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Clinical Article

Usefulness of Allogenic Acellular Dermal Matrix for Prevention of Scalp Depression after Burr Hole Trephination

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Conflict of Interest
The authors have no financial conflicts of interest.

ABSTRACT

Objective: Burr hole trephination is a common treatment for chronic subdural hematoma, intracranial hematoma, and intraventricular hematoma due to its effective drainage of hematoma, minimal invasiveness and short operation time. However, cosmetic complications such as scalp depression can occur. The aim of this study was to evaluate the usefulness of an allogenic acellular dermal matrix (ADM) to prevent scalp depression at the burr hole site.
Methods: A retrospective analysis was performed with 75 cases in 66 patients who were treated with burr hole trephination from January 2018 to December 2019. These cases divided into 2 groups; based on the method used to cover the burr hole site: Gelfoam packing only (GPO) and ADM. The degree of the scalp depression was measured from the more recent follow-up brain computed tomography scan.
Results: There was a significant difference in the degree of scalp depression between GPO and ADM groups (p=0.003). No significant correlation between patient's age and the degree of scalp depression (GPO: p=0.419, ADM: p=0.790). There were no wound infection complication in either group.
Conclusion: ADM is a suitable material to prevent scalp depression after burr hole trephination.

Keywords: Trephination; Acellular dermal matrix; Chronic subdural hematoma; Hematoma, intracranial subdural

INTRODUCTION

Burr hole trephination is a useful surgical treatment for chronic subdural hematoma, intracranial hematoma, and intraventricular hematoma because it is minimally invasive and requires a short operation time. However, scalp depression can be present as a complication following surgery. An allogenic acellular dermal matrix (ADM) is hypothesized to be an appropriate burr hole cover because of its use in other applications, including as a skin substitute, breast reconstructions, abdominal wall reconstruction, nasal augmentation in rhinoplasty, and orbital wall reconstruction.[8-10,14,17,18] However, to the best of our knowledge, there are no reports of ADM use in neurosurgery. In this study, we retrospectively assess the efficacy of ADM in patients following burr hole trephination since 2018. We divided

patients who underwent burr hole trephination into 2 groups based on the method used to cover the burr hole: Gelfoam packing only (GPO) or using ADM. We compared the degree of scalp depression at the burr hole site between these groups. In addition, we investigated any correlation between the patient's age and the degree of scalp depression.

MATERIALS AND METHODS

This was a retrospective analysis of 178 patients who underwent burr hole trephination from January 2018 to December 2019 at our institute. The follow-up period for each patient was at least 3 months after burr hole trephination, which is the minimum time for the substantial subsiding of scalp swelling. We excluded 110 patients who did not engage with the follow-up computed tomography (CT) scan because they missed a revisit or secondary to death. And 2 patients were excluded because a titanium burr hole cover was used instead of Gelfoam of ADM. We reviewed 66 patients' medical records, including 9 cases who underwent bilateral burr hole surgery. Therefore, 75 burr hole cases in 66 patients were included in this study. Cases were divided into 2 groups: GPO (n=44) and ADM (n=31). We did not apply any other inclusion criteria. An ADM (MegaDerm Hydrated; L&C BIO, Seoul, Korea) of approximately 3 mm in thickness was used following its shaping depending on the size of burr hole.

Burr hole trephination was performed in all patients as follows. First, a vertical scalp incision approximately 3cm in length was made at the target of burr hole site. The soft tissue was denuded and retracted using a retractor. Each burr hole was trephined using a high-speed drill (Acorn 6 mm 9AC60; Medtronic, Inc., Minneapolis, MN, USA) (**FIGURE 1A**). The dura mater was incised in a cruciate shape using a blade. Next, a drainage catheter was inserted followed by absorbable gelatin sponge (Gelfoam; Pfizer Inc., New York, NY, USA) packing. In the ADM cases, the correct size ADM was placed on the burr hole without any other procedure (**FIGURE 1B**). In the GPO cases, no material was used to cover the burr hole. Finally, the pericranium, soft tissue, and skin were sutured layer by layer.

