Case Report

A Novel Method to Minimizing Risk of Titanium Mesh Exposure in Cranioplasty: Circumferential Groove Technique

Can Ilker Demir, Emrah Kagan Yasar[1], Murat Sahin Alagöz[1]

Department of Plastic, Reconstructive and Aesthetic Surgery, Faculty of Medicine, Medipol University, Istanbul, [1]Department of Plastic, Reconstructive and Aesthetic Surgery, Faculty of Medicine, Kocaeli University, Kocaeli, Turkey

Abstract

Titanium mesh (TM) is frequently used in cranioplasty. Exposure to the implant is a complication that adversely affects patient outcomes. Reducing the pressure applied by decreasing the contact of sharp edges with the skin reduces this risk. In this study, we aimed to explain the details of a simple method (circumferential groove technique) that reduces the risk of exposure. An 80-year-old male patient presented with a squamous cell carcinoma on the scalp. After tumor excision, it was planned to use free anterolateral thigh flap for soft-tissue reconstruction, tensor fascia lata graft for dura reconstruction, and TM for bone reconstruction. The implant was fixed with the mentioned technique. No exposure was observed at the follow-up 1 year.

Keywords: Complication, cranioplasty, mesh exposure, screw, titanium

Introduction

Three-layer composite defects including soft tissue, cranium, and brain parenchyma may occur after tumor excision from the scalp. Reconstruction of the bone defect, cranioplasty, is essential for aesthetic and functional success. There are many alloplastic materials used for this purpose. Titanium mesh (TM) is a popular option used in cranioplasty due to its advantages, such as being easily shaped, nonabsorbable, strong, light and biocompatible, and causing minimal artifact when imaging is performed with computer tomography (CT).[1,2]

Early or late implant exposure is not uncommon.[3] Exposure may require revision surgery, including removal of the implant, as it predisposes to infection. There are studies that have investigated the mechanism of exposure and suggested various procedures for minimizing the exposure.[4-7] After evaluating these mechanisms, we believe that we have devised a simple process for reducing this type of risk with TM cranioplasty implants.

The aim of this study was to explain the "circumferential groove technique," which is easy to apply and minimizes the contact of the implant with the skin, reducing the risk of exposure.

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Case Report

An 80-year-old male patient presented with a persistent wound on the scalp. On physical examination, there was an ulcerated, runny, foul-smelling wound in the left temporoparietal region. The result of the incisional biopsy was reported as squamous cell cancer. CT showed that the tumor had invaded the bone and extended into the dura [Figure 1]. It was planned to use free anterolateral thigh flap for soft tissue reconstruction, tensor fascia lata graft for dura reconstruction, and TM for bone reconstruction.

Surgical technique

After tumor excision and dural reconstruction, a 2 cm circular area all around the defect was marked in the intact bone, adjacent to the defect. This area was the structure where the edges of the TM will be fixed by sitting. The width was determined as 2 cm to provide sufficient space for the

Address for correspondence: Dr. Can Ilker Demir, Yavuz Sultan Mah, Selale Sok, No: 34, Derince, Kocaeli, Turkey.
E-mail: canilkerdemir@gmail.com

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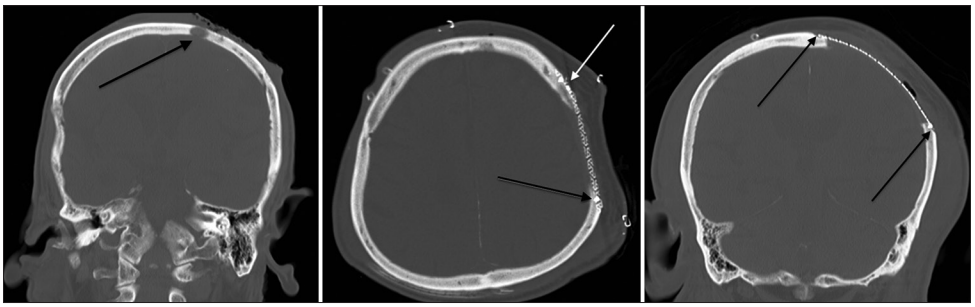

Figure 1: Preoperative CT shows that the tumor causes bone irregularities and extends into the parenchyma by destroying the bone (black arrow)-LEFT Postoperative CT shows that the mesh edges are seated in the groove and same level with the bone (black-white arrow)-MIDDLE It reduces the pressure exerted by the implant on the skin by not creating an extra height. In addition, the contact of the sharp tips with the skin is minimized (middle)-RIGHT CT: Computed tomography

