Socket Preservation Using Autogenous Bone Graft and Dentin Autograft after Surgical Removal of Impacted Mandibular Third Molar – A Split-mouth Study Design

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Abstract

Introduction: In our study, we have compared the efficacy of dentin bone graft for purpose of ridge preservation and have compared it with autogenous bone graft (ABG). A total of 15 patients were included in this study requiring extraction of bilaterally impacted third molar. On the one side, the socket was filled with processed dentin graft prepared after extraction of the third molar, and on the other side, the socket was filled with ABG harvested from external oblique ridge. The two were compared on the basis of various soft tissue and hard tissue parameters. **Aims:** This study aimed to evaluate and compare the efficacy of the dentin autograft with ABG for preservation of socket defect after removal of mandibular third molars clinically and radiographically. **Materials and Methods:** A total of 15 patients were included undergoing extraction for bilaterally impacted third molar. The socket on one side after extraction was filled with processed dentin from the same extracted tooth, and the other side of the socket was filled with ABG harvested from the external oblique ridge. **Results:** It was seen that dentin graft had the regenerative properties and showed potential for ridge preservation. **Conclusions:** Ridge preservation is essential for placement of implant and other prostheses. Preservation of ridge immediately after extraction bypasses the need for extensive ridge augmentation procedure. Hence, dentin graft can be used for this purpose as it has potential for bone regeneration.

Keywords: Autogenous bone graft, autogenous dentin graft, ridge preservation, third molar extraction

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Introduction

One of the routinely performed dental procedures is extraction of the unsalvageable tooth. Post extraction, the alveolar ridge undergoes rapid resorption for initial 6 months (50%).[1] In case of preexisting periodontal disease, traumatic extraction, and periapical lesions, the resorption rate of the alveolar ridge is increased. This indeed leads to difficulty in implant insertion and denture placement and also leads to esthetic concerns in anterior region. As per the literature, it has been noted that a greater amount of ridge resorption takes place in the buccolingual direction leaving a narrower or knife-shaped ridge. For more than two decades, different biomaterials have been used to preserve ridge which include materials such as autogenous bone graft (ABG), allograft, and xenografts. These biomaterials guide and assist specialized cellular components of the periodontium to participate in the regenerative process to preserve bone width and height of the alveolus. Out of all, ABG is considered gold standard as it has osteoinductive, osteoconductive, and osteogenic properties.

Dentin of the tooth has also been used for socket preservation. The chemical composition of teeth, especially dentin, is similar to the bone. Korea has its very own tooth bank where they produce the tooth graft material (AutoBT; Korea Tooth Bank Co., Seoul, Korea) from the extracted tooth which is sold commercially for the clinical use (Su-Gwan Kim, Young-Kyun Kim, Jin-Sung Park).[2]

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Materials and Methods

This study will be conducted in the Department of Oral and Maxillofacial Surgery, School of Dental Sciences, KIMSDU, Karad, after due approval of the Institutional Ethical Committee of KIMSDU**.** It is a prospective, comparative, clinical study. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975. The study period was from January 2020 to June 2021.

Inclusion criteria

Age of the patients ranging from 18 to 40 years; individuals having bilaterally impacted third molar, with similar degree of difficulty (according to Pederson's difficulty index)**;** alveolar sockets which were free of any preexisting periapical pathology based on orthopantomogram; and patients giving consent for the procedure were included in the study.

Exclusion criteria

Pregnant or lactating; any local or systemic medication or disease, which will interfere with bone remodeling and bone metabolism; impacted third molars, which are grossly carious or are associated with any pathology; individuals with a history of radiation therapy; and patients not giving consent for the procedure were excluded in the study.

Materials

The materials used for the procedure include autogenous dentin graft (harvested and processed), sieve (VTS test sieve – ASTM Mesh 300 µ) for including particulates of size more than 300 µ, domestic grinder (Vidiem Vtron Pro 900 Watts with 1000 rpm) for crushing the tooth, carbide straight fissure bur (SSW HP702) for extraction of the impacted tooth, collagen membrane (Healiguide® 15 mm × 20 mm; Advanced Biotech Products (P) Ltd., India) for securing the dentin and bone grafts in the socket, basic alcohol solution (0.5M NaOH and 30% alcohol) for removing the organic content of the tooth, Smartscraper (Geistlich Pharma India Pvt. Ltd.) to harvest the ABG, and 3-black braided silk suture (Healthium MedTech Private Ltd.) for closure.

