The suprapetrosal craniotomy

GUILHERME CARVALHAL RIBAS, M.D., AND ALDO JUNQUEIRA RODRIGUES JR., M.D.

Clinical Anatomy Discipline, Department of Surgery, University of São Paulo Medical School, São Paulo, Brazil

Object. The primary aim of this study was to establish standard sites for bur holes that maintain constant anatomical relationships with the skull base and neural structures and can serve as the basal aspect of supratentorial temporooccipital craniotomies.

Methods. To determine cranial–cerebral relationships, the authors created bur holes in 16 adult cadaveric skulls. Three bur holes were made on each side of the skulls (32 cerebral hemispheres). The authors then introduced plastic catheters through the bur holes to evaluate pertinent cranial and neural landmarks.

The first bur hole, located anterior to the auricle of the ear, appeared to have a particular anatomical relationship with the anterior aspect of the petrous portion of the temporal bone and the most anterior aspect of the midbrain. The second bur hole, whose base was located 1 cm above the interface of the parietomastoid and squamous sutures, had a particular relationship with the posterior border of the petrous portion of the temporal bone and with the posterior aspect of the midbrain. The third bur hole, whose base was located 1 cm above the asterion, was mostly supratentorial and particularly related to the preoccipital notch.

Conclusions. The preauricular bur hole and the bur hole whose base was located 1 cm above the interface of the parietomastoid and squamous sutures delimit anteriorly and posteriorly the external projection of the petrous bone and the midbrain. The middle fossa floor is located anterior to the site of the preauricular bur hole, and the superior surface of the tentorium is posterior to the bur hole located above the parietomastoid–squamous suture interface. Together with the bur hole whose base is located above the asterion, these bur holes can be considered standards for temporooccipital craniotomies.

KEY WORDS • cranial suture • skull base • bur hole • craniotomy
Acquisition of Anatomical Data

After an adequate period of encephalon fixation (≥ 2 months), we sectioned the brainstem at the midbrain level and removed it together with the cerebellum. With the aid of microsurgical loupes (magnification 3.5, Designs for Vision, Inc.) and/or a surgical microscope (variable intraoperative magnifications; MDM, Carl Zeiss, Inc.), we removed the arachnoid membranes and the superficial vessels of the cerebral hemispheres. Following this, we were able to complete a microscopic evaluation of the sites at which we introduced the catheters.

Each side of the skull was considered a single specimen. The number of specimens in each evaluation varied due to occasional damaging of specimens and/or procedural errors encountered at different stages of the study. Measurements were recorded in millimeters by the same investigator (G.C.R.) at least twice and with the aid of compasses and bending plastic rulers. In this paper measurements are expressed in centimeters.

Statistical Analysis

All values of continuous variables are expressed as means ± standard deviations. The right and left sides of each cadaveric brain were compared by performing the Wilcoxon matched-pairs signed-rank (two-tailed) test. A probability value less than 0.05 was considered significant.

For a statistical comparison of the right and left sides, the mean distance from this bur hole to the tip of the temporal lobe was 4.30 cm (90th percentile 1.40 cm), and there was no significant difference between the left and right sides of the skull (p = 0.404). The mean vertical distance of the interface of the squamous and parietomastoid sutures from the posterolateral aspect of the parietal bone was 4.58 ± 0.86 cm (90th percentile 5.70 cm), and again there was no significant difference in this value between the sides of the skull (p = 0.084).

The point at which the ascending posterior portion of the squamous suture and the horizontal parietomastoid suture meet (Fig. 1) was evident in all 30 specimens that could be evaluated. This interface was characterized as an evident depression on palpation in 19 specimens (63%) and as a very shallow depression in 10 (33%); it was not identified as a depression in one (4%) of the 30 specimens. The depression was characterized by a usually higher position of the temporal squamosal portion of the temporal bone as it relates to the posterior aspect of the mastoid tip, which is easily palpated, was 4.09 ± 0.55 cm (90th percentile 5.00 cm), and there was no difference in this value between the sides of the skull (p = 0.789).

With regard to the brain surface, this bur hole was related to the inferior temporal sulcus in 14 (50%) of 28 specimens evaluated, and to the inferior temporal gyrus in the other 14 (50%).

The mean distance between this bur hole and the base of the temporal lobe was 0.89 ± 0.39 cm (90th percentile 1.32 cm) with no significant difference between sides (p = 0.718). Along its coronal plane this bur hole was a mean of 0.43 ± 0.83 cm posterior to the most posterior aspect of the midbrain (90th percentile 0.50 cm) with no significant difference between sides (p = 0.765).

