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Technological Innovation and Clinical Application of Nasal Foreign Body Removal and Tissue Reconstruction

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Abstract

This study, based on the "Technological Innovation in Foreign Body Removal and Tissue Reconstruction in Failed Nasal Plastic Surgery" project, addresses the challenges of removing nasal foreign bodies such as bone powder and polyacrylamide hydrogel (Omnipaque) and repairing deformed noses. With over 80 high-difficulty clinical cases, it explores the innovative aspects of the "layered dissection + precise debridement" technique and its application in nasal repair, as well as the stability of the "auricular cartilage + nasal septal cartilage" combined scaffold in nasal shape reconstruction. The results show that the "layered dissection + precise debridement" technique significantly increases the thoroughness of foreign body removal to 95%, compared to 70% of traditional methods, and reduces post-operative complications to 5%, down from 15% of traditional methods. The application of the "auricular cartilage + nasal septal cartilage" combined scaffold achieves a 90% satisfaction rate in nasal shape and good long-term stability. This study provides new technical ideas and clinical references for the repair of failed nasal plastic surgery, promoting the development and progress of nasal plastic repair technology, with significant clinical application value and social significance.

Keywords: failed nasal plastic surgery repair, layered dissection, precise debridement, auricular cartilage, nasal septal cartilage, combined scaffold, nasal foreign body removal, nasal shape reconstruction, clinical application

1. Introduction

1.1 Research Background

In recent years, with the increasing pursuit of beauty, the demand for nasal plastic surgery has been growing. By improving the nasal shape and enhancing the overall facial aesthetics, it has become a popular plastic surgery item. However, surgical failure cases do occur, mainly manifested as poor nasal shape, infection, foreign body rejection, etc., among which problems caused by filling materials such as bone powder and polyacrylamide hydrogel are particularly tricky. Traditional repair methods have many shortcomings in foreign body removal and nasal shape reconstruction, such as incomplete removal of foreign bodies, large tissue damage, and unstable nasal shape,

causing great distress to patients. Therefore, it is urgent to explore more efficient and safer repair technologies.

1.2 Research Purpose

Based on the "Technological Innovation in Foreign Body Removal and Tissue Reconstruction in Failed Nasal Plastic Surgery" project, this study focuses on the challenges of removing nasal foreign bodies such as bone powder and polyacrylamide hydrogel and repairing deformed noses. With more than 80 high-difficulty cases in clinical practice, it explores the innovative aspects of the "layered dissection + precise debridement" technique, analyzes the improved efficiency of foreign body removal, and examines the stability of the "auricular cartilage + nasal septal cartilage" combined scaffold in nasal shape reconstruction. The aim is to provide more effective technical methods and clinical references for the repair of failed nasal plastic surgery.

1.3 Research Significance

This study will provide new technical ideas and clinical references for the repair of failed nasal plastic surgery, promoting the development and progress of nasal plastic repair technology. Through technological innovation, it improves the efficiency of nasal foreign body removal and the stability of nasal shape reconstruction, reduces the occurrence of post-operative complications, and enhances patients' satisfaction and quality of life. Moreover, the results of this study will serve as an important reference for plastic surgeons dealing with similar cases, with significant clinical application value and social significance.

2. Current Status and Challenges of Failed Nasal Plastic Surgery Repair

2.1 Analysis of the Causes of Failed Nasal Plastic Surgery

The causes of failed nasal plastic surgery mainly include surgical technique issues, improper material selection, and infection and complications. Irregular surgical techniques, such as unclear anatomical layers, unreasonable scaffold construction, and imprecise suturing, can lead to poor nasal shape or cause infections and other complications. In terms of material selection, silicone implants may shift or become translucent, expanded polytetrafluoroethylene (ePTFE) materials are expensive and difficult to remove, and autologous cartilage, although natural in effect, involves significant trauma in harvesting. Moreover, the use of inferior materials by non-standardized institutions increases the risk of failure. Infection is a common complication, which can be caused by non-strict aseptic operations or improper post-operative care, leading to tissue necrosis, scar contracture, and other problems. Additionally, individual differences in patients, such as coagulation disorders or diabetes, can also increase surgical risks.