Method

Graft preparation

Autogenous dentin graft

The extracted tooth was cleaned with the saline and made free of any calculus, or soft tissue attached to it by using a carbide straight fissure bur (SSW HP702). The tooth in toto along with enamel and cementum was then grinded in a high-speed sterile domestic grinder (Vidiem Vtron Pro) with 1500 watts and 700 rpm [Figure 1]. The dentin particulate was separated through a sieve (VTS test sieve) [Figure 2] that keeps particles between 500 and 1200 µm. This fine particulate (<300 µm) is considered a nonefficient particulate size for grafting. The particulate dentin was immersed in basic alcohol for 10 min [Figure 3], in a small sterile glass container. The basic alcohol cleanser consists of 0.5M of NaOH and 30% alcohol (v/v), for defatting, dissolving all organic debris, bacteria, and toxins of the dentin particulate. The particulate was washed twice, in sterile phosphate-buffered

Figure 1: (a) Domestic grinder of 1500 watts with 700 rpm, (b) extracted 38 tooth (c) particulate of the grinded tooth

Figure 2: Sieve used to separate particulate size of <300 µ

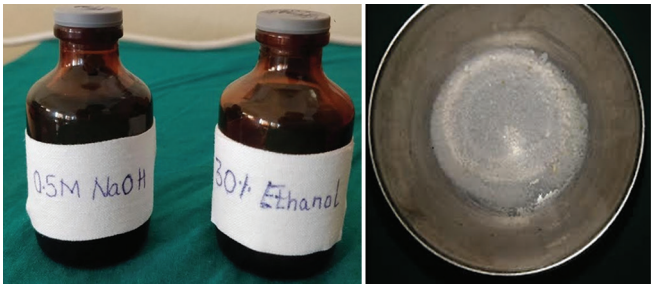

Figure 3: Dentin particulate soaked in basic alcohol solution

saline. The process from tooth extraction until grafting takes approximately 15–20 min. The extraction socket of 38 (i.e., Group A) was filled with the processed dentin and secured with absorbable collagen membrane to secure the graft. Thereafter, the extraction site was closed using 3-0 black braided silk suture [Figure 4].

Autogenous bone graft

Similarly, surgical extraction of 48 teeth (Group B) was extracted after 1–2 weeks and the socket was filled with ABG and secured with a collagen membrane [Figure 5]. The bone graft was harvested from the external oblique ridge of the mandible using a bone scraper [Figure 6].

Postoperative antibiotic, analgesic, and antacid coverage was given for a period of 5 days. Patients were also advised to use mouthwash to keep the surgical site clean.

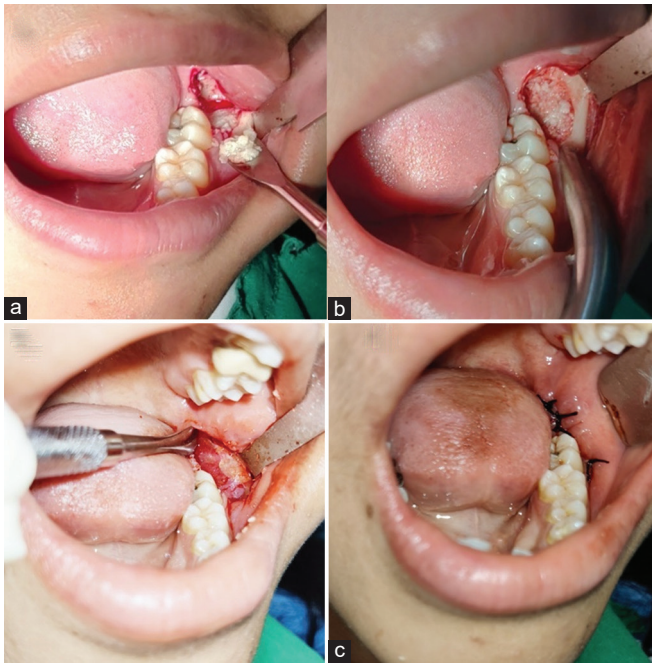

Figure 4: (a) Filling the extraction socket with dentin graft. (b) Collagen membrane placed. (c) Closure done with 3-0 braided silk suture

