The sphenopetroclival venous gulf: a microanatomical study

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Object. The sphenopetroclival area is the border zone between the middle and posterior cranial fossa. Several authors have studied the microsurgical anatomy of this area and have furnished sometimes contradictory descriptions of this area, which still represents a great challenge for the neurosurgeon. On the basis of previous anatomical data reported in the literature, the authors undertook a new microanatomical analysis of the sphenopetroclival region and report their findings.

Methods. Twenty human cadaveric heads were used to reproduce, in the laboratory, different skull base approaches to expose the petroclival area. Measurements were taken in 40 specimens.

From this study has emerged the finding that the sphenopetroclival area is a venous space, which the authors have named the “sphenopetroclival venous gulf” (SPCVG). The SPCVG is filled anteriorly by blood from the cavernous sinus (lateral sellar compartment [LSC], medially by blood from the basilar plexus, and laterally by blood from the superior petrosal sinus; this venous gulf is drained by the inferior petrosal sinus. The SPCVG is comparable in shape to an irregular hedron figure. It contains the Dorello canal, the venous segment of the abducent nerve, and the superior sphenopetrosal (Gruber) ligament, the fibers of which are in anatomical continuity with those of the inferior sphenopetrosal (petrolingual) ligament, forming a “falciform ligament.”

Conclusions. The structures defining the posterior surface of the SPCVG may represent a helpful surgical corridor through which it is possible to approach the LSC via the posterior fossa. This conceptualization of the SPCVG is an attempt to define univocally the microanatomy of the sphenopetroclival region in its entirety.

Key Words • abducent nerve • skull base • cavernous sinus • Dorello canal • petroclival region

Several authors have recently studied the microsurgical anatomy of this area and sometimes their descriptions have delineated some contradictions regarding the definition and boundaries of the Dorello canal, which is an extremely important surgical landmark, as well as the borders of the entire area. The region has been divided into several spaces that represent surgical corridors and are often described using different nomenclature.5,13,15,24,25,27,28 During the last 10 years, many surgical approaches have been suggested to reach the sphenopetroclival region;5,9,10,17,18,21 nevertheless, tumors and vascular lesions in this area still represent a remarkable challenge for neurosurgeons, with high risks of perioperative mortality and permanent morbidity for patients and related high monetary costs to patients and social programs.

Previously, important studies have focused on some portions of this anatomical region and, hence perhaps, the differences in their descriptions are due to the lack of a total anatomical perspective. The purpose of this anatomical study is to review the entire anatomy of this complex area, which crosses the middle and posterior fossae and the LSC, particularly regarding the so-called “posterior cavernous sinus” and its content, to analyze constant, fixed anatomical landmarks useful to surgery. Furthermore we will suggest a surgically unabridged microanatomical description of this venous area we call the SPCVG.
Materials and Methods

Twenty cadaveric heads (40 specimens) were fixed in a three-pin Mayfield head holder, simulating the surgical position we use in the operating room, to obtain as realistic surgical information as possible. Five heads (10 specimens) were injected with colored silicone to define the vascular structures more clearly. Lateral surgical approaches (subtemporal–anterior transpetrosal, translabyrinthine, transcochlear, and extended middle fossa) and posterior surgical approaches (retrosigmoid and presigmoid), a combined approach (supratentorial-infratentorial-presigmoid), and the frontotemporoorbitozygomatic approach (with total unroofing of the optic canal, removal of the anterior clinoid process, and opening of the foramen rotundum and foramen ovale) were performed with the aid of the operative microscope to expose the sphenopetral area and compare surgical views (Fig. 1). In seven specimens the retrosigmoid approach was combined to perform an intradural apex petrosectomy and removal of the tentorium.

Finally, the skull vault was removed and the brain was carefully removed to expose the entire skull base and perform a microanatomical dissection of the sphenopetral area under optic magnification ($\times$3–40; Fig. 2). The distances among the dural entry points of the oculomotor, trochlear, trigeminal, and abducent nerves and the posterior clinoid were measured. The inner layer of the dura mater that covers the SPCVG posteriorly was carefully removed to expose the course of the nerves and the venous ostia.