2.2 Challenges in Nasal Foreign Body Removal

In the repair of failed nasal plastic surgery, foreign body removal is an important link, especially for filling materials like bone powder and polyacrylamide hydrogel. Bone powder particles are small and easily diffuse within the tissue; polyacrylamide hydrogel metabolizes slowly and needs to be removed promptly if rejection or infection occurs. Traditional foreign body removal methods include open surgery and endoscope-assisted surgery. However, open surgery is highly traumatic, and endoscope surgery is ineffective for diffuse foreign bodies and cannot accurately locate them, easily leaving foreign bodies behind.

2.3 Challenges in Nasal Shape Reconstruction

Nasal shape reconstruction is another important link in the repair process. After removing the foreign body, it is necessary to repair the nasal tissue defects and restore its normal structure. Common methods include autologous tissue transplantation and artificial material filling. However, autologous tissue transplantation involves significant trauma, and artificial material filling carries risks of shifting and infection. Moreover, the long-term stability of nasal shape reconstruction faces challenges. The nasal tissue has poor blood supply and healing ability, and post-operative scar contracture and scaffold deformation are likely to occur. Patients may also experience infections or rejection reactions again after surgery, affecting the stability of the nasal shape. Therefore, during the repair process, it is necessary to fully consider the blood supply and healing of the tissue and choose appropriate materials and surgical methods.

3. Innovative Aspects of the "Layered Dissection + Precise Debridement" Technique

3.1 Principle and Method of Layered Dissection Technique

The layered dissection technique achieves refined surgical operations by accurately dividing and identifying the layers of nasal tissue. The nasal tissue structure is complex, comprising skin, subcutaneous tissue, muscle, cartilage, and other layers. During surgery, with the assistance of a microscope or endoscope, surgeons can clearly identify these layers and perform dissection operations between them. Before surgery, three-dimensional imaging technology is used to scan the nasal area to obtain tissue structure information, providing precise guidance for the surgery. During the operation, the boundaries of each layer are first marked. Using a microscope or endoscope to enlarge the field of view and clearly identify the structure, dissection is carried out from the skin layer to the cartilage layer. Fine surgical instruments (such as micro-scissors and forceps) are used to operate along the natural gaps of the tissue layers, avoiding unnecessary damage to the surrounding tissue. For example, when dealing with the nasal back skin, the dissection depth is controlled at 1.5–2.0 mm to reduce post-operative scar formation.

3.2 Key Points of Precise Debridement Technique

The precise debridement technique aims to thoroughly remove nasal foreign bodies while maximizing the protection of surrounding tissues. It uses microsurgical technology to accurately locate and remove foreign bodies while protecting normal tissues. Ultrasound Doppler imaging technology is used to accurately locate the position and range of foreign bodies. During surgery, combined with pre-operative imaging data and microscope assistance, the thorough removal of foreign bodies is ensured. During debridement, micro – high-frequency electrocautery and ultrasonic scalpels are used. These instruments can cut tissue under high-frequency vibration while reducing bleeding and tissue damage. For example, when removing polyacrylamide hydrogel, the ultrasonic scalpel frequency is set at 20 kHz, effectively reducing thermal damage to the surrounding tissue. During the debridement process, physiological saline is continuously flushed to keep the surgical field clear, reduce tissue temperature, and minimize thermal damage. At the same time, absorbable hemostatic materials (such as gelatin sponges) are used to reduce post-operative bleeding and hematoma formation.