Figure 6: Bone scraper

An immediate postoperative radiovisiography (RVG) [Figure 7] was done and the height and density of the filled sockets were noted. The patient was evaluated for the soft tissue healing parameter on postoperative days 1 and 7.

Patients requiring extraction of bilaterally impacted third molar extraction with similar grade of difficulty according to Pederson's difficulty index were selected, as shown in Figure 8.

Intraoral and extraoral examination was done. Patients' mouth opening was evaluated preoperatively [Figure 9].

Surgical steps for extraction of third molar

First, the surgical extraction of left side third molar (Group A) was carried out in a standard stepwise manner in aseptic condition. The socket was then irrigated using betadine and saline.

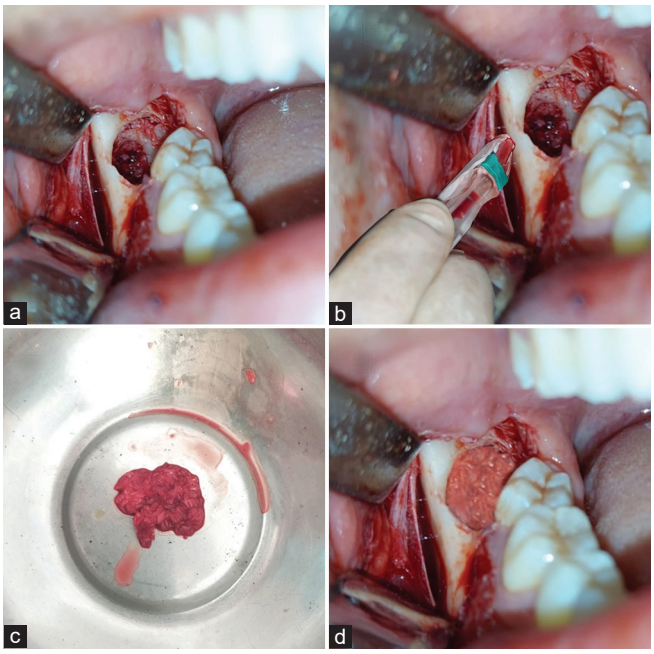

Figure 5: (a) 48 socket. (b) Smartscraper used for bone harvesting. (c) Bone chips collected. (d) Socket filled with autogenous bone graft

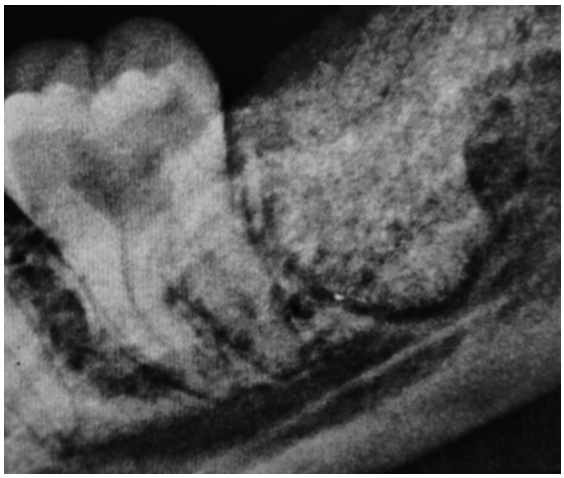

Figure 7: RVG showing 38 socket filled with autogenous dentin graft, RVG: Radiovisiography

Postoperatively, mouth opening or any sign of trismus was evaluated and facial measurement was taken with silk thread using Amin and Laskin's modified criteria for evaluating postoperative inflammation and swelling. Soft tissue healing was assessed using Landry, Turnbull, and Howley's wound healing index, which includes redness of soft tissue, granulation tissue, incision margin, and bleeding on probing. Pain was evaluated using the Visual Analog Scale (VAS) on immediate postoperative days 1 and day 7. The hard tissue evaluation was done on postoperative day 1 and 6 months [Figure 10], using dental imaging software 6.13.3 to assess the height of the socket and density of the underlying bone.