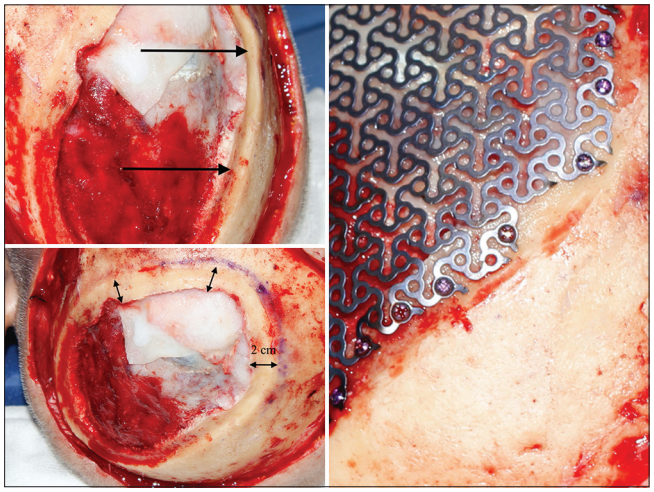

Figure 2: The groove formed by circling around the defect is visible. The level difference can be revised according to the thickness of the implant to be used. In this case, the bone was thinned approximately 5–6 mm (black arrow)-LEFT-BOTTOM The groove width should be around 2 cm (black arrow)-LEFT-BELOW in order for the mesh edges to fit comfortably in the groove, to have sufficient distance for fixation, and to support the weight of the implant. The screw size to be used for fixation of the implant should be decided on a case-by-case basis to avoid dural injury. In this case, fixation was done with 5 mm screws. Peroperative view-RIGHT immediately after implant fixation

implantation of the screws and to prevent unwanted bone fractures when carrying the weight of the implant. The marked area was thinned by rounding with a 4 mm drill in combination with the use of a motor system (Nouvag AG MD30, Goldach, Switzerland). The level difference between the groove and the adjacent bone was approximately 4–5 mm. This amount can be increased or decreased according to the thickness of the implant used. The TM was shaped to be 2 cm larger than the diameter of the defect, given the appropriate contour, irrigated with 10% povidone-iodine (Batiqon, Turkey) and rifampicin solution (Rif amp., Koçak, Turkey), and then placed in the groove. It was fixed with sufficient 5 mm screws at the corners [Figure 2]. Thus, the contact of sharp tips and screws with the covering soft tissue is reduced.

Results

No complications such as infection, exposure were observed in the follow-up 1 year.

Discussion

Scalp defects that occur after craniomaxillofacial operations result in composite defects that require the reconstruction of many tissues, such as dura, bone, and soft tissue. Autogenous and alloplastic materials are used in cranioplasty. The most important advantages of alloplastic materials are that they do not cause additional morbidity, shorten the operation time, and are easy to apply. TM has become very popular in recent years due to its strong, light, and biocompatible structure and easy formability.[1,2]

TM exposure is not uncommon and may result in many problems, including an increased propensity to infection, especially in patients with weakened immune systems. Revision surgery that requires the removal of the implant and reconstruction of the bone and soft tissue may prolong the patient's return to normal life. The most common causes are reported to be circulatory collapse and ulceration due to pressure on the skin, and thinning of the skin by the sharp edges of the TM.[6] The risk is higher in patients with soft tissue reconstruction with local flaps and thin scalp.[8] In addition, the porous structure of the mesh increases the risk of exposure with an effect similar to the sinking skin flap syndrome, depending on the pressure gradient between the atmospheric and extradural space.[2,9] Prevention of these mechanisms by careful evaluation reduces morbidity by preventing exposure.

In contrast to the classical application of TM, in the circular groove technique, the upper border of the implant is at the same level as the intact bone and does not cause extra height on the bone. Reducing the pressure exerted by the implant on the skin prevents circulatory disorders and thinning. Skin with good vascularization heals faster, reducing the risk of wound dehiscence. Maintaining the thickness of the skin ensures that sufficient covering tissue remains, despite subcutaneous tissue invading the pores of the mesh. Another problem encountered is that if the sharp edges of the TM are exposed they may pierce the

skin directly. In our technique, the edges do not come into contact with the skin. The bone acts as a barrier between the implant and the skin, reducing the risk of ulceration and perforation.

Postcranioplasty infection with rates have been reported to range from 0% to 16% and are an important cause of postoperative morbidity.[7] This morbidity may be magnified due to the proximity to the brain parenchyma. Excellent operating theater sterility, careful surgery, and antibiotic use are not always sufficient to prevent infection. There may be an increased risk of infection in the dead space between the dura and the TM.[4,10] In the classical application, there is a dead space between the implant and the dura, approximating the thickness of the cranium. In our technique, the placement of the implant is much closer to the dura resulting in a much-reduced volume of dead space. This, in turn, should reduce the risk of infection by allowing the faster filling of the space with granulation tissue. We hypothesize that reduced contact minimizes the risk of skin ulceration and circulatory disorders, reducing the possibility of direct exposure. The reduction of the dead space between the dura and the implant and the resistance to infection are secondary benefits of this technique.

"Time-consuming extra burr and using a foreign body can be counted as limitations of the technique. It is essential to pay attention to sterility in order to reduce the risk of infection due to foreign body."

Conclusion

During cranioplasty implementation of protective procedures in the implantation of the TM reduces the risk of exposure. The circular groove technique, which is designed to circumvent two of the mechanisms of exposure, direct physical damage, and infection risk, is an easy procedure in which classical neurosurgery and plastic surgery procedures are used. It should be remembered that careful operating room sterility control and covering the implant with thick soft tissue will increase the success rate of cranioplasty procedures.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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