Calcium Phosphate Cement Cranioplasty Decreases the Rate of Cerebrospinal Fluid Leak and Wound Infection Compared with Titanium Mesh Cranioplasty: Retrospective Study of 672 Patients

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OBJECTIVE: **A variety of biomaterials have been developed for cranial reconstruction after craniectomy, including polyethylene titanium mesh and calcium phosphate cement. This study sought to compare complication rates of calcium phosphate cement and titanium mesh cranioplasty in patients undergoing retromastoid craniectomy.**

METHODS: **The authors retrospectively reviewed clinical data from 672 consecutive patients who underwent retromastoid craniectomy at a single institution for microvascular decompression or tumor resection from July 2009 to July 2014. Of these, 336 patients received calcium phosphate cement cranioplasty and 336 underwent (polyethylene) mesh cranioplasty. Charts were abstracted for occurrence of cerebrospinal fluid (CSF) leak, wound infection and/or other wound complication, and the groups were compared.**

RESULTS: **In the mesh cranioplasty group, there were 38 complications related to the surgical site, including 18 infections (5.4%), 20 patients (6%) with CSF leak or pseudomeningocele, and no (0%) other wound complications. In the cement cranioplasty cohort, 2 patients (0.6%) experienced wound infection, no patients (0%) had CSF leak, and 2 patients (0.6%) had other wound complications (including one sterile wound dehiscence and one reoperation for removal of excess cement). There was a statistically significant decrease in the rate of wound infection and CSF leak in the patients who underwent cement cranioplasty (*P* <0.001 for both).**

CONCLUSIONS: **Calcium phosphate cement cranioplasty offers an alternative to titanium cranioplasty and may reduce the risk of surgical site complication. Randomized, prospective comparisons of cement cranioplasty to traditional techniques are warranted.**

INTRODUCTION

Retromastoid craniectomy (RMC), a lateral suboccipital approach, allows the neurosurgeon access to the posterior cranial fossa for a variety of indications. This approach is used routinely in the surgical treatment of cranial nerve pathology, including microvascular decompression (MVD) for cranial nerve neuralgias, and for the resection of tumors involving the cranial nerves and lateral brainstem. After suboccipital craniectomy, the bone defect can be reconstructed in many ways, including replacement of the autologous bone flap; use of artificial materials such as titanium mesh, acrylics, and calcium phosphate cements; the combination of native and synthetic materials; or no replacement whatsoever (i.e., no covering over dura before scalp closure).[1,2]

Complications frequently are reported after suboccipital craniectomy, including wound infection, cerebrospinal fluid (CSF) leakage from the wound and/or pseudomeningocele formation, and the need for surgical revision for wound problems, including screw misplacement/migration, redundant cement, or sterile wound breakdown.[3-6] The use of autologous cranioplasty is associated with a greater risk of sinus injury in this location. In the attempt to mitigate such complications after RMC, research continues on the optimal technique for closure and many biosynthetic materials have been proposed and developed.[4,7]

Key words
- Calcium phosphate cement
- Cerebrospinal fluid leak
- Cranioplasty
- Retromastoid craniectomy
- Titanium mesh

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
MVD: Microvascular decompression
RMC: Retromastoid craniectomy
RMC-C: Retromastoid craniectomy with calcium phosphate cement
RMC-T: Retromastoid craniectomy with titanium mesh

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Our group recently reported a retrospective series of 79 patients who underwent calcium phosphate cement cranioplasty after RMC; we found that this technique may be associated with a lower incidence of CSF leak than had been reported for other cranioplasty techniques. We suggested this incidence may be attributable to the watertight properties of hardened cement.[2] In the current report, we retrospectively reviewed patients undergoing RMC at a single institution to determine whether there was a difference in complication rates between those who received a retromastoid craniectomy with titanium mesh (RMC-T) compared with those undergoing retromastoid craniectomy with calcium phosphate cement (RMC-C). Moreover, because previous studies have suggested that smoking status and high body mass index are associated with postoperative wound complications in neurosurgery,[8-11] these parameters were compared between the 2 groups.

MATERIALS AND METHODS

From July 2009 to July 2014, 672 patients underwent RMC for various surgical indications with either titanium mesh or calcium phosphate mesh reconstruction. Indications for RMC in both groups included tumor and cranial nerve neuralgias (hemifacial spasm, trigeminal neuralgia, geniculate or glossopharyngeal neuralgia). Patients who did not have a cranioplasty or underwent cranioplasty with materials other than calcium phosphate cement or titanium mesh were excluded from analysis. The University of Pittsburgh Medical Center, Pittsburgh Institutional Review Board approved this study.