Statistical test used

Statistical analysis was done using the IBM SPSS Statistics v23.0; Chicago, SPSS Inc. Frequency and descriptive analysis of different parameters was done. To compare the data between the study group and the control group, paired *t*-test was used where the value of $P < 0.05$ suggested that the result did not occur by chance and the value of P is clinically significant. Bonferroni correction test was used to identify P value to evaluate the difference between the mouth opening between the three time intervals, i.e., preoperatively, postoperative day 1, and on day 7 rejecting the null hypothesis. Mann–Whitney test was used to find the P value for swelling and soft tissue healing as the sample size is more than 7.

Figure 8: OPG showing bilaterally impacted mandibular third molars with similar difficulty index, OPG: Orthopantomogram

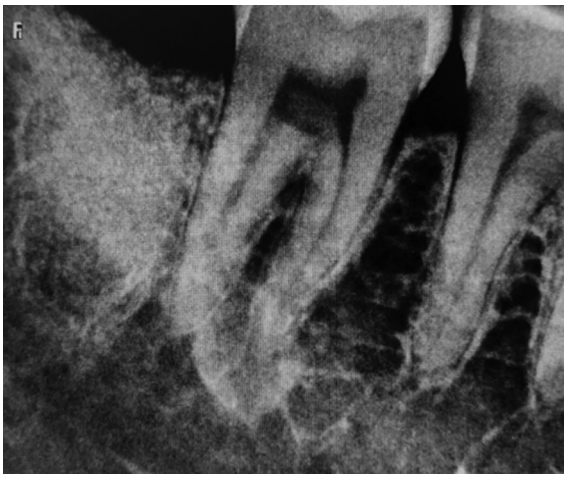

Figure 10: RVG showing 48 socket filled with autogenous bone graft, RVG: Radiovisiography

Results and Analysis

The data obtained were entered in Microsoft Excel (2013). Moreover, the statistical analysis was done using social sciences (SPSS) software (v. 23.0). Since we had lost follow-up of three patients, the analysis was carried out with the collected data of the remaining 12 patients.

Preoperatively interincisal mouth opening was recorded using stainless steel scale.

On postoperative days 1 and 7, mouth opening was seen to be more in Group A as compared to Group B, i.e., P value on day 1 was 0.021. Group B showed reduced mouth opening since bone harvesting is a comparatively more invasive procedure than dentin harvesting on day 7 the P value was seen to be 0.768 [Table 1 and Figure 11]. This leads to more edema and swelling which in turn leads to decrease in mouth opening and also the patient complained more pain on the right side postoperatively which was recorded using VAS [Table 2 and Figure 12].

Swelling was assessed in Groups A and B using Amin and Laskin's modified criteria.[2] A comparison of the swelling between the two groups was done using Mann–Whitney U-test. The mean value of Group A on postoperative day 1 was 13.67 and of Group B was 17.07. The value of P on day 1 was 0.008, which is clinically significant. The mean value of Group A on

Figure 9: Mouth opening is checked using a stainless steel scale

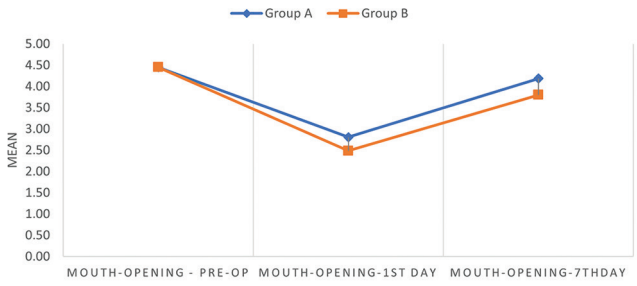

Figure 11: Comparing mouth opening in Group A and Group B based on mean values

day 7 was 1.40 and of Group B was 3.70; the value of *P* was found to be 0.003 which is clinically significant [Table 3 and Figure 13].

