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Clinical Study of Autologous Skull Transplantation for the Treatment of Skull Defects

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Abstract: *Objective:* To explore the clinical value of autologous skull transplantation in the treatment of skull defects. *Methods:* Sixty-six patients who underwent skull defect reconstruction treatment in our hospital from January 2022 to March 2024 were selected and divided into an autologous skull transplantation group (n=31) and an artificial bone transplantation material group (n=35) based on different bone transplantation materials. The two groups of patients were followed up for 12 months to observe the bone healing and the incidence of postoperative complications. *Results:* After 9 months of treatment, the bone healing performance of the autologous skull transplantation group was better than that of the artificial bone transplantation material group ($P < 0.05$). By the end of the last follow-up, the incidence of bony postoperative complications in the autologous skull transplantation group was lower than that in the artificial bone transplantation material group ($P < 0.05$). *Conclusion:* Autologous skull repair for skull defects has good biocompatibility, can promote bone healing, and reduce the incidence of postoperative complications.

Keywords: Bone transplantation; Skull defect reconstruction; Autologous bone transplantation; Biomaterials

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1. Introduction

Skull defects disrupt the integrity of the cranial cavity, and the loss of bony protection for brain tissue and the imbalance of intracranial pressure due to changes in external atmospheric pressure and natural temperature can lead to symptoms such as dizziness and headache, which have a severe impact on patients' physiology and psychology. Large defects can also cause changes in local blood flow and intracranial pressure, which can result in local brain atrophy and exacerbate the patient's brain function deficits [1]. Cranioplasty is the main treatment method for skull defects, which can restore the early closed state of the cranial cavity, maintain normal intracranial

pressure, promote the recovery of brain physiological functions, reduce the occurrence of skull defect syndrome, and avoid cerebrospinal fluid circulation disorders caused by ectopic brain tissue [2]. Although cranioplasty is effective, there is currently no unified conclusion on the choice of repair materials. Autologous skull flaps meet physiological requirements, have the same tissue source, have good tissue compatibility, are not easily deformed, and have perfect shaping. They are not only safe and reliable but also inexpensive, making them the preferred material for cranioplasty. Based on this, sixty-six patients who underwent skull defect reconstruction treatment in our hospital from January 2022 to March 2024 were selected as the research subjects to explore the clinical value of autologous skull transplantation in the treatment of skull defects, as follows.

2. Materials and methods

2.1. General information

Sixty-six patients who underwent skull defect reconstruction treatment in the hospital from January 2022 to March 2024 are selected. The patients are divided into two groups based on different bone transplantation materials: an autologous skull transplantation group with 31 patients and an artificial bone transplantation material group with 35 patients. The general information of the two groups is comparable ($P > 0.05$), as shown in **Table 1**. The study is approved by the ethics committee of the hospital.

Table 1. Comparison of general data between the two groups

Group	Number of cases	Gender		Age (years)	Defect area(cm^2)	BIMindex (kg/m^2)	Time from craniotomy to repair surgery (days) (d)
		Male (%)	Female (%)				
Artificial bone graft material group	35	18 (51.43)	17 (48.57)	54.34 ± 11.32	115.43 ± 21.18	25.66 ± 3.51	119.45 ± 23.42
Autologous skull transplantation group	31	16 (54.84)	15 (45.16)	54.12 ± 11.61	117.41 ± 23.35	25.75 ± 3.62	120.11 ± 21.32
X^2/t		0.077		0.078	0.361	0.102	0.119
P		0.782		0.938	0.719	0.919	0.906

2.2. Inclusion and exclusion criteria

The inclusion criteria of the study are: (1) clinically examined and diagnosed; (2) skull defect area larger than 3cm; (3) no history of intracranial infection, coagulation dysfunction, or intracranial hypertension after decompressive craniotomy; (4) agreed to surgery and signed the informed consent form.

Meanwhile, the exclusion criteria are: (1) presence of severe systemic diseases such as general malnutrition, severe abnormal liver and kidney function, and malignant tumors; (2) presence of infections such as pneumonia and severe mental system diseases; (3) loss of follow-up after surgery; (4) incomplete clinical data.

2.3. Methods

After anesthesia, routine disinfection and draping are performed. The scalp is incised along the original surgical incision, and scalp clips are used for hemostasis. Sharp separation is performed along the dura mater and temporal muscle fascia or galea aponeurotica. For patients with severe adhesions, normal saline is first injected epidurally, taking care to protect the blood supply at the base of the skin flap. During scalp separation, damage to the deep

dura mater is avoided to prevent postoperative effusion. To avoid cerebrospinal fluid leakage after surgery, the scalp separation should not be too thin. The skull defect area is fully exposed, and hemostasis is strictly performed.

(1) Artificial bone graft material group: Domestic ordinary plexiglass with polymethyl methacrylate as the main component is used. The material is cut according to the size of the patient's skull defect before surgery, placed in a fumigation box for strict disinfection after cutting to the appropriate size, and shaped by steaming and baking on an alcohol burner during surgery to ensure it matched the physiological curvature of the skull. The overlay method is used for repair.

(2) Autologous skull transplantation group: The skull bone flap is soaked in alcohol for 30 minutes for disinfection, placed back into the defect site, and repaired using the mosaic method. When the defect area is large and the marginal area did not match well, small metal titanium plates are used for fixation to prevent the bone flap from floating.