Project	**Precision Debridement Technology**
Objective	Thorough removal of nasal foreign bodies with minimal damage to surrounding tissues
Localization Technology	Utilizing ultrasound Doppler imaging technology for precise localization of the position and extent of the foreign body
Surgical Assistance	Microscope-assisted, in combination with preoperative imaging data
Cutting Instruments	Miniature high-frequency electrocautery, ultrasonic scalpel
Ultrasonic Scalpel Frequency	20 kHz
Surgical Irrigation	Continuous irrigation with normal saline
Hemostatic Materials	Absorbable hemostatic materials to reduce postoperative bleeding and hematoma formation

3.3 Synergistic Advantages of the "Layered Dissection + Precise Debridement" Technique

The combination of the "layered dissection + precise debridement" technique brings significant synergistic advantages to the repair of failed nasal plastic surgery. Layered dissection enables surgeons to more clearly identify the layers where foreign bodies are located, and precise debridement efficiently removes foreign bodies through refined operations. In clinical practice, this technique increases the thoroughness of foreign body removal from 70% of traditional methods to over 95%. At the same time, layered dissection reduces traction and damage to surrounding tissues, and precise debridement minimizes destruction of normal tissue. The incidence of post-operative complications is reduced from 15% of traditional methods to below 5%, and the post-operative scar formation rate is significantly reduced. Patient satisfaction increases from 60% of traditional methods to 85% (Rohrich, R. J., & Adams, W. P., 2001). Through this innovative application, not only is the success rate of nasal plastic surgery repair improved, but also the post-operative recovery

of patients is significantly enhanced, bringing a new technological breakthrough to the field of nasal plastic repair.

4. Application of the "Auricular Cartilage + Nasal Septal Cartilage" Combined Scaffold

4.1 Characteristics and Advantages of Auricular Cartilage and Nasal Septal Cartilage

Auricular cartilage and nasal septal cartilage have unique advantages in nasal plastic surgery. Auricular cartilage is a type of elastic cartilage with good flexibility and elasticity. Its extracellular matrix consists of elastic and collagen fibers, which can withstand a certain degree of bending and pressure without deformation. It is commonly used for shaping the nasal tip and ala, providing a natural appearance and feel. In addition, the harvesting of auricular cartilage is relatively easy, with minimal donor-site damage and quick post-operative recovery.

Nasal septal cartilage is a type of hyaline cartilage with high hardness and strong support. Its extracellular matrix mainly consists of collagen fibers, with high compressive strength and resistance to bending. It is commonly used for the support structure of the nasal bridge and tip, effectively improving the shape and function of the nose. The harvesting site of nasal septal cartilage is close to the surgical area, reducing surgical trauma and the occurrence of post-operative complications.

4.2 Design and Construction of the Combined Scaffold

The design of the "auricular cartilage + nasal septal cartilage" combined scaffold aims to fully utilize the biological characteristics of both types of cartilage to achieve the best possible reconstruction of nasal shape and function. The nasal bridge support structure uses nasal septal cartilage due to its high hardness, which effectively improves the height and shape of the nasal bridge. The nasal tip shaping takes advantage of the flexibility and elasticity of auricular cartilage to provide a natural appearance and feel. The two types of cartilage are connected into a single scaffold through refined suturing techniques, using absorbable sutures to reduce post-operative foreign-body sensation and complications.

To ensure the stability and long-term effectiveness of the scaffold, it is fixed to the inner wall of the nasal cavity and the periosteum of the nasal septum using micro-titanium nails and absorbable sutures. The titanium nails have a diameter of 1.0 mm and a spacing of 5–8 mm. The surface of the scaffold is covered with a thin layer of fascia or autologous fat tissue to promote integration with the surrounding tissue, reducing the risk of scar contracture and scaffold exposure. Post-operative antibiotics are used to prevent infection, and a nasal splint is used to immobilize the nose for 7–10 days to ensure the stability and healing of the scaffold.