Other soft tissue healing parameters were evaluated using Landry, Turnbull, and Howley Index, using Mann–Whitney *U*-test the *P* value was found to be insignificant [Table 4]. The height and density were measured on day 1 and after 6 months. The density of socket of Group A mean was 136. 4 on day 1 and after 6 months was 146.80 and that of Group B on day 1 was 120.80 and on the 6th month was 140, the P value on day 1 and after 6 months was 0.00 which is highly significant using students paired *t*-test [Table 5 and Figure 14]. This shows that dentin is osteoconductive in nature. Whereas the height on day 1 for Group A mean was 12.43 and after 6 months was 12.88, the mean height of Group B on day 1 was 9.79 and after 6 months was 9.98. The *P* value on day 1 was 0.00 and after 6 months was 0.00 which is highly significant [Table 6 and Figure 15].

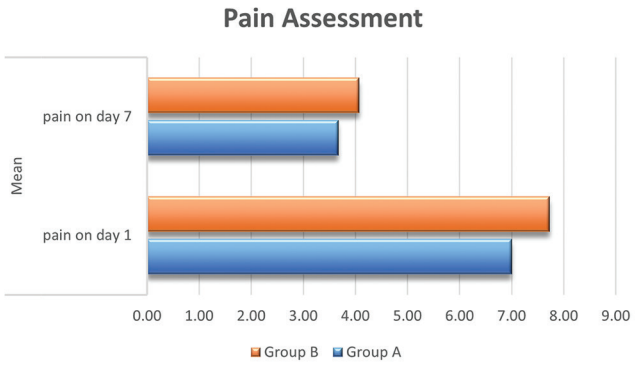

Figure 12: Comparing pain by vas in Group A and Group B based on mean values

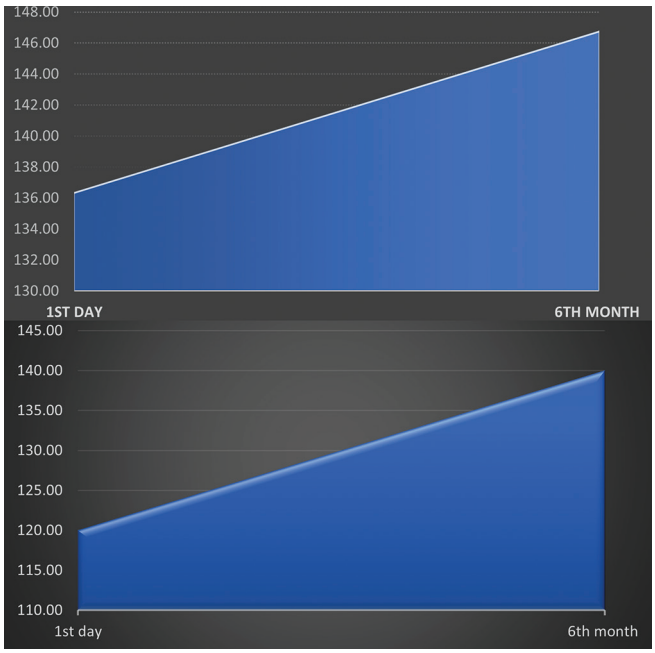

Figure 14: Comparing bone density in Group A and Group B based on mean values

Discussion

The loss of alveolar ridge height after tooth extraction is an undesired phenomenon with natural healing after extraction. Reductions in width between 2.6 and 4.6 mm and in height between 0.4 and 3.9 mm are observed. DI Ten Heggeler JMAG, 2011,[3] and Pinho *et al*., 2006,[4] in the same study showed that this resulted in shrinkage and shortening the remnant bone. To understand the use of tooth material as bone graft, we must consider the chemical composition of human teeth and alveolar bone. The ratio of inorganic/organic/water from various components of teeth goes as: enamel (95%/0.6%/4%), dentin (70%–75%/20%/10%), and cement (45%–55%/50%–