The degree of the scalp depression was measured from the most recent follow-up brain CT scan at follow-up that measured bone density. A line was drawn through 2 points of adjacent

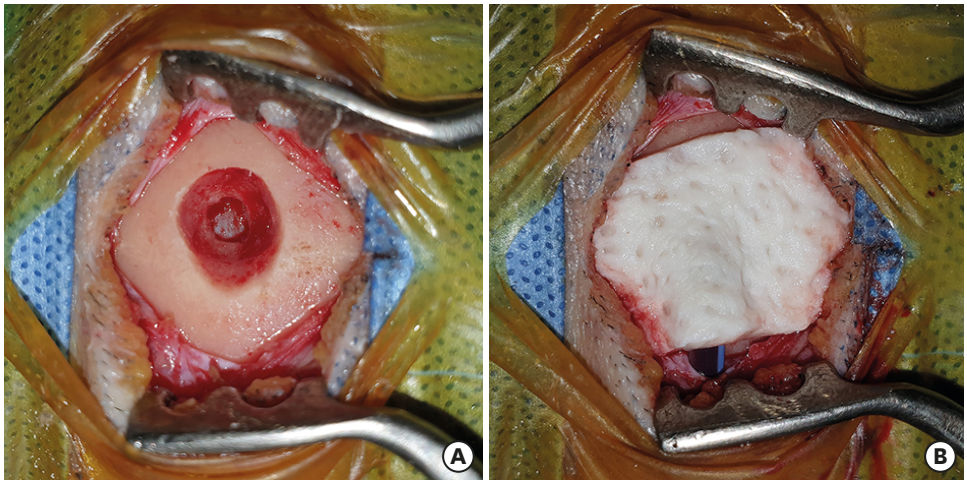

FIGURE 1. (A) A burr hole is trephinated for drainage hematoma. (B) A proper size of acellular dermal matrix is just put on the burr hole.

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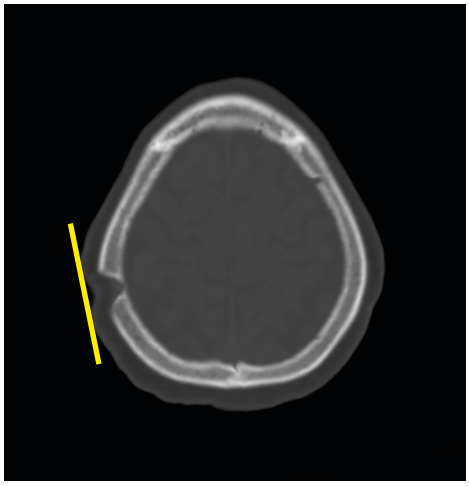

FIGURE 2. A brain computed tomography after burr hole trephination shows a definite scalp depression. A hypothetical line (yellow line) was drawn through 2 points of adjacent edge of normal scalp. The deepest vertical depth from the hypothetical line was measured.

edge of normal scalp. The deepest vertical depth from this line was measured at each burr hole site (**FIGURE 2**).

Statistical analyses were performed using Statistical Package for the Social Sciences version 22.0 (IBM Corp., Armonk, NY, USA). To compare group differences, Student's *t*-test and Pearson's χ^2 were performed with the continuous and categorical variables, respectively. In addition, within-group correlation was analyzed between patient's age and the degree of scalp depression. Data were considered statistically significant when $p<0.05$.

This study received approval from the Institutional Review Board (DFE20ORIO070).

RESULTS

Forty-two (63.6%) and 24 (36.4%) patients were male and female, respectively. The mean age was 67.03 (range, 22–01; **TABLES 1** & **2**). The mean burr hole diameters were 12.94±3.28

TABLE 1. Comparison of clinical data between the GPO group and ADM group

Group	GPO group (n=39)	ADM group (n=27)	*p*-value
Sex			0.142*
Male	22 (56.4)	20 (74.1)	
Female	17 (43.6)	7 (25.9)	
Age	67.10±11.66	66.93±14.61	0.957†

Data are shown as mean±standard deviation or number (%).
GPO: Gelfoam packing only, ADM: acellular dermal matrix.
*Pearson's χ^2 test; †Student *t*-test.

TABLE 2. Comparison of scalp thickness between the GPO group and ADM group

Group	GPO group (n=44)	ADM group (n=31)	*p*-value
Scalp thickness	6.61±1.61	6.98±2.14	0.397*

Data are shown as mean±standard deviation.
GPO: Gelfoam packing only, ADM: acellular dermal matrix.
*Student *t*-test.

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TABLE 3. Comparison of radiological data between the GPO group and ADM group

Group	GPO group (n=44)	ADM group (n=31)	*p*-value
Scalp depression depth	1.74±1.43	0.80±1.06	0.003*
Burr hole diameter	12.94±3.28	12.60±2.61	0.635*

Data are shown as mean±standard deviation.
GPO: Gelfoam packing only, ADM: acellular dermal matrix.
*Student *t*-test.

TABLE 4. The correlation between patient's age to the degree of scalp depression and initial scalp thickness to the degree of scalp depression in GPO group and ADM group

Group	GPO group (n=39)		ADM group (n=27)	
	Scalp depression depth	*p*-value	Scalp depression depth	*p*-value
Age	0.125*	0.419†	−0.050*	0.790†

GPO: Gelfoam packing only, ADM: acellular dermal matrix.
*Pearson correlation coefficient; †Simple correlation analysis.

