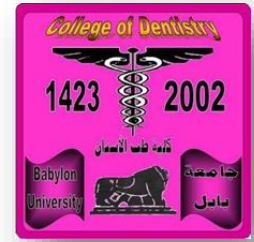


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# The Application of autogenous demineralized dentine matrix as a bone graft: A Review

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**Abstract:**

**Background:** ADDM has been used in clinical dentistry. It has been used for socket preservation, ridge augmentation and sinus floor lifting to improve implant stability. However, its effect is still questionable.

**Aim:** to revise the effect of ADDM on socket preservation, ridge augmentation and sinus floor lifting.

**MATERIALS AND METHODS:** google scholar, Scopus database, and manual search were performed to find out articles on the effect of ADDM on socket preservation, ridge augmentation and sinus floor lifting.

**Results:** Ten articles were found, two Randomized clinical study , two retrospective studies, three prospective studies, two pilot studies and one case series discussing the effect of ADDM on the above mentioned clinical applications and subsequent effect on success rate of dental implant.

**Conclusion:** ADDM exhibited a promising effect on tooth socket preservation when combined with other biomolecules. ADDM had a comparable effect to other bone substitutes on ridge augmentation. More studies should be conducted to draw a definitive conclusion on the effect of ADDM on sinus floor lifting and success of dental implant.

## 1.INTRODUCTION:

Over two million bone graft operations are performed worldwide every year, and this number is increasing dramatically due to an aging population (Pereira and Habibovic, 2018). Autogenous bone, allogenic bone, xenogeneic bone, and alloplastic materials are bone graft materials that are used in dentistry. They can be categorized into materials that induce osteogenesis, osteoinduction and osteoconduction according to bone healing mechanism (Kim et al, 2010). An ideal bone graft material should stabilize the blood clot, provide a biomechanical scaffold for cell migration, proliferation and differentiation; contain functional proteins and peptides, such as growth factors; and exhibit appropriate resorption and remodeling during new bone formation (Ogundipe et al, 2011). The most ideal material for reconstructing hard tissue defects is an

autogenous bone graft material that heals quickly and results in osteogenesis, osteoinduction, and osteoconduction, without immune rejection. Autogenous bone, however, has very limited harvesting volume, resorption is unavoidable, and a second defect is induced in the donor area. allogeneic and xenogeneic graft materials have concerns regarding the spread of infection in addition to their high cost. Synthetic bone, in contrast, is relatively inexpensive and involves no risk of disease, but it lacks the ability to promote osteogenesis and osteoinduction, and thus its utility is limited for the formation of viable bone (Kim , et al, 2010).

The tooth is increasingly attracting attention as a material for alveolar bone regeneration. It is well known that the structure and composition of dentin is similar to that of bone, consisting of collagen 20%, hydroxyapatite 70%, and body fluid 10% by weight (Bath-Balogh and Fehrenbach, 2006). Dentin is thought to have a high osteoconductivity since it is a natural mineralized tissue consisting of hydroxyapatite. Furthermore, dentin matrix is expected to exhibit osteoinductivity because it contains bone morphogenetic proteins (BMPs) (Yeomans and Urist, 1967). Moreover, the tooth has a much lower fat content and no marrow compared to bone, which makes it easier to be changed into graft material (Jahangiri et al, 1998).

Several basic animal studies have shown demineralized dentin matrix (DDM) to be not only biocompatible, but also osteoinductive, similar to demineralized bone matrix (Finkelman et al, 1990; Guo et al, 2009; Li et al, 2011). In some patients, tooth extraction is required and these teeth are usually discarded. It would be beneficial if they could be utilized as autogenous grafting material and thereby avoid the risk of disease

transmission (Minamizato et al, 2018). Due to chemotactic properties for osteoblasts and osteoprogenitor cells, DDM from the patient's own extracted healthy tooth can be used for promoting the bone regeneration process at reconstructive dentistry, including extraction socket preservation, ridge augmentation, sinus bone graft, and guided bone regeneration (GBR) for implant site development (Kim et al, 2014; Lee et al, 2013; Park et al, 2012). However, Autogenous demineralized dentin matrix has some limitations. Primarily, it is time-consuming because of the inevitable surgical extraction and the external manufacturing process required to prepare the material. Following, the amount of Auto-DDM obtained is unpredictable as it depends on several clinical conditions, such as dental caries, restorations, and prostheses in the harvested teeth (Tanoue et al, 2018).