Table 1: Comparing mouth opening in Group A and Group B based on mean values

Mouth opening	Group	Mean difference	Bonferroni test (*P*)	
Mouth opening preoperatively	Group A	4.45	0.678	NS
	Group B	4.45		
Mouth opening postoperative day 1	Group A	2.80	0.021	HS
	Group B	2.48		
Mouth opening postoperative 7th day	Group A	4.18	0.768	HS
	Group B	3.80		

NS=Not significant; HS=Highly significant

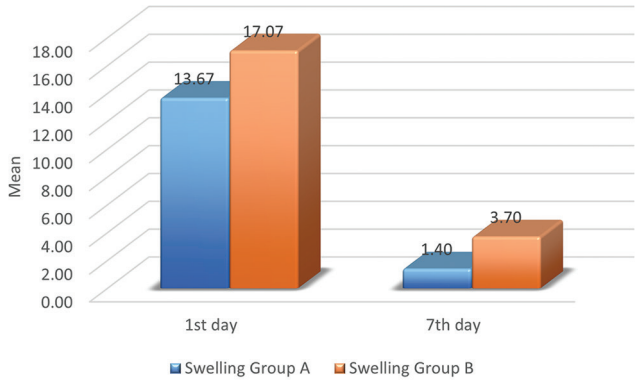

Figure 13: Comparing swelling in Group A and Group B based on mean values

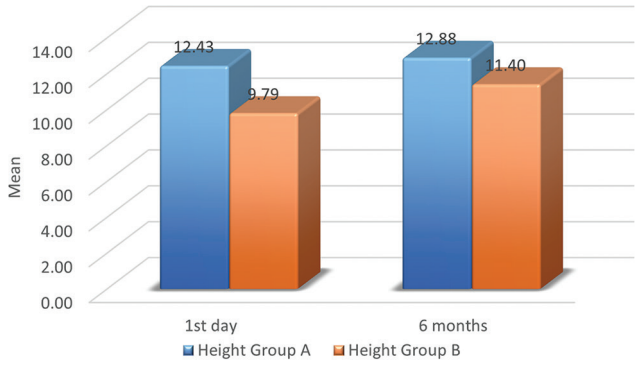

Figure 15: Comparing bone height in Group A and Group B based on mean values

55%).[5] Moreover, when the components are compared with the bone, the ratio is seen to be 65%/35%/0%, this shows the similarity between the bone and dentin. Given these possibilities, researchers began to look for various hard tissues present in the teeth. Pioneer studies showcasing the bone-inducing potential of dentin by Yemen and Urist opened new frontiers for implants. Yeomans and Urist were the first to discover the osteoinduction capacity demineralized dentin matrix. In the same year, Bang and Urist also noted similarities between the collagen matrix of the dentin and bone, thereby discovering the osteoconductive capacity of the dentin.[6]

Given the role of dentin and its higher composition in the tooth when compared to enamel and cementum, several studies have approached different methods of treating the dentin matrix for its optimization to produce its clinical effects. In the inorganic part of dentin, X-ray diffraction analysis revealed this contrast enamel hydroxyapatite, dentin hydroxyapatite (contains 70% dentin volume) equipped with low-crystalline calcium phosphate in return Osteoclasts allow this mineral to degrade easily, promoting efficient bone formation transformation.[7] This property not only resembles bone tissue, but is mainly composed of due to the low crystalline calcium phosphate, but also essential for the regeneration of the alveolar column, provides osteoconductive capacity.[8] In addition to hydroxyapatite, there are three other biological calcium phosphates such as tricalcium phosphate, octacalcium phosphate, and amorphous calcium phosphate. All these forms interact with each other and play one positive role in bone remodeling. The organic component of the dentin matrix

Table 2: Comparing pain by the Visual Analog Scale in Group A and Group B based on mean values

	n	Mean	SD	*t*-test (*P*)	
1st day					
Group A	12	7.00	1.31	0.000	HS
Group B	12	7.73	1.90		
7th day					
Group A	12	3.67	0.90	0.00	HS
Group B	12	4.07	0.59		