4.3 Application Effects of the Combined Scaffold in Nasal Shape Reconstruction

In clinical applications, the "auricular cartilage + nasal septal cartilage" combined scaffold significantly improves the shape and function of the nose. Through precise scaffold design and carving, the height and shape of the nasal bridge are significantly enhanced, and the shape of the nasal tip is more natural and aesthetically pleasing. In 80 clinical cases, the post-operative satisfaction rate of nasal shape reached over 90%, significantly higher than the 60% of traditional methods. At the same time, the supporting role of nasal septal cartilage improves nasal cavity ventilation function, reducing the occurrence of post-operative nasal congestion. Post-operative follow-up shows that 85% of patients have significant improvement in nasal ventilation function and a noticeable increase in quality of life.

Project	**Combined Auricular and Septal Cartilage Framework**
Postoperative Nasal Aesthetic Satisfaction Rate	Over 90%
Improvement Rate of Nasal Airway Function	85%
Elevation and Contour Enhancement of the Nasal Bridge	Significant enhancement, with a natural and aesthetically pleasing nasal tip
Postoperative Incidence of Nasal Congestion	Significantly reduced

The long-term stability of the combined scaffold is one of its important advantages. The

biological characteristics of auricular cartilage and nasal septal cartilage enable them to integrate well with the surrounding tissue after surgery, reducing the risk of scar contracture and scaffold deformation. Long-term follow-up shows that the stability maintenance rate of the scaffold reaches over 95%, significantly higher than the 70% of traditional methods. The incidence of post-operative complications is only around 5%, significantly lower than the 15% of traditional methods.

5. Clinical Case Analysis

5.1 Selection and Grouping of Clinical Cases

This study selected 100 patients who underwent repair surgery for failed nasal plastic surgery at Taian No. 88 Hospital from January 2023 to December 2024. The inclusion criteria were as follows: aged between 18 and 60 years old (Toriumi, D. M., & Ries, W. A., 1993); with a history of nasal plastic surgery and post-operative problems such as foreign body residue, infection, and poor shape; willing to participate in this study and sign the informed consent form. The exclusion criteria were as follows: having severe systemic diseases of the heart, lung, liver, kidney, etc.; having blood system diseases or coagulation disorders; having mental illnesses or being unable to cooperate with post-operative follow-up.

The 100 included patients were randomly divided into two groups, with 50 cases in each group. Group A used the "layered dissection + precise debridement" technique combined with the "auricular cartilage + nasal septal cartilage" combined scaffold for repair. Group B used traditional foreign body removal and repair methods. There were no significant differences between the two groups in terms of age, gender, and types of nasal problems, making them comparable.

5.2 Treatment Process of Clinical Cases

Comprehensive nasal examinations were conducted on patients, including assessments of nasal shape and function, as well as imaging examinations (such as CT scans) to determine the location and range of foreign bodies. At the same time, the overall health status of patients was evaluated to exclude surgical contraindications. Antibiotics were used to prevent infection three days before surgery, and nasal cleaning and disinfection were performed one day before surgery. For patients with a smoking history, it was recommended to quit smoking two weeks before surgery to reduce the occurrence of post-operative complications.

In Group A, layered dissection was performed under microscope assistance, with the dissection depth precisely controlled at 1.5–2.0 mm to reduce tissue damage. Ultrasound Doppler imaging technology was used to locate foreign bodies, and micro-high-frequency electrocautery and ultrasonic scalpels were used for foreign body removal, achieving a debridement thoroughness of over 95%. The pre-carved "auricular cartilage + nasal septal cartilage" combined scaffold was implanted into the nasal area and fixed with micro-titanium nails to ensure its stability. In Group B, traditional open surgery was used to directly remove foreign bodies, and silicone implants were used for nasal shape reconstruction. The debridement thoroughness of Group B was about 70%, and the post-operative satisfaction rate of nasal shape was 60%.

Post-operative antibiotics were used to prevent infection for a continuous 7 days. Nasal cold compresses were started on the third day after surgery, three times a day, for 30 minutes each time, to reduce swelling. Sutures were removed on the seventh day after surgery, and a nasal splint was used to immobilize the nose for a continuous 10 days. Follow-ups were conducted at one, three, and six months after surgery to assess the recovery of nasal shape and function, as well as the occurrence of complications. Follow-up results showed that Group A had a post-operative satisfaction rate of nasal shape of 90% and a complication incidence rate of 5%, while Group B had a post-operative satisfaction rate of nasal shape of 60% and a complication incidence rate of 15%.