The aim of this review was to evaluate the application of ADDM as bone graft material in tooth socket preservation, ridge augmentation and sinus floor lifting).

## **2. MATERIAL AND METHOD:**

Electronic Search was conducted on PubMed, Google scholar and research gate to find out articles on the use of ADDM for tooth socket preservation, ridge augmentation and sinus floor lifting. This was performed by using keywords such as autogenous demineralized dentin matrix, socket preservation, ridge augmentation, sinus lift and implant stability. Searching query was modified for each database if needed to achieve most relevant studies. The data were collected based on the relevance to the study topic and the main objective. Twenty-two studies were chosen according to the title skimming and abstract screening, and

then the references of these studies were searched and checked in Google Scholar. After removing duplicates, the relevant ones were added based on the title and abstract screening. Only ten papers were chosen for data extraction. according to the following inclusion and exclusion criteria:

Inclusion criteria:

- 1) Articles written in English in a peer-reviewed journal
- 2) Patients age older than 18 years.
- 3) Patients number not less than 8
- 4) Minimum follow-up of 3 months after the procedure
- 5) Articles published between 2014 -2021

Exclusion criteria:

- 1) Studies performed in animals
- 2) Single-case reports.
- 3) Studies that used other dental tissues apart from dentin.
- 4) Studies that used xenogeneic or allogenic dentin
- 5) Articles not written in English language.

These collected articles were analyzed according to the reference, type of study, clinical applications, patients' number, age, gender, follow up and outcome. The reviewed articles were categorized based on their clinical application into: socket preservation (three papers), alveolar ridge augmentation / implant stability (five papers) and sinus lift procedure (two papers).

### **3. RESULT:**

Ten articles were chosen to review the effect of ADDM on tooth socket preservation, ridge augmentation and implant stability and sinus floor lifting. Three articles on the use of ADDM for socket preservation, five articles for ridge augmentation and implant stability and two articles for sinus floor lifting. Summary of these articles are shown in table:

author	Type of study	Clinical application	n =	Mean age (yrs.)	Gender Male / female	Comparison	Follow up	outcome
Ahmed elfana et al, 2021	Randomized clinical study	socket preservation	20	autogenous whole tooth graft (AWTG) =33.5 ADD Graft = 31.2	4/16	AWTG vs ADD graft	6 months	Reduction for buccal bone height was 0.61 mm for AWTG and 0.72mm for ADD graft
Dhuvad et al, 2021	Randomized clinical trial	socket preservation	200	N/A	122/88	bone density at ADDM graft site vs adjacent bone	6 months	after 6 months, the bone density was much higher (169) in area packed with ADDM compared with the adjacent bone (105)
In Woong Um 2018	A case series	Socket preservation	16	60.06	8/8	Demineralized dentin matrix (DDM) and recombinant human bone morphogenetic protein-2 (rhBMP-2)	3-6 months	The amount of bone formation 34.39% in the DDM/ rhBMP-2group and 29.75% in the DDM group

Yonsoo Shin et al, 2020	Retrospective study	Implant stability / Alveolar Ridge Augmentation	30	51.8	N/A	ADDM and ADDM+mix with autogenic, allogenic, xenogenic, synthetic bone graft material, or combination of the above	7.2 yrs	95.19% success rate
Kang-Mi Pang et al. 2016	Prospective randomized	Implant stability / Alveolar Ridge augmentation	24	autoBT 38.53 yrs Bio-oss 60.56 yrs	Auto BT (n=15) 8.7 Bio-Oss (n=9) 3:6	autogenous tooth graft material )AutoBT( compared to that of anorganic bovine bone BIO-OSS	6 months	the volume fractions of newly formed bone were 31.24% for AutoBT and 35.00%for Bio- Oss
Peng Li MD 2015	A prospective clinical study	Implant stability / alveolar ridge augmentation	40	36	24/16	DDM vs Bio-Oss can cellous granules )Geistlich Pharma AG, Wolhusen, Switzerland )	1.5 yrs	Stability ISQ value = 79.5 for DDM, 80.2 for Bio-Oss granules with no statistical significance difference
In-Woong Um et al 2020	Pilot study	Dental Implant/alveolar Ridge augmentation	96	57.3	59/37	Allo-DDM and Auto-DDM	12 months	No significant difference
Minamizato T, et al. 2017	Pilot study	Dental Implant Stability / alveolar ridge augmentation	16	50	10/6	N/A	2 yrs	No implant was lost

