Burr-hole ring-cap and electrode anchoring device

Technical note

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A new burr-hole ring and cap are described. The threaded ring is C-shaped, holding itself in the burr hole by elastic recoil. A ventricular catheter or deep brain electrode may be passed through the slotted ring and anchored in place by means of a mushroom-shaped silicone rubber cap. The cap fills, sealing the plug. This simple two-part device, originally designed for use with a deep brain stimulator system, may also be used as a standard \( \frac{3}{8} \)-in. (16 mm) burr-hole plug.

KEY WORDS - burr-hole plug • brain electrode • deep brain stimulation

This anchoring device was constructed as an ancillary part of a new system for deep brain implantation of stimulating electrodes.\(^*\) Its primary functions are twofold. 1) It is a simple, reliable, and rapid means for the attachment of one or several indwelling brain electrodes (or catheters). 2) It is a simple, reliable, and rapid means for the closure of a burr hole using a silicone rubber cap for watertight sealing and cosmesis.

Metallic and plastic burr-hole filler plugs or covers have been available for some time. They are designed to be held in place by various mechanical forces, such as restitution of the scalp overlying the device, or a two-part construction where one part is placed into the burr hole down to the inner table, and the second part is pressed against the outer table, opposing the first part. None of these devices is directly applicable for anchoring indwelling brain electrodes or catheters. On the other hand, existing retainer units to maintain electrodes in the skull have generally been made entirely of rigid material in a variety of sizes or depths to accommodate different thicknesses of the skull.\(^4\) Rapid-setting, two-part acrylic material may be used to anchor electrodes but, once it has polymerized, the acrylic cannot be altered or removal or replacement of the electrode is quite difficult.\(^5\)


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Burr-hole plug and anchoring device

FIG. 1. Burr-hole cap and ring separated. Note the C-shaped construction with slot to allow compression using points of a hemostat. The sigmoid shape of the cap edge fits tightly inside the ring. The overhanging lip of the cap also fits tightly over the upper surface of the ring. The buttress (facing upward) retaining threads of the cap are seen.

This ring-shaped part is made to fit into a standard 3/4-in. diameter hole as drilled by a Smith automatic burr-hole perforator drill of 1/2-in. diameter (so designated by the diameter of the penetration through the inner table of the skull). This hole (approximately 16 mm in diameter) is bored with sufficient diametric accuracy so that the self-gripping buttress threads molded into the C-shaped ring will firmly anchor into the walls of the burr hole (Fig. 1).

The gap in the ring is compressed by points of a curved mosquito hemostat passed into the small holes provided near either side of the slot. With the slot gap compressed, the device is pressed into the burr hole and released. The natural elastic recoil holds the device firmly inside the hole. Burr holes with a variation of 0.5 mm smaller to 1 mm larger than 1/2 in. can be accommodated. The ring will firmly anchor into skulls varying in thickness from 5 mm up. If the hole is bored slightly off from true perpendicular (shallow on one edge), the plug may not firmly anchor unless the burr hole is further shaped with an air turbine drill. In that case, a slight overhanging lip is cut just inside the outer table of the burr hole, with care taken not to increase the most superficial diameter. The ring is tried again until a good fit is obtained.

Once the ring is firmly seated in place, deep brain electrodes of flexible wire tress may be passed through the ring. Because of the C-slot construction, the ring may be installed into the burr hole either before or after a catheter or electrodes are passed into the brain. Once placed, the electrodes are gently bent over the edge of the plug and the second part of the unit, the silicone rubber cap, is then inserted to act as an anchor for the electrodes. The cap is made of firm (durometer 65), biocompatible silicone rubber. The cap is pressed into the hole of the ring while angulating it against the rim on which the electrodes are bent. The cap is designed such that it will press the electrodes against the rounded rim of the ring, holding them tightly to prevent the electrodes from being displaced as the cap is seated. When the cap is seated on and within the ring, it exerts outward pressure, expanding the ring tighter against the walls of the burr hole, thus further preventing displacement of the ring or electrodes.

Several electrodes may be placed adjacent to each other, held by the cap. Furthermore, if subsequent removal of an electrode is required, the cap can be carefully pulled off, the electrode removed, and the cap replaced without disturbing the remaining electrodes. An indwelling catheter can be passed out through the gap so that it is not compressed by the cap. However, the catheter must be carefully anchored into galea with sutures to prevent inadvertent displacement later.

Remolding of the bone by regrowth will lock the buttress-type threads even more firmly inside the burr hole. Once the cap is placed, a watertight closure may be effected by using a small amount of bone wax pressed into the slot of the ring. The scalp is closed over the ring and cap in a routine two-layer manner. Electrode extension wires are brought out through the skin at some distance from the ring in order to prevent immigration of bacteria. The presence of an electrode anchored beneath the cap is shown in Fig. 2. The ring itself is not radio-opaque, and there is no present

§ Smith automatic burr-hole perforator drill manufactured by Codman, Inc., Randolph, Massachusetts.

[1] Silastic silicone rubber (MDX4-45159) manufactured by Dow Corning Corp., Midland, Michigan.
reason that it should be, but this could be achieved by the addition of micro barium sulfate into the injection mold mix.

Even though the cap exerts a considerable holding strength against the implanted electrodes, the later can still be pulled out with a vigorous tug. Caution must always be exercised when working with delicate wire electrodes to prevent their being injured or displaced. Modified versions of this ring and cap combination might be useful for holding small tubes in the brain or epidural space. This device has proved very useful in the stereotaxic implantation of subcortical electrodes in nearly 30 cases. Other uses exist in general neurosurgery, for instance, in the routine cosmetic closure of burr holes.

References


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