HS=Highly significant; SD=Standard deviation

Table 3: Comparing swelling in Group A and Group B based on mean values

	Swelling on day 1	Swelling on day 7	Mann–Whitney test (*P*)	
Group A	13.67	1.4	0.008	HS
Group B	17.2	3.70	0.003	HS

HS=Highly significant

Table 4: Comparing soft tissue parameters in Group A and Group B

Parameter	*n*	Mean	SD	Median	IQR		Mann–Whitney test (*P*)	
					25th	75th		
1st day								
Bleeding on probing								
Group A	15	2.00	0.655	2.00	2.00	2.00	1.000	NS
Group B	15	2.00	0.655	2.00	2.00	2.00		
Color of gingiva								
Group A	15	1.80	0.561	2.00	1.00	2.00	0.814	NS
Group B	15	1.67	0.488	2.00	1.00	2.00		
Granulation tissue								
Group A	15	2.20	0.414	2.00	2.00	2.00	0.529	NS
Group B	15	2.20	0.414	2.00	2.00	2.00		
Incision margin								
Group A	15	2.00	0.535	2.00	2.00	2.00	0.555	NS
Group B	15	2.00	0.535	2.00	2.00	2.00		
7th day								
Bleeding on probing								
Group A	15	4.27	0.594	4.00	4.00	5.00	1.000	NS
Group B	15	4.20	0.676	4.00	4.00	5.00		
Color of gingiva								
Group A	15	3.67	0.724	4.00	3.00	4.00	0.242	NS
Group B	15	3.80	0.676	4.00	3.00	4.00		
Granulation tissue								
Group A	15	4.53	0.516	5.00	4.00	5.00	1.000	NS
Group B	15	4.20	0.775	4.00	4.00	5.00		
Incision margin								
Group A	15	4.60	0.507	5.00	4.00	5.00	0.073	NS
Group B	15	4.13	0.743	4.00	4.00	5.00		

NS=Not significant; HS=Highly significant; SD=Standard deviation; IQR: Interquartile range

Table 5: Comparing bone density in Group A and Group B based on mean values

	Group A	Group B	Student's paired *t*-test (*P*)	
Day 1	136.4	120.80	0.00	HS
6th month	146.80	140.00	0.00	HS

HS=Highly significant

Table 6: Comparing bone height in Group A and Group B based on mean values

	Group A	Group B	Student's paired *t*-test (*P*)	
Day 1	12.43	9.79	0.00	HS
6th month	12.88	9.98	0.00	HS

HS=Highly significant

contains a dense network of type 1 collagen 90% of its content is fiber.[9] The other 10% consists of so-called noncollagen proteins such as osteocalcin, osteonectin, sialoprotein, and phosphoprotein known to be involved in bone calcification. In addition, growth factors are also present, including bone morphogenetic proteins (BMPs), the mineral protein LIM 1 (LIM proteins carry two tandem copies of the LIM domain (the acronym stands for Lin-11, Islet-1, and Mec-3 —the three original members of the family) and transforming growth factor β. Bessho *et al*. compared BMP for the dentin matrix with BMP for the bone matrix and came to that conclusion they are not identical; they both stimulate bone formation.[10] Similarly, Boden *et al*.[11] proposed that mineral differentiation 1 LIM 1 is a positive regulator of osteoblastic differentiation. These growth factors, along with other noncollagen proteins, have been shown to have osteoinductive potential.

In our study, the processing of dentin was done chairside once the extraction of lower third molar was completed. After cleaning the tooth surface of adjacent and overlying tissue with the help of a straight fissure bur, the tooth was grinded in a domestic grinder which was also used by Joshi *et al*.,[12] whereas Binderman *et al*.[13] used Smart Dentin Grinder which is commercially available for the purpose of grinding dentin into specific size far costly than domestic grinder.

