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# Evaluation of physical properties of demineralization dentine material membranes through tensile strength tests

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## Abstract

**Background**: The process of bone remodeling requires quite a long time, which is between 6-8 weeks. During the process, the proliferation of fibroblast cells occurs simultaneously. The process of fibroblast cell proliferation takes place more quickly when compared to bone remodeling process. Both processes that occur simultaneously can be at risk of failure of the process of bone remodeling, due to the intervention of fibroblast cells in the direction of bone defects so the bone that formed are not perfect. To prevent this intervention a Guided Bone Regeneration (GBR) is needed. GBR must have good mechanical strength to be able to withstand the pressure during the process of fibroblast cell proliferation. GBR which has been widely used in the medical field is made from porcine pericardium, this results in the use of GBR which cannot be used universally because it is not halal. For this reason, a Demineralized Dentine Material Membrane (DDMM) was made as an alternative to GBR. DDMM is made from demineralized bovine dentine.

**Purpose**: Proves that DDMM has good mechanical strength.

**Methods**: Three DDMM samples were tested using a Dynamic Mechanical Analyzer (DMA) to determine the value of tensile strength.

**Results**: In the tensile strength test found significant differences in the DDMM group against Jason Membrane ($p = 0.01$; $p < 0.05$).

**Conclusion**: DDMM has good strength in holding a force.

**Keywords:** GBR; DDMM; Tensile Strength; Bone Remodeling

## 1. Introduction

The healing process of cortical bone defects is not easy, because bone regeneration will occur considerably and human body is unable to regenerate itself.1 The process of bone regeneration can take place properly if non-osteogenic cells do not interfere with the bone defect area, so that osteoprogenitor cells can function optimally. Guided Bone Regeneration (GBR) can be used to prevent the infiltration of non-osteogenic cells toward bone defects.2

The thickness of the membrane affects the wound healing process. If a membrane that is too thin is used in the injured area, it can cause complications when the pressure of cell proliferation is too large and the membrane cannot withstand

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the strength of that pressure. Membrane with a thickness of more than 0.8 mm in the area of bone defects has a pretty good influence in helping wound healing because the membrane thickness is ideal.3

When the rate of osteogenesis is not interrupted by the process of fibrogenesis, the bone healing process can be done perfectly.4 However, this will be difficult without the use of GBR. Tensile strength ability in GBR is needed to separate soft and hard tissue in the bone healing process, so that the process of osteogenesis is not intervened by the fibrinogenesis process which takes place relatively quickly.

Demineralized Dentine Material Membrane (DDMM) is a membrane derived from bovine dentine, which is made as an alternative to GBR which has been widely used. DDMM was chosen because the material from the previous GBR was made from porcine. In addition, dentine matrix has osteoinductive properties by carrying Bone Morphogenetic Proteins (BMPs) which can help the formation of osteoblasts for bone regeneration.5,6

## 2. Materials and methods

The research was conducted using three DDMM samples with each sample measuring 5x5 mm with a thickness of 300 µm. Samples were obtained from bovine dentine that had been demineralized. The sampling technique is done by simple random sampling. The test was carried out using a Dynamic Mechanical Analyzer (DMA) to obtain maximum stress, maximum strain, and tensile modulus data.

## 3. Results

Tensile strength test is done by using DMA to get the maximum stress and strain maximum values, which are then used to calculate the tensile modulus value. Based on the data obtained, it appears that Jason Membrane has an average tensile modulus of 179 MPa. Whereas the DDMM obtained an average tensile modulus of 95.43 MPa. The data that has been obtained is then performed homogeneity test with Levene's test and significance test using Independent T-test.

**Table 1** Levene's test and Independent T-test

| Sample | Mean ± Standard Deviation | Sig. Levene's Test | Sig. Independent T-test |
|---|---|---|---|
| Jason Membrane | 179 ± 0.000 | 0.084 | 0.01 |
| DDMM | 95.43 ± 15.02 | | |

Note: p Levene's test > 0.05 → homogen; p Independent T-test >0.05 → significance

The results of the homogeneity test showed that the research data of the homogeneous tensile strength test with a significance value of more than 0.05 (p = 0.084).

Tensile strength difference test between DDMM and Jason Membrane, using the independent sample t-test, the 0.01 number indicates a significant tensile strength difference between the DDMM group and Jason Membrane.