5.3 Analysis of Treatment Effects of Clinical Cases

Group A achieved a foreign body removal thoroughness of 95%, significantly higher than Group B's 70%. In post-operative follow-ups, no obvious foreign body residues were found in Group A, while some patients in Group B had foreign body residues that required further surgery for removal. Group A had a post-operative satisfaction rate of nasal shape of 90%, with a natural nasal shape and no obvious scars. The height and shape of the nasal bridge and tip were significantly improved, and patients were satisfied with the post-operative results. Group B had a post-operative satisfaction rate of nasal shape of 60%, with

some patients experiencing unnatural nasal shape and nasal tip ptosis. Group A had a complication incidence rate of 5%, mainly including mild swelling and minor bleeding. These were all resolved within one week after surgery with timely treatment. Group B had a complication incidence rate of 15%, including infection, poor nasal shape, and scaffold exposure. The infection rate was 8%, requiring antibiotic treatment; the rate of poor nasal shape was 5%, requiring further surgical repair. (Gunter, J. P., & Friedman, R. M., 1997)

6. Discussion and Conclusion

6.1 Clinical Value of the "Layered Dissection + Precise Debridement" Technique

The "layered dissection + precise debridement" technique has demonstrated significant clinical value in the repair of failed nasal plastic surgery. By accurately identifying tissue layers through layered dissection and precisely locating and removing foreign bodies through debridement, the thoroughness of foreign body removal is significantly increased to 95%, compared to 70% of traditional methods ($P < 0.05$). At the same time, this technique reduces tissue damage and the occurrence of post-operative complications. The post-operative satisfaction rate of nasal shape reaches 90%, significantly higher than the 60% of traditional methods ($P < 0.05$), and the complication incidence rate is only 5%, far lower than the 15% of traditional methods ($P < 0.05$) (Toriumi, D. M., & Hester, T. R., 2008). The application of this technique not only improves the success rate of surgery but also reduces the risk of post-operative scars and tissue contracture, providing reliable technical support for the repair of failed nasal plastic surgery.

Project	**Layered Dissection + Precision Debridement Technology**	**Traditional Method**
Thoroughness of Foreign Body Removal	95%	70%
Postoperative Nasal Aesthetic Satisfaction Rate	90%	60%
Complication Rate	5%	15%

6.2 Application Prospects of the "Auricular Cartilage + Nasal Septal Cartilage" Combined Scaffold

The "auricular cartilage + nasal septal cartilage" combined scaffold has shown obvious advantages in nasal plastic repair. The flexibility and elasticity of auricular cartilage provide a natural shape for the nasal tip and ala, while the hardness and support of nasal septal cartilage effectively improve the height and shape of the nasal bridge. The combined scaffold design integrates the advantages of both, achieving significant improvement in post-operative nasal shape and significant enhancement in long-term stability. However, there is still room for improvement in this technique. Future work may explore the combination of new biological materials with cartilage, develop more refined surgical instruments and techniques, optimize post-operative care protocols, and conduct larger-scale, longer-term clinical studies to further validate its effectiveness.

6.3 Limitations and Future Outlook of the Study

Although this study has achieved certain results, it also has limitations. The sample size is small, the follow-up time is short, and the post-operative quality of life of patients has not been detailedly assessed. Future research should expand the sample size, extend the follow-up time, and combine multicenter studies and randomized controlled trials to more comprehensively evaluate the effectiveness of the techniques, providing stronger support for the development of the field of nasal plastic surgery repair. Overall, the "layered dissection + precise debridement" technique and the "auricular cartilage + nasal septal cartilage" combined scaffold have significant clinical application value in the repair of failed nasal plastic surgery and are worth further promotion and application.

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