Six surgeons were represented in both the RMC-C and RMC-T cohorts; of note, a single surgeon performed the majority of RMC-C procedures. The operations were performed at a teaching institution, and all operations were performed by attending of operative record with assistance from house staff and fellows. Size of craniectomy varied within each of the groups, and largely contingent on the surgical staff performing the approach.

Per hospital protocol, patients were administered prophylactic and intraoperative antibiotics per the SCIP (i.e., Surgical Care Improvement Project)[12] recommendations, including first-line treatment with a cephalosporin unless contraindicated. After MVD or tumor resection, the dura was closed primarily with interrupted 4-0 nylon suture (Nurolon; Ethicon, Somerville, New Jersey, USA) or by repair with bovine pericardium graft if native dural quality was unsuitable for closure. Rarely, but on occasion, a fibrin sealant (DuraSeal; Confluent Surgical Inc., Waltham, Massachusetts, USA) was applied over the dural closure. RMC-C was performed with calcium phosphate cement (Cranios Reinforced, Synthes, Inc., West Chester, Pennsylvania, USA; or HydroSet, Stryker, Kalamazoo, Missouri, USA) according to the manufacturer's instructions (**Figure 1**). RMC-T was performed with polyethylene titanium mesh (KLS Martin LP., Jacksonville, Florida, USA; or Synthes, Inc.) and held in place with titanium screws. Throughout the procedure, antibiotic saline was restricted to the extradural portions of the operation in both groups. The wound was otherwise closed in standard fashion according to the surgeon's preference. The fascial layer and deep dermal layers were closed with interrupted 2-0 and 3-0 synthetic absorbable suture (VICRYL; Ethicon), respectively, skin was closed and the wound dressed sterilely.

Charts were abstracted for patient demographic data, indication for surgery, type of cranioplasty, and duration of follow-up.

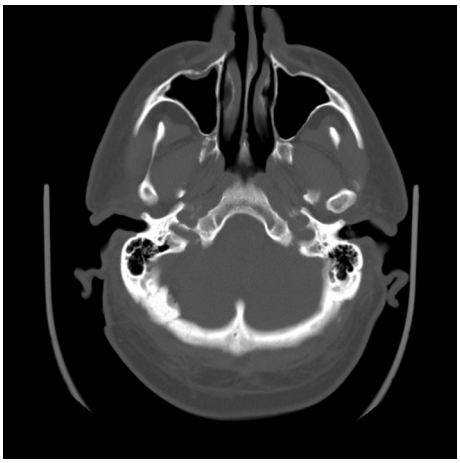

Figure 1. Axial computed tomography showing cement reconstruction of retromastoid occipital bone (right).

Wound complication was recorded and categorized as external CSF leak or pseudomeningocele formation, surgical-site infection, or other complication related to the cranioplasty reconstruction or surgical wound. A single, disinterested observer (B.P.) blinded to the study aims collected the data. Patients were examined at their first routine postoperative office visit (postoperative days 3–6) and then contacted over telephone and e-mail for long-term follow-up.

Statistical analysis was performed via a 2-tailed Student *t* test to compare demographic characteristics between the 2 cohorts. The Pearson χ^2 test was used for categorical variables to compare the incidence of CSF leak/pseudomeningocele formation, wound infection, and other wound complication. Analysis was performed by the use of SPSS (IBM; Armonk, New York, USA).

RESULTS

During a 5-year period, 672 patients underwent RMC and were reconstructed with cement or titanium mesh. Cement cranioplasty was introduced to our institution in March 2011; from first use to July 2014, 336 patients underwent RMC-C. To match the number of patients in the RMC-C group, patients who underwent RMC-T at our institution between July 2009 and July 2014 were included ($n = 336$). Demographic information for the patients in this series is presented in **Table 1**. Mean follow-up was 26.6 months and 16.5 months for the RMC-C and RMC-T groups, respectively ($P < 0.001$). There was no statistical difference in any of the demographic parameters between the 2 cohorts. Indications for surgical intervention are presented in **Table 2**.

Of the RMC-T group, there were 38 wound complications, including 18 (5.4%) patients with infection and 20 (6%) patients with CSF leak or pseudomeningocele (15 external CSF leaks and 5 pseudomeningoceles). No patients (0%) had other wound complications. Most cases of infection grew *Staphylococcus* species; of note, cultures were taken via skin swab. In the RMC-C cohort, 2 patient (0.6%) experienced wound infection, and no patients (0%) had CSF leak or pseudomeningocele. Two patients (0.6%) had