The mean distance between this bur hole and the base of the temporal lobe was 0.91 ± 0.40 cm (90th percentile 1.40 cm), and there was no significant difference between the left and right sides of the skull (p = 0.404). The mean distance from this bur hole to the tip of the temporal lobe was 4.30 ± 0.84 cm (90th percentile 5.30 cm), and again there was no significant difference between sides (p = 0.555).

Along the coronal plane, the preauricular bur hole at its most anterior aspect was located at a mean of 0.32 ± 0.65 cm anterior to the midbrain (90th percentile 1.62 cm), and there was no significant difference between sides (p = 0.343).

Results

Preauricular Bur Hole

The preauricular bur hole was created above the preauricular depression, which is characterized by the ascendent position of the superior aspect of the posterior portion of the zygomatic process, which is located just anterior to the tragus and external acoustic meatus (Fig. 1). The preauricular depression was easily palpated and identified in all 32 specimens; it was always adjacent to the foramen spinosum and next to the deepest portion of the middle fossa floor, and along its coronal plane it was anatomically related to the upper third of the clivus.

With regard to the brain surface, the preauricular bur hole was found to be related to the inferior temporal sulcus (between the middle and inferior temporal gyr) in 17 (55%) of the 31 specimens that were examined, with the inferior temporal gyrus in 12 (39%), and with the middle temporal gyrus in only two (6%).

The mean distance from the preauricular bur hole to the base of the temporal lobe was 0.91 ± 0.40 cm (90th percentile 1.40 cm), and there was no significant difference between the left and right sides of the skull (p = 0.404). The mean distance from this bur hole to the tip of the temporal lobe was 4.30 ± 0.84 cm (90th percentile 5.30 cm), and again there was no significant difference between sides (p = 0.555). Along the coronal plane, the preauricular bur hole at its most anterior aspect was located at a mean of 0.32 ± 0.65 cm anterior to the midbrain (90th percentile 1.62 cm), and there was no significant difference between sides (p = 0.343).
percentile 5.92 cm), and again there was no significant difference between sides (p = 0.759).

Discussion

Considering our findings, it is interesting to note that external cranial depressions and protuberances, to some extent, reflect important internal skull base anatomical structures (Fig. 1).

The ascendent placement of the superior aspect of the most posterior portion of the zygomatic process, which characterizes the preauricular depression, corresponds intracranially to the most anterolateral position of the petrous portion of the temporal bone and, hence, to the most anterior aspect of its ascending intracranial surface. The preauricular site thus also corresponds to the anatomical site of the transition between the temporal fossa and the ascending petrous bone surface.

The external junction of the parietomastoid and squamous sutures, which is an obvious site given the usual horizontal placement of the former and the ascending placement of the latter suture, corresponds intracranially to the most posterolateral part of the intracranial petrous surface, and hence to the anatomical delimitation between the petrous surface and the superior surface of the tentorium.
The interface of the parietomastoid and squamous sutures is usually characterized as an external cranial depression due to the prominence of the supramastoid crest, which is usually located just basal to its site. Frequently the entire posterior portion of the squamous part of the temporal bone is also more prominent than the portion of the parietal bone that is located above the parietomastoid suture, easing its identification through external palpation. According to our findings, the interface of the parietomastoid and squamous sutures can also be estimated as vertically lying roughly 4 cm above the posterior aspect of the mastoid process.

The preauricular bur hole and the bur hole whose base is located 1 cm above the junction of the parietomastoid and squamous sutures correspond to the anterior and the posterior limits of the intracranial petrous surface, respectively, and together constitute the basic bur holes required for an adequate suprapetrous surgical exposure. The middle fossa lies anterior to the former bur hole, and the superior tentorial surface lies posterior to the latter bur hole. According to our findings the distance between these bur holes is 4 to 5 cm. The use of bur holes more basally located is associated with the risk of entering the skull base or petrous bone and not providing proper exposure of the supratentorial compartment.

