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LETTER TO THE EDITOR

Histologically demonstrated skull bone integration in a hydroxyapatite prosthesis in a human

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Dear Editor,
Surgical treatment for skull bone defects consists of cranioplasty using different materials including polymethylmethacrylate, titanium, resin prostheses, polyesther and ceramics [1–4]. The increasing tendency to employ decompressive craniectomy for the treatment of cerebral trauma has led to the need for high-quality materials that can possibly be both resistant and biocompatible. An additional advantage could be osteoinductivity, with promotion of osteoblastic migration across the prosthesis. This property can be found in porous custom-made hydroxyapatite (HA) prostheses, which have been shown to induce osteogenesis in experimental animal models [4]. We had the opportunity to demonstrate that osteogenesis induced by bioceramic protheses occurs also in humans.

A 69-year-old woman had been operated on for left atypical parasagittal meningioma in 2006 at the Department of Neurosurgery of the Istituto Neurologico "Carlo Besta" in Milan. The need to remove the bone flap developed during surgery as the bone was infiltrated by the lesion. One year after her first surgery, the patient underwent cranioplasty with a previously manufactured custom-made hydroxyapatite ceramic new flap. The prosthetic bone flap was obtained by three-dimensional stereolithography based on a computerized tomography 3D model of the patient's skull and bone defect. The material consists of porous hydroxyapatite (including both macropores and micropores). Because of recurrence of the meningioma, she underwent Cyberknife therapy and, subsequently, further surgery 2 years after the first operation. The size of the lesion and the tight adherence of the ceramic material to the skull forced us to remove the prosthesis together with a portion of the surrounding skull, thus resulting into enlargement of the craniotomy. The removed flap was then sent for histological examination, which revealed the presence of fresh bone tissue along the superior margin of the prosthesis and of bone formation along the interface (Fig. 1).

The thickness (in frontal sections) of both the synthetic and the newly developed bone was 4.38 mm; the thickness of the autologous bone layer was 0.13 mm.

The search for perfect or nearly perfect bone integration in bone prostheses implanted as cranioplasty has led to the development of new materials that could help the fusion with the bone edges. In our patient porous hydroxyapatite showed these characteristics. The mainstay is obviously the bone integration at the interface with the used material, but in our case new bone formation occurred also along the superior surface of the prosthesis. Although several reports of radiologically demonstrated successful bone-prosthesis fusion exist [5], this is the first report in the literature of effective bone-HA integration in humans as demonstrated in the postoperative histological examination.

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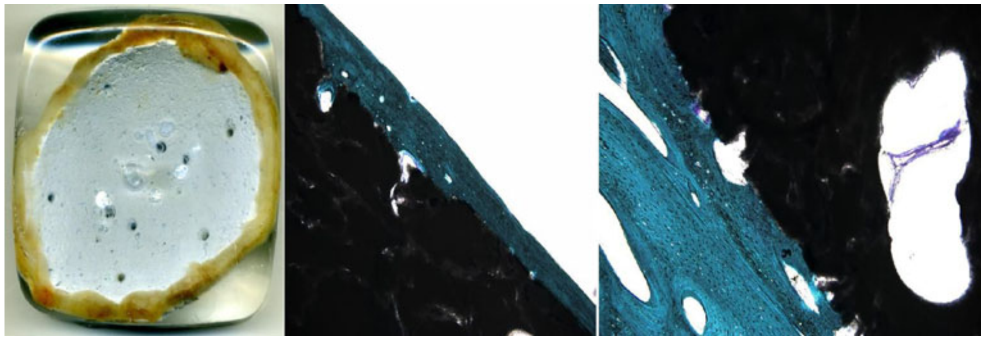

Fig. 1 *Left*: Macroscopic view of the implanted hydroxyapatite prosthesis surrounded by bone after surgical removal. *Middle*: Detail of histological section showing newly formed bone (blue) along the superior surface of the prosthesis (grey). *Right*: Detail of the frontal section of the prosthesis showing bone growth at the interface

Conflicts of interest None.

References

1. Ducic Y (2002) Titanium mesh and hydroxyapatite cement cranioplasty: a report of 20 cases. J Oral Maxillofac Surg 60:272–276
2. Fabbri M, Celotti GC, Ravaglioli A (1995) Hydroxyapatite-based porous aggregates: physico-chemical nature, structure, texture and architecture. Biomaterials 16:225–228
3. Iwama T, Yamada J, Imai S, Shinoda J, Funakoshi T, Sakai N (2003) The use of frozen autogenous bone flaps in delayed cranioplasty revisited. Neurosurgery 52:591–596, discussion 595–596
4. Marcacci M, Kon E, Zaffagnini S, Giardino R, Rocca M, Corsi A, Benvenuti A, Bianco P, Quarto R, Martin I, Muraglia A, Cancedda R (1999) Reconstruction of estensive long-bone defects in sheep using porous hydroxyapatite sponges. Calcif Tissue Int 64:83–90
5. Staffa G, Nataloni A, Compagnone C, Servadei F (2007) Custom made cranioplasty prostheses in porous hydroxy-apatite using 3D design techniques: 7 years experience in 25 patients. Acta Neurochir (Wien) 149(2):161–170, discussion 170