The superior sphenopetral (Gruber) ligament and the inferior sphenopetral (petrolingual) ligament were removed en bloc, fixed in formalin, embedded in paraffin, and cut into 3-μ-thick histological sections for light microscopic examination. The elastic van Gieson staining technique (collagen fibers colored red, cells yellow-brown, and nuclei black) was used to demonstrate the continuity of the fibers of these two ligaments.

An AX 70 microscope (Olympus Optical Co., Tokyo, Japan) was used for the histological examinations. A surgical microscope (model OPMI; Zeiss, Oberkochen, Germany) was used for the dissections and photographs were obtained with an OM10 camera (Olympus Optical Co.) and Ektachrome 160 T film (Eastman Kodak, Rochester, NY).

Results

From our observations has emerged the finding that the frontotemporoorbitozygomatic approach provides excellent exposure of the lateral aspect of the LSC after removal of its lateral dural wall. The middle fossa and subtemporal–anterior transpetrosal approaches also provide wide access to the LSC; in our experience, removal of the zygomatic arch can achieve a more basal anterior extension of the approach. Combining the epidural and subdural routes, a wider exposure of the LSC and surrounding structures can be obtained. Nevertheless, the area of the Dorello canal is covered by the trigeminal nerve and the gasserian ganglion (Fig. 3). They obscure a large part of the posterior portion of the LSC and the SPCVG. The lower portion of the Gruber ligament; the posterior segment of the petrolingual ligament; the petrous apex with the petrous tubercle and, hence, the lateral portion of the SPCVG; the abducent nerve; and a part of the posterior bend of the CA can be observed after downward retraction of the trigeminal nerve, its ophthalmic root, and the gasserian ganglion (Fig. 4). The medial portion of the gulf and the “venous” segment of the abducent nerve, within the SPCVG, are covered by the petrous tip. A combined supra- and infratentorial approach associated with partial resection of the tentorium and various degrees of extensive petrosectomy, including translabyrinthine and transcochlear techniques, can enlarge the corridor posteriorly through which these structures and the
clivus can be reached, thus extending the surgical view over the midline (Fig. 5).

The posterior approaches, which eventually were combined, provide a straight entrance within the SPCVG through a “door” located among the posterior clinoid process and the fourth, fifth, and sixth cranial nerves. Cutting of the tentorium and drilling of the suprameatal bone are extremely important for enlarging access through the door and the surgeon’s working space. After removal of the dural sleeve, the SPCVG is exposed; the Gruber ligament is appreciable in all its length; and the first and second genu of the abducent nerve, the medial surface of the gasserian ganglion, and the petrous portion of the petrolingual ligament are identifiable. The posterior surface of the dural bend of the intracavernous ICA can also be reached.

The SPCVG

The SPCVG (Fig. 6) is an extradural venous space comparable in shape to an irregular hexahedron. Anteriorly, it is filled by blood of the LSC, medially by that of the basilar plexus, and laterally by that of the superior petrosal sinus. The blood is drained inferiorly into the inferior petrosal sinus (Fig. 7). The distances we measured in this anatomical area are summarized in Table 1.

The posterior wall of the SPCVG is trapezoidal. It is the inner layer of the dura mater, which is bordered by the posterior clinoid process superomedially, the foramen of the trigeminal nerve inferolaterally and, finally, the foramen of the abducent nerve inferomedially (Fig. 8). The mean distance between the posterior clinoid process and the entry point of the fourth cranial nerve is 13.16 ± 3.04 mm, 12.16 ± 3.75 mm on the right side and 14.16 ± 2.46 mm on the left; the mean distance between the entry points of the trochlear and trigeminal nerves is 5.66 ± 0.75 mm, 5.5 ± 0.86 mm on the right side and 5.83 ± 0.76 mm on the left; the mean distance between the entry points of the trigeminal and abdu-
Sphenopetroclival venous gulf

Fig. 5. Schematic illustration showing the surgical corridor of the petroclival area after a total petrosectomy has been performed. This procedure provides excellent exposure of the intradural compartment, extending the view over the midline. The tentorium has been resected, clearly exposing the supratentorial area, and the third and fourth cranial nerves and the posterior clinoid process are reached. The ascending and transverse segments of the petrous ICA have been unroofed, and the tympanic and mastoid segments of the facial nerve have been exposed. BA = basilar artery; CA = petrous portion of the CA; CON.VI = contralateral abducent nerve; GG = gasserian ganglion; Gg = geniculate ganglion; JB = jugular bulb; SCA = superior cerebellar artery.