2.4. Observation indicators

2.4.1. Comparison of bone healing between the two groups after 9 months of repair

Criteria for bony healing: Examination shows continuous bone callus passing through the fracture line, and the fracture line is nearly invisible or completely disappears.

2.4.2. Comparison of complications between the two groups

Patients were followed up for 12 months after surgery, and complications such as headache, infection, epidural hematoma, and subcutaneous effusion are recorded.

2.5. Statistical methods

Data are analyzed using SPSS 22.0 statistical software package. Count data are expressed as relative numbers, and comparisons between the two groups were performed using the x^2 test. $P < 0.05$ is considered statistically significant.

3. Results

3.1. Comparison of bone healing between the two groups after 9 months of repair

In the autologous skull transplantation group, 30 cases achieved bony healing after 9 months, with a bony healing rate of 96.77%. In the artificial bone graft material group, 25 cases achieved bony healing after 9 months, with a bony healing rate of 71.43%. The bony healing rate in the autologous skull transplantation group was significantly higher than that in the artificial bone graft material group (X^2=7.604, P=0.006).

3.2. Comparison of complications between the two groups

The incidence of complications in the autologous skull transplantation group was significantly lower than that in the artificial bone graft material group ($P < 0.05$), as shown in **Table 2**.

Table 2. Comparison of complications between the two groups [n, (%)]

Group	Number of cases	Headache	Infection	Epidural hematoma	Subcutaneous effusion	Total occurrence
Artificial bone graft material group	35	2(5.71)	3(8.57)	1(2.86)	4(11.42)	10(28.57)
Autologous skull transplantation group	31	1(3.23)	0(0)	1(3.23)	0(0)	2(6.45)
X^2						5.407
P						0.020

4. Discussion

Performing cranioplasty as soon as conditions allow after a skull defect can reduce the psychological burden caused by the skull defect and prevent secondary brain tissue damage caused by the defect [3]. Research has shown that skull defects can affect cerebral blood flow, and cranioplasty can improve the hemodynamics of local brain tissue, increasing local cerebral blood flow by 15% to 30% [4]. For cranioplasty, the ideal repair material should have stable chemical properties and sufficient mechanical strength, can fuse bone windows and transmit radiation, and have a small tissue reaction, non-carcinogenic, non-toxic, and not easy to age [5]. Various synthetic biomaterials have emerged with the development of medical and tissue engineering technology. Although they can be used to repair skull defects, they may cause rejection reactions and cannot integrate with the host bone. The main component of plexiglass is polymethyl methacrylate, which has the advantages of being convenient, non-conductive of heat and electricity, heat-moldable, good quality, and not affected by radioactivity. It was once the preferred material for cranioplasty.

However, it is prone to aging, poor impact resistance, easy to stab brain tissue, and easy to form subgaleal effusion. At the same time, it has poor application effects on areas with high plastic requirements, such as the orbital region [6]. Studies have shown that the incidence of subgaleal effusion can be as high as 65.6% when plexiglass is used for repair [7]. Studies have pointed out that polyetheretherketone (PEEK) is used in skull defect repair with subcutaneous effusion in the surgical area [8]. Yang *et al.* pointed out that the use of autologous bone in cranioplasty patients can reduce hospital stay [9]. Although there are currently many types of materials used for cranioplasty, there is no material that can completely replace autologous skull in terms of heat insulation, cold resistance, plasticity, compression resistance, impact resistance, and biocompatibility.

In selecting skull defect repair materials, promoting bone formation should be the selection strategy. During the healing process after skull defect repair, the survival of implanted bone cells, osteoconduction, and osteoinduction play decisive roles. Autologous skull bone, used for skull defect repair, shares a consistent embryonic origin and tissue structure with the patient. The transplanted bone volume and shape can be maintained for a long time after surgery. It has biological activity and osteoinductive effects, making it easier to integrate with recipient bone tissue and having a low resorption rate. This study shows that the bony healing rate in the autologous skull transplantation group is significantly higher than that in the artificial bone graft material group ($P < 0.05$). The autologous skull tissue has a consistent source, meets physiological requirements, has sufficient strength, can avoid rejection, and can also induce bone formation. It promotes bone growth by utilizing the periosteum on the bone flap and the surrounding normal bone, resulting in better bone healing. Skull repair surgery

has a complication rate of about 10%–40%, and the repair material is one of the important influencing factors for postoperative complications.

The tissue reactivity of the repair material during skull repair surgery is the main cause of infection and subcutaneous effusion [10]. The autologous skull flap avoids immune rejection, eliminates the need for additional material sourcing and shaping, has a good scalp reactive edema, is less prone to subcutaneous effusion, and may even eliminate subcutaneous effusion. The results of this study show that the incidence of complications in the autologous skull transplantation group is significantly lower than that in the artificial bone transplantation material group ($P < 0.05$). The autologous skull retains the skull shape and structure, has good anatomical reduction, eliminates the need for additional material sourcing and shaping, reduces operation complexity and the risk of infection, and has good tissue compatibility, reducing subcutaneous effusion and postoperative complications.

5. Conclusion

In summary, the autologous skull meets physiological requirements, has good tissue compatibility, avoids rejection reactions, promotes bone healing as a skull repair material, and reduces postoperative complications, demonstrating clinical value.

Disclosure statement

The author declares no conflict of interest.

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