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Case Report
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Single-Stage Free Tissue Transfer Reconstruction Overlying a 3D Custom Made Hydroxyapatite Cranial Implant to Reconstruct Recurrent BCC of the Frontal Scalp and Calvarium

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Abstract

Basal cell carcinoma is the most common skin malignancy, it frequently presents in head and neck areas, in rare cases where extensive destruction into the calvarium occurs, more complex resections and reconstructive procedures have to be undertaken.

We report the first case in the United Kingdom of a patient who underwent a single-stage free tissue transfer reconstruction above a custom-bone hydroxyapatite cranial implant following tumour extirpation.

Introduction

The calvarium can be compromised due to cancerous tumours extirpation [1]. The remaining bone defect is restored through cranioplasty with subsequent reconstruction of the overlying soft tissue [2]. Cranioplasty reconstruction may utilize either autogenous tissue or alloplastic materials [3]. Subsequent soft tissue reconstruction may utilise various plastic surgical techniques including local, regional or free tissue transfer [4]. We report the first case in the United Kingdom of a patient who underwent a single-stage free tissue transfer reconstruction above a custom-bone hydroxyapatite cranial implant following tumour extirpation.

Case Presentation

A 75-year-old man presented to the plastic surgery department with an extensive radiotherapy resistant infiltrative BCC of the right frontal scalp. This problem had been an ongoing issue for the past 13 years, having previously been treated with radiotherapy followed by Mohs micrographic surgery. CT head revealed the involvement of the underlying calvarium. The planned wide local excision including intended cranial resection was scanned onto the neuronavigation system to aid accurate craniectomy incisions during tumour extirpation. The involved skin was later excised en bloc with the underlying frontal bone with a 1cm clinical margin. A cranioplasty using a custom-made hydroxyapatite implant and a free radial forearm flap was performed to reconstruct the defect. The craniectomy was performed with the micro-burr using StealthStation® neuronavigation

Figure 1: Defect post craniectomy, PDS sutures in situ that will be used to secure the cranioplasty.

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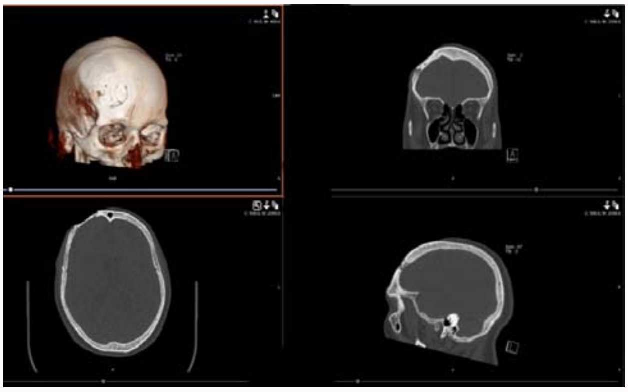

Figure 2: Pre-operative CTS scan results showing abnormal bone right frontal scalp area.

Figure 3: 3D model prototype of the patient's skull with planned craniectomy and cranioplasty plate.

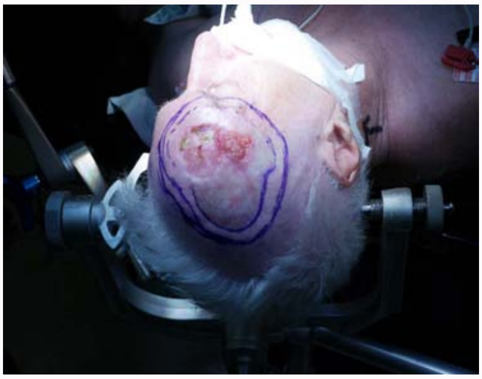

Figure 4: Patient mounted in operating theatre with excision margin drawn.

system (Medtronic, Inc. (Minneapolis, MN) guidance (Figure 1). The Custom bone plate which was custom made from data obtained from a CT scan 3D computer reproduction (Figure 2,3 and 4) was then inserted and fixed with PDS sutures (Figure 5). The cranioplasty used was of porous hydroxyapatite (Fin-Ceramic Faenza-Italy). A free radial forearm flap was used to reconstruct the soft-tissue defect with the vessels anastomosed with the facial vessels in the neck (Figure 6). Postoperatively a small area of the free flap reconstruction developed marginal necrosis (Figure 7 and 8), this had clearly demarcated by day 3, and he underwent excision of this non-viable area and direct closure was achieved. Our patient made a full recovery, including complete wound healing during his length of hospital stay which was 30 days and histology later came back confirming completed excision.

Figure 5: Custom bone cranioplasty implant in position.