Fig. 6. Anatomical construct of the SPCVG. It is an extradural venous space comparable in shape to an irregular hexahedron. It is filled anteriorly by blood from the LSC (cavernous sinus), medially by blood from the basilar plexus, and laterally by blood from the superior petrosal sinus. The blood is drained inferiorly by the inferior petrosal sinus or even laterally by the superior petrosal sinus, according to the position of the head and/or intracranial pressure conditions. c.n. = cranial nerve.

Fig. 7. Photograph of a cadaveric specimen. The left SPCVG has been dissected. The inferior (double arrow) and superior (single arrow) petrosal sinuses have been incised longitudinally and spread to show their outlets into the gulf. Blood clots are located inside. The outlet of the superior petrosal sinus is located between the trochlear (4) and trigeminal (5) nerve entry points. In this specimen the Gruber ligament (arrowhead) does not insert into the petrous tubercle, but into the posterior surface of the petrous apex close to the entry point of the abducent nerve. It has to be noted that the venous segment of the abducent nerve follows an almost vertical ascending course before reaching the lateral surface of the CA.

The anterior wall, which represents the boundary with the LSC, is a coronal plane passing through the posterior petroclinoid fold superiorly and the lateral aspect of the upper clivus inferiorly. It corresponds to the posterior wall of the vertical segment of the CA in the LSC. Its pulsations support the draining function of the gulf.

The superior limit of the SPCVG corresponds to the posterior petroclinoid fold. The inferior wall is an axial plane passing through the dural porus of the sixth cranial nerve medially, the porus of the trigeminal nerve laterally and the sphenopetrosal synchondrosis. In 24 (60%) of the 40 specimens, the ostium of the inferior petrosal sinus, being lateral to the porus of the abducent nerve, represented the posterior portion of the inferior face. In 16 (40%) of 40 specimens,
for the most part this ostium was medial to the nerve and, hence, the floor of the SPCVG was mostly represented by synchondrosis. This bone surface is 5.7 mm (range 4–7 mm) in width and 3.2 mm (range 1.5–4.5 mm) in length. Based on our observations the inferior petrosal sinus is 2.9 mm (range 0.9–4.7 mm) wide. In all observations, the blood of the inferior petrosal sinus surrounded the porus of the abducent nerve.

The medial wall of the SPCVG is a virtual sagittal plane passing through the lateral edge of the dorsum sellae anteriorly and the porus of the abducent nerve posteriorly and inferiorly. It virtually separates the gulf from the basilar plexus.

The lateral wall is represented by the ostium of the superior petrosal sinus and it is bordered by the medial surface of the petrous apex anteroinferiorly, the porus of the trigeminal nerve posteroinferiorly, and the insertion of the posterior petroclinoid fold on the petrous apex superiorly. The superior petrosal sinus is 2.5 mm wide (range 1–4.5 mm).

### Contents of the SPCVG

#### The Abducent Nerve

After piercing the dural porus, the abducent nerve enters the SPCVG and then reaches the LSC. The nerve runs superiorly and medially, passing through the Dorello canal and under the Gruber ligament. At the exit of the Dorello canal, the nerve, fixed to the petrous apex by connective tissue, curves inferiorly and laterally to reach the posterolateral surface of the posterior bend of the ICA into the LSC (Figs. 10–12). This segment has been named the “venous segment” because of its course inside the venous gulf. The mean length of the venous segment of the abducent nerve is 11.5 ± 3.66 mm on the right side and 11.53 ± 3.73 mm on the left; its mean diameter is 0.42 ± 0.21 mm. The dorsal meningeal artery of the me-