TABLE 5. The correlation between patient's age to the degree of scalp depression and initial scalp thickness to the degree of scalp depression in GPO group and ADM group

Group	GPO group (n=44)		ADM group (n=31)	
	Scalp depression depth	*p*-value	Scalp depression depth	*p*-value
Scalp thickness	0.005*	0.977†	−0.110*	0.557†

GPO: Gelfoam packing only, ADM: acellular dermal matrix.
*Pearson correlation coefficient; †Simple correlation analysis.

and 12.60±2.61 mm in the GPO and ADM groups, respectively (**TABLE 3**). There were no significant differences in age, sex, and burr hole diameter.

The mean scalp depressions depth in the GPO and ADM groups was 1.74±1.43 and 0.80±1.06 mm, respectively, which was significantly different (p=0.003; **TABLE 3**).

There was no significant correlation between age and the degree of scalp depression within each group (GPO: p=0.419; ADM: p=0.790; **TABLES 4** & **5**).

DISCUSSION

Burr hole trephination is simple and easy procedure for chronic subdural hematoma, intracranial hematoma, and intraventricular hematoma. This surgical option is associated with complications such as bleeding, seizure, and infections; however, scalp depression can be overlooked by some neurosurgeons as an unimportant complication. This cosmetic defect may be seemed trivial but it can lead to functional difficulties. Many materials such as autologous bone, muscle, fat tissue, and synthetic or metallic substitutes have been used to prevent skull defects.[2,5,12,22,23] In 2014, the clinical efficacy of a titanium burr hole cover was evaluated in our institute.[6] This material was effective cosmetically and functionally; however, several complications were expected, such as screw loosening, displacement of burr hole cover, implant protrusion, and scalp perforation. Therefore, we sought to evaluate different material to overcome these instrumental failures without increasing the operation time.

ADM is created using cadaveric skin under proprietary processing techniques to preserve the biochemical and structural components of the extracellular matrix (ECM). This promotes tissue regeneration without an immune response.[3,14,15,18] Therefore, ADM is suitable for implant materials. Megaderm is a structurally intact ADM that can function as a biological

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scaffold to induce angiogenesis, tissue ingrowth, and tissue regeneration. Its manufacturing process uses electron beams to generate cross-linked collagen[11,14] which results in increased tensile strength and its elastic modulus. Kim et al.[9] have reported that Megaderm is an alternative material for orbital wall reconstruction.

Wound healing following ADM implantation, such as inflammation, angiogenesis, ECM deposition, and remodeling, is important for host tissue integration and subsequent incorporation. The rapid degradation of non-cross-linked ADM can prevent the tissue from achieving adequate tensile strength. In contrast, durability and long-term strength has been achieved using cross-linked materials.[1,9,14]

Previous literatures has reported that implanted ADM is fully absorbed at a few weeks after graft implantation, and the thickness of the implanted ADM is inversely proportional with the absorption time *via* neovascularization, collagenous fiber formation, and the replacement of autologous tissue.[7,13] However, Kim et al.[10] have reported no significant difference in absorption or thickness with time in a mouse model. Na et al.[20] have shown the maintenance of ADM as a biological scaffold for a long period after implantation. Furthermore, previous studies have shown the maintenance of implanted ADM volume over time.[4,9,16]

ADM does not induce an immune response in animals or humans. Megaderm is a produced sterile allograft that is created by eliminating the antigenic target of cell-mediated rejection.[18]

The postoperative infection rate after burr hole trephination is ranges from 1.1–10%.[19,21] In this study, there was no reported infection in any cases.

Those are the reasons why we hypothesized that ADM could be an effective material for use in burr hole trephination. Furthermore, our study found reduced scalp depression in ADM group when compared with the GPO group.

We hypothesized that there would be differences in the degree of scalp depression relative to age because skin tone is different between the young and the old. Interestingly, there was no significant correlation between age and the degree of scalp depression within each group.

The present study has some limitations. First, too many patients in the ADM group were excluded because of no follow-up data. Consequently, the number of patients in ADM group is much less when compared with the GPO group. We expected a better outcome if more patients could have been included. Second, we considered that a 3-month follow-up was sufficient to prove the efficacy of ADM. Future studies should use a longer-term follow-up period to assess the longitudinal effects of ADM.

CONCLUSION

In conclusion, ADM is a suitable material for the reconstruction of small skull defects after burr hole trephination. It possesses sufficient strength to act as a biological scaffold and shows no significant complications, such as immune reactions, infections, or instrumental failures.

To the best of our knowledge, this is the first study to assess the efficacy of ADM in neurosurgery. Therefore, more studies are required to confirm these promising results.

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