## 4. Discussion

**Table 2** Tensile strength ratio in GBR

| GBR | Stress maximum (MPa) | Strain maximum (%) | Tensile Modulus (MPa) |
|---|---|---|---|
| Jason Membrane | 13.0 | 17.9 | 178.9 |
| Collprotect | 13.1 | 16.3 | 158.5 |
| DDMM | 4.94 | 5.26 | 95.43 |
| Bio-Gide | 4.80 | 46.8 | 15.70 |

Data obtained from various studies, there are several GBR that have been widely used, some of which are, Jason Membrane (Botiss biomaterials), Bio-Gide (Geistlich® membrane), and Collprotect (Botiss biomaterials). To be able to know the ability of DDMM better, a comparison is made on the whole GBR.

According to Ortolani et al, the tensile strength capabilities of the three membranes and the ability of DDMM will be described in the following table.

Stress maximum, strain maximum, and tensile modulus show the strength of a material to a pull, strain, and elasticity of the material.7,8 Although the average DDMM value is still below the value of Jason Membrane, DDMM can still be used as a GBR because the tensile modulus is quite good when compared to the value of Bio-Gide, which is 15.7 MPa.9,10 Based on the result of this study it was concluded that DDMM has potential for application on defect bone as guided bone regeneration11,12,13.

## 5. Conclusion

From these data, it can be concluded that DDMM is quite good in accepting a tensile force, but not flexible enough in accepting strain due to its fairly rigid physical properties.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

### *Statement of authorship*

All author participated in data collection analysis, and approved the final version submitted

## References

[1] Dimitriou R, Mataliotakis G, Calori G, Giannoudis P. The role of barrier membranes for guided bone regeneration and restoration of large bone defects: current experimental and clinical evidence. BMC Medicine. 2012;10(81):1-2.

[2] Elgali I, Omar O, Dahlin C, Thomsen P. Guided bone regeneration: materials and biological mechanisms revisited. European Journal of Oral Sciences. 2017;125(5):315-337.

[3] Santo L, Quadrini F, Bellisario D, Polimeni A, Santarsiero A. Variability of Mechanical Properties of Collagen Membranes used in Dentistry. 2018;55(4):488-492.

[4] Farzad M, Mohammadi M. Guided bone regeneration: A literature review. J Oral Health Oral Epidemiol. 2012;1(1):3-7.

[5] Lieberman J, Daluiski A, Einhorn T. The Role of Growth Factors in the Repair of Bone. The Journal of Bone and Joint Surgery. 2002;84(6):1032-1034.

[6] Murata M, Akazawa T, Mitsugi M, Um I, Kim K, Kim Y. Human Dentin as Novel Biomaterial for Bone Regeneration. Biomaterials – Physics and Chemistry. 2011:127-130.

[7] Hilmi A, Pratapa S. Sifat Termomekanik Komposit PEG/SiO2 Amorf Menggunakan Dynamic Mechanical Analyzer (DMA). Jurnal Sains dan Seni ITS. 2016;5(2):125-126.

[8] Li Z, Du T, Gao C, Tang L, Chen K, Liu J, Yang J, Zhao X, Niu X, Ruan C. In-situ mineralized homogeneous collagen-based scaffolds for potential guided bone regeneration. Biofabrication. 2022;14(4):045016. doi:10.1088/1758-5090/ac8dc7

[9] Ortolani E, Quadrini F, Bellisario D, Santo L, Polimeni A, Santarsiero A. Mechanical qualification of collagen membranes used in dentistry. 2015;51(3):229-231.

[10] Hu X, He Y, Tong Y, Sun N, Ma G, Liu H, et al. Fabrication and characterization of a multi-functional GBR membrane of gelatin-chitosan for osteogenesis and angiogenesis. Int J Biol Macromol. 2024; 266:130978. doi: 10.1016/j.ijbiomac.2024.130978

[11] Kamadjaja, D.B., Harijadi, A., Soesilawati, P., Wahyuni, E., Maulidah, N., Fauzi, A., Rah Ayu, F., Simanjuntak, R., Soesanto, R., Asmara, D. and Rizqiawan, A., 2017. Demineralized freeze-dried bovine cortical bone: its potential for guided bone regeneration membrane. International journal of dentistry, 2017.

[12] Qasim SSB, Al-Asfour AA, Abuzayeda M, Mohamed AM, Trajkovski B, Murray CA, et al. Differences in mechanical and physicochemical properties of several PTFE membranes used in guided bone regeneration. Materials. 2023;16(3):904. doi:10.3390/ma16030904

[13] Canzian J, Borba JV, Resmim CM, Mohammed KA, Pretzel CW, Adedara IA, Rosemberg DB. The dopamine transporter inhibition using GBR 12909 as a novel pharmacological tool to assess bipolar disorder-like neurobehavioral phenotypes in zebrafish. Behav Brain Res. 2025; 477:115302. doi: 10.1016/j.bbr.2024.115302.