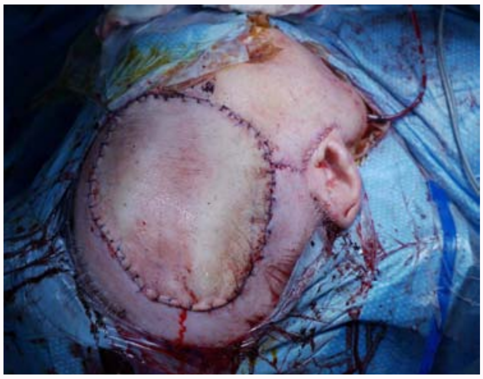

Figure 6: Final result on table after free radial forearm flap coverage and closure.

Figure 7: Area of watershed necrosis of the flap edge.

The thin radial forearm flap conformed well over the cranioplasty implant to form a satisfactory aesthetic result. Clinical follow-up and an MRI head scan at 8 months post-operation showed no sign of recurrent disease.

Discussion

Basal Cell Carcinoma (BCC) is the most common cancer affecting humans [5], it is slow-growing, yet if left untreated can cause extensive local tissue destruction including extension into the orbit and intracranially in neglected cases [6,7].

In our case, this was an aggressive BCC that recurred following prior surgical excision, radiotherapy and Mohs resection. Its involvement of the cranial vault meant that a curative procedure required a wide local excision of the soft tissue as well as a craniectomy and a

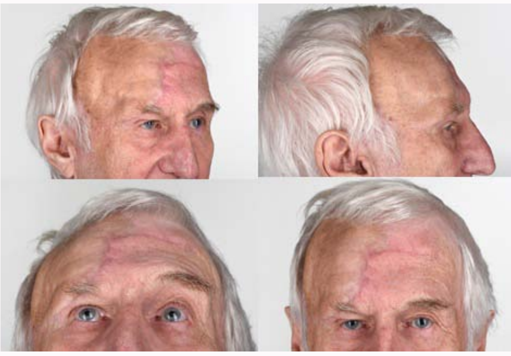

Figure 8: Patient photograph 5 months post cranioplasty and free radial forearm flap to right forehead.

challenging reconstruction. Numerous calvarium reconstruction options have been reported in the literature including autologous tissues such as iliac bone, rib grafts, and alloplastic material such as titanium, ceramic and hydroxyapatite among others [5,8,9] there is no consensus about the best material and hence the choice is often based on surgeon's preference [10]. Autologous tissue reconstruction is limited by donor site availability, resorption of tissue and donor site morbidity. Hydroxyapatite–based ceramics, are increasingly being used for cranioplasty. The advantages of hydroxyapatite are a minimal tissue reaction and good biocompatibility, increased bone healing, and good osseointegration [5,8], the limitation is mechanical fragility. The limitation of the method discussed in this report is manufacturing time, availability of this modern technology to perform 3D printing process, and its high cost £6120. Following cranioplasty immediate soft tissue cover must be achieved to reduce risk of infection, cerebrospinal fluid leak and haemorrhage. With the use of a multidisciplinary approach, it is possible to achieve tumour excision and single-stage reconstruction. However, surgical clearance of the tumour must be achieved prior to reconstruction. Frozen section for margin control is less reliable than that of traditional formalin stained slides [6]. The extent of bone involvement of the tumour is determined by pre-surgical imaging. This can enable surgical planning using neurosurgical navigation programmes, as in our case, which enables precise craniectomy guidance adhering to pre-planned excision margins clear of the involved bone. We attempt to excise the tumour with at least a margin 1cm of healthy bone.

Structural bone support is important otherwise the recumbent patient is exposed to the risk of external forces resulting in increased intracranial pressure and its sequelae [7]. When considering soft tissue coverage free tissue transfer provides more resistance to infection than local flaps due to its superior vascularity [11].

A systematic review performed in 2011 suggested that early surgery or implant material did not affect the rate of cranioplasty infections [11], a review of materials used for cranioplasty, demonstrate that the infection rate of hydroxyapatite implants, and spontaneous extrusion compared to other materials, is to be found at the lower end of the spectrum [12]. This reflects our own experience with this case.

Conclusion

We describe the first use of a 3D planned osseo-conductive hydroxyapatite implant in the United Kingdom, combined with free radial forearm tissue transfer for soft tissue coverage at a single operation. There were no significant complications of infection, exposure or fracture of the implant. Hydroxyapatite prosthesis has been demonstrated as a valid alternative to traditional cranioplasty materials. Its principal limitations are the resources and planning needed in the process and the high cost. This single-stage procedure should be undertaken for reconstructing defects following cancer resection only when clear margins can confidently be planned.

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