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**TABLE 1**

Distances between various cranial nerves and the posterior clinoid process*

<table>
<thead>
<tr>
<th>Structures</th>
<th>Both Sides</th>
<th>Rt Side</th>
<th>Lt Side</th>
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<tbody>
<tr>
<td>CN III–CN III</td>
<td>23.66 ± 2.08</td>
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<td>NA</td>
</tr>
<tr>
<td>CN III–CN IV</td>
<td>9.16 ± 2.38</td>
<td>8.83 ± 2.75</td>
<td>9.50 ± 2.50</td>
</tr>
<tr>
<td>CN III–CN V</td>
<td>11.00 ± 0.80</td>
<td>11.12 ± 1.18</td>
<td>10.87 ± 0.25</td>
</tr>
<tr>
<td>CN III–CN VI</td>
<td>15.83 ± 1.17</td>
<td>15.25 ± 1.04</td>
<td>16.30 ± 1.15</td>
</tr>
<tr>
<td>CN III–PC</td>
<td>5.93 ± 0.97</td>
<td>6.37 ± 0.94</td>
<td>5.50 ± 0.91</td>
</tr>
<tr>
<td>CN IV–CN V</td>
<td>5.66 ± 0.75</td>
<td>5.50 ± 0.86</td>
<td>5.83 ± 0.76</td>
</tr>
<tr>
<td>CN IV–CN VI</td>
<td>11.91 ± 2.03</td>
<td>11.66 ± 1.25</td>
<td>12.16 ± 2.92</td>
</tr>
<tr>
<td>CN IV–PC</td>
<td>13.16 ± 3.04</td>
<td>12.16 ± 3.75</td>
<td>14.16 ± 2.46</td>
</tr>
<tr>
<td>CN V–CN VI</td>
<td>8.05 ± 1.64</td>
<td>7.50 ± 1.00</td>
<td>8.60 ± 2.07</td>
</tr>
<tr>
<td>CN V–PC</td>
<td>16.05 ± 1.89</td>
<td>15.70 ± 2.16</td>
<td>16.50 ± 1.68</td>
</tr>
<tr>
<td>CN VI–CN VI</td>
<td>20.70 ± 0.67</td>
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<td>NA</td>
</tr>
<tr>
<td>CN VI–PC</td>
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<td>16.91 ± 1.82</td>
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</tr>
<tr>
<td>PC–PC</td>
<td>11.80 ± 1.03</td>
<td>NA</td>
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</tr>
</tbody>
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* Values are presented as means ± standard deviations. Abbreviations: CN = cranial nerve; NA = not applicable.
ningohypophysial trunk, which contributes to the blood supply of the nerve in this region, runs superolaterally to the venous segment and passes under the Gruber ligament in 35 (87.5%) of 40 cases. Small branches arising from the lateral artery of the clivus vascularize this nerve segment.

The Dorello Canal. The term “Dorello canal” has been used to define the narrow triangular space that is bordered superolaterally by the Gruber ligament, medially by the lateral edge of the dorsum sellae, inferiorly by the petrous apex, and inferolaterally by the bone of the petrous apex (Fig. 11). The height of the Dorello canal at its midpoint is $1.7 \pm 0.14$ mm and its width is $8.37 \pm 2.15$ mm; the length of the canal corresponds to the width of the Gruber ligament. The canal contains the second bend of the abducent nerve medially and the dorsal meningeal artery laterally. In four specimens (10%), fibers of the Gruber ligament, running over the petrous apex, reached the anterior surface of the bone thus forming a real osteofibrous canal.

Falciform Ligament. The term “falciform ligament” has been used to define the narrow triangular space that is bordered superolaterally by the Gruber ligament, laterally by the lateral edge of the dorsum sellae, medially by the superior aspect of the clivus, and inferiorly by the bone of the petrous apex (Fig. 11). The height of the Dorello canal at its midpoint is $1.7 \pm 0.14$ mm and its width is $8.37 \pm 2.15$ mm; the length of the canal corresponds to the width of the Gruber ligament. The canal contains the second bend of the abducent nerve medially and the dorsal meningeal artery laterally. In four specimens (10%), fibers of the Gruber ligament, running over the petrous apex, reached the anterior surface of the bone thus forming a real osteofibrous canal.

The superior sphenopetrosal ligament, or Gruber ligament, arises beneath the posterior clinoid process, at the level of the lateral aspect of the dorsum sellae, and runs to the apex of the petrous bone. The ligament is inserted into a bony spur named the “petrous tubercle,” which in 80% of cases is particularly redundant. It is butterfly shaped, larger at its medial (4.27 ± 2.5 mm) and lateral (5.48 ± 2.2 mm) insertions and thinner at the level of its medial point (2.05 ± 1.8 mm). Its length is 13.31 ± 2.34 mm. In three (7.5%) of 40 specimens it was found to be ossified and in one (2.5%) of 40 it was hypoplastic, very thin, and translucent. In another specimen (2.5%) it was found not to be inserted into the tubercle, but 3 mm lower on the posterior surface of the petrous apex. This ligament is composed of close, parallel collagen fibers, which are organized in a dense connective tissue; this explains its particular resistance and silver color. The ligament can be considered the posterior portion of the falciform ligament.