The extraction of 48 teeth was carried out in the following week carrying out the same surgical steps. The socket was filled with the ABG harvested from the external oblique. In the study, harvesting of enough bone to fill the entire socket was difficult, not enough volume was achieved to fill the socket till the cementoenamel junction, and different levels of bone fill were achieved in all the 12 patients depending on the bone harvested. RVG of the socket was taken for the purpose of comparison. Data on soft tissue were collected on the day of suture removal of the control side, and the patient was called for follow-up after 6 months.

Soft tissue healing was recorded on the basis of Landry, Turnbull, and Howley's index.[14] It was essential to evaluate the soft tissue healing as a new blood supply is invariably important in all kinds of bone healing and a complete coverage of soft tissue is essential for the underlying graft. In our study, we found out that the *P* value for the grafted site and control site was significant only in terms of pain, mouth opening, and swelling which was seen to be more on the side where the autogenous graft was harvested.

There was no clinical significance when other soft tissue parameters such as color of gingiva, incision margin, and bleeding on probing were compared and there was a clinical difference found between the two. Furthermore, the healing in 10 out 12 patients was uneventful. Only two patients in our study had suppuration on postextraction day 7; this was attributed to local factors such poor maintenance of oral hygiene in the control group. The main objective of our study was to assess the beneficial effect of the dentin graft, and the results were found to be positive. The bone height and density were noted on day 1 and the next follow-up was after 6 months; during this period, none of the patients returned with any complaint regarding the operated site. The results were seen to be clinically significant when the two grafted sites were compared. It was noted that the mean increase in Group A was nearly 0.88 mm whereas there was not much change when compared to the socket filled with the bone graft. By using Student's *t*-test, the value of *P* for both the groups after 6 months was 0.00 which is highly significant. The bone density was checked in digital imaging software 6.13.3 by choosing the densitometric analysis in the toolbar after taking RVG. This showed a significant difference on post-operative day 1. The site filled with dentin appeared more radio-opaque than the socket filled with bone as the mineral and crystalline content of dentin is more pronounced. Secondly the volume of bone graft was less in comparison to volume of dentin, hence socket appeared slightly radiolucent. Keeping the formula of density in mind which is, area or surface density is the amount of a quantity (often mass) per unit of area; density = quantity/area. It is important to note that densitometric analysis shows the mean grayscale value of selected area in a radiograph which depicts the density of bone in a selected area. The *P* value was found to be 0.00 which is considered highly significant with a mean value of about 136.40 for Group A and 120.27 for Group B. The formation of new bone was seen in both the socket after 6 months, but the site grafted with dentin showed higher mean grayscale value of about 146.80 and a mean value of 140.00 in the ABG site that is the site grafted with the bone graft with the value of $P < 0.05$. The hard tissue finding in our study was highly significant. This result coincided with studies performed by Joshi *et al*.,[12] Kabir *et al*.,[15] and other authors who studied the regenerative property of dentin autograft.

Conclusions and Summary

Even though ABG is considered gold standard for restoring the lost bone and has proven to have better regenerative property, the drawback is it can lead to donor site morbidity. Like in our case, we noticed that there was increased patient discomfort in terms of postoperative pain, swelling, and mouth

opening when the patient had undergone surgical extraction with 48 sides which was then filled with ABG whereas there was comparatively better result was seen when dentin grafting procedure was carried out. For the past few decades, the authors have been testing the effectiveness of dentin autograft and trying to break the age-old tradition of discarding a tooth after the extraction. Allografts are the graft material from the same species but different individuals, even though allografts undergo different tests prior to use the chance of disease transmission still exists and cannot be dismissed. Alloplastic materials are osteoconductive, but they lack the intrinsic potential of osteogenesis and osteoinduction; the downside of these materials is that it is not economical for every patient. Similarly, xenografts are also expensive and there is always a risk of infection that should be considered, thereby leading to its failure. On the other hand, dentin autograft has shown good results with several authors backing their study with positive results in case of sinus lift, socket preservation, or immediate implant placement.

Ethical statement

The institutional Ethics committee of Krishna institute of Medical Sciences. (Protocol number 167/2019-2020).

Financial support and sponsorship

This study was financially supported by the Research Department, KIMSDU.

Conflicts of interest

There are no conflicts of interest.

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