Fig. 2. Representative suprapetrous craniotomy for a basal meningioma. A: Sagittal magnetic resonance image obtained in a 60-year-old woman harboring a meningioma that is attached to the left superior surface of the petrous portion of the temporal bone. B: Photograph showing the patient in the lateral position. Marks have been made on the skin to delineate the incision for a left suprapetrous craniotomy, which has as its main basal landmarks the preauricular depression and the point at which the parietomastoid suture and squamous sutures meet. Together these sites delimit the external projection of the petrous bone. C–F: Intraoperative photographs. The two main basal bur holes that delimit the petrous bone: the bur hole located just above the preauricular depression (1) and the bur hole whose base lies 1 cm above the interface of the parietomastoid and squamous sutures (2). A third bur hole (3), whose base lies 1 cm above the asterion or the inion–asterion line, constitutes a more posterior basal bur hole for a posterior extension of a supratentorial temporoorbital craniotomy (C). Exposure of the transverse sinus and the lateral margin of the temporooccipital skull base after bone flap removal and complementary basal bone drilling. The position of the two initial bur holes allows the delineation of three different parts of the temporooccipital base (the Middle fossa, Petrous Bone, and Tentorium) (D). Exposure of the tumor underneath the inferior temporal gyrus (ITG) after opening of the dura mater (E). View of the temporooccipital skull base (Middle Fossa, Petrous Surface, Tentorium) after removal of the meningioma with preservation of the primary vein of Labbé (VL1), which is draining at the transition of the transverse and sigmoid sinuses (F). VL2 = secondary vein of Labbé.
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Intracranially, the preauricular bur hole always was found to be adjacent to the foramen spinosum. This bur hole was always related to the deepest aspect of the middle fossa and the upper aspect of the clivus, hence slightly anterior to the midbrain along its coronal plane. With regard to the brain surface, the preauricular bur hole was found to be mostly related to the most superior aspect of the inferior temporal gyrus.

Basal temporal approaches having as their epicenter the preauricular bur hole site, which is usually described as immediately anterior to the external acoustic meatus, were described as early as 1928 by Frazier and Gardner for extradural trigeminal section, in 1961 by House and later by Brackman et al. for translabyrinthine approaches through the middle fossa, and by Drake in 1961 and 1979 for subtemporal approaches to basilar artery aneurysms, among others.

The bur hole whose base is located 1 cm above the interface of the parietomastoid and squamous sutures intracranially was also anatomically related to the superior aspect of the inferior temporal gyrus and was slightly posterior to the most posterior aspect of the midbrain along its coronal plane. Both bur holes together thus also define the cranial topography of the lateral aspect of the midbrain and of the parapeduncular or lateral incisural space. Between both bur holes, the structures constituting the temporal base that lies over the petrous surface include the basal aspect of the inferior temporal gyrus and the fusiform and parahippocampal gyri, with the fusiform gyrus at this level corresponding to the floor of the ventricular atrium.

In 1905, at the time Cushing proposed cranial decompressive surgery for the treatment of inaccessible tumors, he provided an illustration of the associated basal temporal cranietomy located immediately anterior to the most posterior aspect of the squamous suture and just superior to the level of the parietomastoid suture, thus with its posterior aspect already related to the intracranial petrous surface. Since that time many authors have also illustrated basal temporooccipital craniotomies properly with regard to the procedures’ relations to the external cranial landmarks examined in this study, but without providing pertinent descriptions in their texts.

Although anterior basal extensions of the suprapetrosal exposure can be easily achieved by removal of bone along the middle fossa, posterior extensions of temporooccipital craniotomies can have as their epicenter the bur hole whose base is located 1 cm above the asterion.

Considering our present and previous findings, the bur hole whose base is located above the asterion is particularly related to the superior aspect of the transverse sinus and the most basal aspect of the supratentorial compartment at this level. We found its distance from the interface of the parietomastoid and squamous sutures, which corresponds to the length of the parietomastoid suture, to be approximately 2 cm, and its distance from the occipital pole to be approximately 5 cm, in accordance with distances found by other authors. Intracranially, the asterion usually corresponds to a dural plicature and to its related preoccipital notch, which arbitrarily separates the temporal and occipital lobes. During more posterior extensions of basal temporooccipital supratentorial craniotomies the surgeon can rely on the inion–asterion line as a landmark; in a previous study this line appeared to be roughly related to the topography of the transverse sinus. Nevertheless, the more posterior the craniotomy, the higher the bur hole should be placed so that it will be mostly supratentorial. Posterior to the asterion, such a bur hole should have its base at least 1 to 2 cm above the inion–asterion line.

Although the surgeon can begin a procedure with these bur holes located along the base of the cranial supratentorial compartment, in real basal supratentorial craniotomies, in which anterior and/or posterior extensions of the surgical field are needed, complementary drilling for an ideal basal exposure is required (Fig. 2).

Conclusions

We studied three sites for bur holes in 16 cadaveric skulls containing 32 cerebral hemispheres. Based on our examinations, these bur hole sites can be used as standards when performing temporooccipital basal craniotomies.

References


Address reprint requests to: Guilherme Carvalhal Ribas, M.D., Rua Eduardo Monteiro 567, São Paulo, SP 05614-120, Brazil. email: guilherme@ribas.med.br.