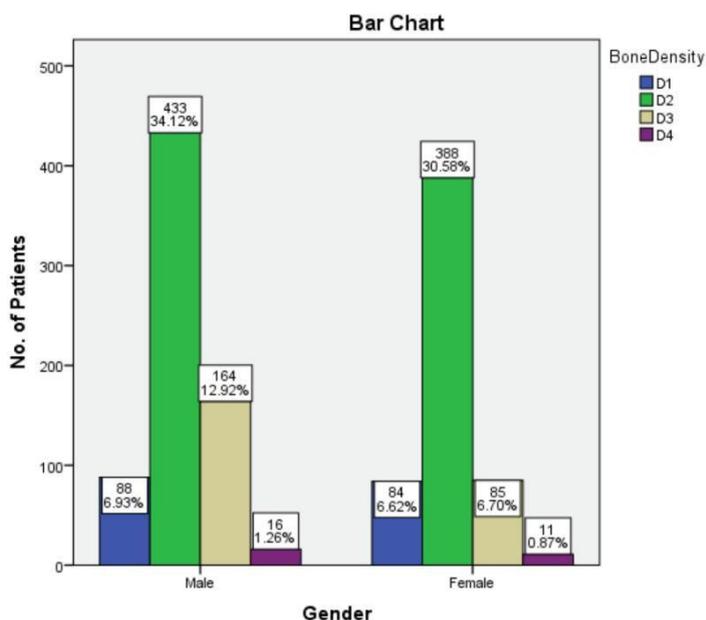


Figure 3: Bar graphs showing the association of gender and bone density. X axis represents the Primary stability and Y axis represents the no of patients. The types of bone density are D1 bone density (blue), D2 (green), D3 bone density (beige) and D4 bone density (purple). Chi square association was done and found to be significant, (chi square value: 14.773 , df: 3 , p value: 0.002 (< 0.05), hence proving that males have better bone density than females.

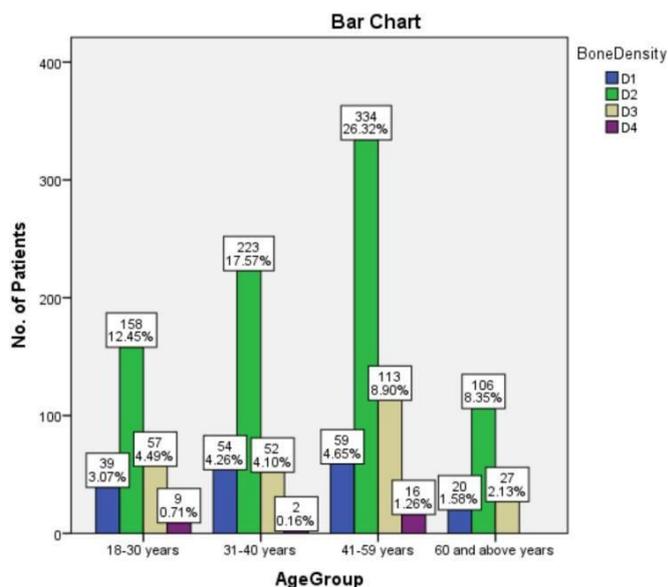


Figure 4: Bar graphs showing the association of age group and bone density. X axis represents the Primary stability and Y axis represents the no of patients. The types of bone density are D1 bone density (blue), D2 (green), D3 bone density (beige) and D4 bone density (purple). Chi square association was done and found to be statistically significant, (chi square value: 21.560, df: 9 , p value: 0.010 (< 0.05), hence proving that 41- 59 years of age group has better bone density than other age groups.

Bone density		Age group						Chi Square Value
		Primary Stability		18-30 years	31-40 years	41- 59 years	60 above years	
	D1	40-50 Ncm		12	14	17	10	0.343
		30- 40 Ncm		22	28	36	10	
		20-30 Ncm		4	8	4	0	
		15-20 Ncm		1	4	2	0	
	D2	40-50 Ncm		32	45	74	27	0.634
		30- 40 Ncm		104	133	200	63	
		20-30 Ncm		14	35	44	14	
		15-20 Ncm		8	10	16	2	
	D3	40-50 Ncm		15	10	31	3	0.542
		30- 40 Ncm		28	23	44	12	
		20-30 Ncm		10	11	24	9	
		15-20 Ncm		4	8	14	3	
	D4	40-50 Ncm		1	0	0	0	0.482
		30- 40 Ncm		5	0	6	0	
		20-30 Ncm		2	1	4	0	

			15-20 Ncm	1	1	6	0	
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*The Chi-square statistic is significant at the 0.05 level.

Table 1: Association between the bone density, age group and primary stability. Chi square association was done and found to be statistically not significant between the groups.