Young Kyun Kim et al 2014	retrospective study	Sinus lift	22	AutoBT =57.5 Synthetic bone grafting = 63.9	Auto B T= 8.3 Synthetic bone grafting= 5:6	AutoBT vs synthetic bone graft	1 year	Mean increase in bone height =4.89 mm for AutoBT and 6.22 mm for Synthetic bone grafting
Hesham Fattouh et al 2018	prospective study	Sinus lift	12	N\A	N\A	No comparison	12 months	at 12 months, total graft height loss was $2.65 \pm 0.7$ mm. The percentage of graft loss was $22.4 \pm 4.4$ %

\*AWTG:Autogenous Whole Tooth Graft, \*ADD: Autogenous demineralized dentin, \*N/A: Not available, \*DDM: Demineralized dentin matrix, \*rhBMP-2: recombinant human bone morphogenetic protein-2, \*ADDM: Autogenous demineralized dentin matrix, \*AutoBT : autogenous tooth graft material, \*BIO-OSS: anorganic bovine bone, \*Allo-DDM: Allogenic-demineralized dentin matrix

**1- Alveolar bone or socket preservation:** Three articles were found on the usage of ADDM for socket preservation. Two articles were randomized clinical trials and one study was a case series. In the study of (Elfana et al, 2021), the effect of ADDM was compared with autogenous whole tooth graft (AWTG) on alveolar bone preservation after tooth extraction. The patients were followed-up for 6-months and the results revealed that the reduction in buccal bone height was about 0.61 and 0.72 mm for AWTG and ADDM, respectively. (Dhuvad et al, 2021) used ADDM to preserve tooth extraction socket and they followed-up the patients at different time intervals (1, 3, 6 months). The results indicated that there were no significant differences in the new bone formations at these time intervals. In the study of (Um et al, 2018), the effect of ADDM on socket

preservation was compared as a single graft and as a combination with a recombinant human bone morphogenetic protein -2 (rhBMP-2). After 3-6 months follow-up, the results showed that the amount of bone formation was 34.39% for the combination of DDM/rhBMP and 29.75% for those treated with ADDM alone.

**2- Alveolar ridge augmentation /Implant stability:** five articles were reviewed, two prospective randomized clinical trials, one retrospective study and two pilot study. In the study of (Pang et al, 2016), they compared the effect of ADDM against anorganic bovine bone (Bi-Oss) for ridge augmentation and implant stability. The patients were followed-up for 6 months and the results indicated that the volume fractions of the newly formed bone were 31.24% for AutoBT and 35.00% for Bio-Oss. The retrospective study of (Shin et al, 2020), studied the effect of ADDM and ADDM mixed with autogenic, allogeneic, xenogeneic, synthetic bone graft material as a combination on ridge augmentation and implant stability. The patients were followed-up for 7.2 years. This study come to conclusion that the success rate of inserted implant was 95.4% whether ADDM used alone or in combination with other bone grafts. In the study of (Peng Li et al, 2015), they compared the effect of ADDM against Bio-Oss cancellous granules (Geistlich Pharma AG, Wolhusen, Switzerland) for implant stability. The patients were followed up for 1.5 years and the result indicated that the stability for ISQ value is 79.5 for ADDM and 80.2 for BIO-Oss granules with no significance statistical difference. The pilot study of (In-woong et al 2020), compared between Allo-ADDM and Auto-DDM and the patient follow up for 12 months. The result showed that there was no significant difference between the two types of ADDM. Another pilot study was carried out by (Minamizato et al 2017) using

ADDM to augment atrophied ridge and improve implant stability. The authors of the study claimed that no implant was lost when ADDM used as a bone graft.

**3- Sinus floor lift:** For this application, two articles were obtained, one prospective study and the other retrospective study. In the retrospective study of (kim et al 2014), they compared the effect of ADDM against synthetic bone graft on sinus floor lifting. The patient was followed up for 1 year. The results of (Kim et al, 2018) indicated that synthetic bone graft increases bone height more than ADDM (6.22 versus 4.22 mm, respectively). (Fattouh et al, 2018) used ADDM for sinus floor lifting and delayed implant placement after 6 months of grafting procedure. The patients were followed-up for 6 months. The results of (Fattouh et al, 2018) revealed that the amount of bone loss was 2.44 mm (19.9%) after sinus lifting and 0.2 mm after implant placement. Besides, the success rate of the placed implants was 100%.

## 4. DISCUSSION:

DDM is autogenous tooth dentine that has osteoinductive and osteoconductive potential since dentine contains collsgene-1 and various growth factors. According to demineralization process, the factors remain available to the host environment; however, extracting proper concentration of collagen and bioactive molecules from the extracted tooth is a challenging and requires meticulous preparation of the tooth dentine. DDM is widely used in oral surgery, in the treatment of extraction socket preservation and other bone regeneration (sinus floor lifting and ridge augmentation). DDM can act as a scaffold to support bone regeneration and as a carrier for bone morphogenetic protein (BMP-2).

When it acts as a carrier, it combines the properties of the grafting material with those of delivered substances (UM et al, 2017).

In this review, ADDM induced more bone formation and support extraction socket preservation when combined with other biomolecules such as bone morphogenetic protein (BMPH-2) compared to those using ADDM as a single bone graft. This conclusion based on the revision of three randomized clinical trials. However, this decision cannot be considered as a definitive conclusion, as these articles lack enough information regarding surgical procedure, the variation in the method used to measure the amount of bone formation after using ADDM alone or in combination with other bioactive substances. Besides, the number of articles is low and is not enough to build a full judgment on these articles.

ADDM has been used for ridge augmentation to improve dental implant stability. Primary implant stability is one of the important factors that should be achieved for successful osteintegration (Barbera-Millan, 2021). In this review, the results of the five articles indicate that ADDM exhibited insignificant effect on primary implant stability when used as a bone graft to augment atrophied alveolar ridge. Although the study of (Shin et al, 2020) revealed that the success rate of dental implants was 95.4% when ADDM was used alone or in combination with other artificial materials, this study did not mention the degree of maxillary or mandibular atrophy, the correlation between the age of the patients and the degree of hypertrophied ridge and the type and diameter of implant inserted. Conclusively, ADDM has a comparable effect on ridge augmentation and does not have an overwhelming influence on implant stability compared with other bone substitutes.

There are many factors influencing graft stability in sinus floor lifting, type of grafting materials and the presence of implant which is the most important factor (Mardinger et al, 2011). The study of (Kim et al, 2014) indicated that synthetic bone graft increases more bone height more than that of ADDM. However, Kim and his co-workers studied this effect retrospectively and did not mention the baseline of the bone height before grafting procedure. Besides, they did not mention the method used to assess the amount of increased bone height in case of synthetic bone graft, the material of bone graft and whether this grafting procedure was followed- by implant placement or not. In contrast to study of (Kim et al, 2014), the prospective study of (Fattouh et al, 2014)

Revealed that ADDM was more stable than other bone substitute, as ADDM showed less resorption rate compared with other bone graft. Besides, they claimed that the implant success rate was 100%. Nevertheless, the study of (Fattouh et al, 2018) investigated the effect of ADDM without comparing this effect with other bone grafts. In addition to that, they did not mention the baseline of primary implant stability. Overall, there is no definitive conclusion can be drawn based on these two articles and more studies should be conducted to assess the effect of ADDM on sinus floor grafting and implant success rate.

## **5. CONCLUSION:**

ADDM exhibited a promising effect on tooth socket preservation when combined with other biomolecules. ADDM had a comparable effect to that of other synthetic bone grafts on ridge augmentation and implant stability. More studies should be conducted to assess the stability of

ADDM as a grafting material for sinus floor lifting and its effect on success rate of dental implants.

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