The inferior sphenopetrosal ligament, or petrolingual ligament, runs from the petrous apex to the lingula sphenoidalis and covers the lateral surface of the CA before entering the LSC (lateral ring). It is bow shaped with a body larger than the wings. This ligament measures 9 to 17 mm (mean 12 mm) in length and 2.7 to 7.5 mm (mean 4.5 mm) in width. Its thickness varies from 0.7 to 2 mm (mean 1.5 mm). It covers the C-3 segment of the CA, according to the classification suggested by Bouthillier, et al., is mediolaterally located, and laterally is in contact with a loose, thin connective tissue that covers the medial surface of the trigeminal nerve. An easily dissectable cleavage plane between

**Fig. 10.** Photograph of a cadaveric specimen in which the SPCVG and the LSC have been dissected. The posterior clinoid process, the CA (A), the Gruber ligament (G), and the abducent nerve (6) can be identified. The Meckel cave has been opened and the trigeminal nerve (5) covers the lateral insertion point of the Gruber ligament. The narrowing of the abducent nerve indicates its entry point into the SPCVG (arrow).

**Fig. 11.** Another cadaveric specimen in which the SPCVG and LSC have been dissected. The oculomotor, trochlear, and trigeminal nerves have been reflected laterally by using forceps, and the petrous insertion of the Gruber ligament (G) is now evident. It is possible to appreciate the abducent nerve (6) as it courses below the Gruber ligament into the Dorello canal (arrow), around the ICA (A), and on to the superior orbital fissure (SOF). The forceps tip indicates the petrolingual ligament (P).
these structures has been always found. In one specimen (2.5%) the ligament was found to be ossified. Parallel and vertical fibers that cross each other constitute the ligament. Horizontal fibers, which originate from the endosteal dural sheet on the petrous apex and from the carotid canal cross the vertical collagen fibers that are the continuation of the Gruber ligament fibers. All these fibers are organized in a loose, opaque connective tissue that covers the intracranial portion of the CA before its entry into the LSC, separating it from the Meckel cave. The petrolingual ligament can be considered the anterior portion of the falciform ligament.

A histological examination of the joint between the Gruber and petrolingual ligaments has allowed us to determine that the fibers of the two ligaments are in anatomical continuity. In fact, part of the fibers of the Gruber ligament are fixed at the level of the petrous tubercle, whereas other fibers continue to the lingula sphenoidalis together with collagen fibers arising from the endosteal dural sheet of the petrous apex and from the carotid canal. For this reason we consider the two ligaments to be a unique anatomical entity and we have named this the “falciform ligament” because it is shaped like a falx (Figs. 12 and 13). The knee of the falciform ligament, corresponding to the junction of the two ligaments, and the initial part (1–3 mm) of its anterior portion (petrolingual) are located in the SPCVG.

Discussion

The sphenopetroclival region is a venous crossroad connected anteriorly to the LSC. Recent advances in surgical techniques related to this area have revived an extreme interest in its microsurgical anatomy.

Attempts to classify the sphenopetroclival region have been made by some authors. Nevertheless, in the majority of studies investigations of this anatomy continue to have as their focus the Dorello canal and the abducent nerve. The aim of this anatomical study was to attempt a reconstruction of this area, taking into consideration all its anatomical components.

Perneczky, et al., have divided the LSC into three parts: anterior, middle, and posterior. They have defined the region that is located behind the V3 branch of the gasserian
ganglion and anterior to the trigeminal nerve as it enters into the Meckel cave as the “posterior cavernous sinus.” Fukushima has described a “posteroinferior triangle,” that is, the triangular space bordered by the abducens nerve, the posterior clinoid process, and the porus trigeminus. Through this space the abducens nerve and the “posterior portion of the cavernous sinus” are exposed.

Sekhar, et al.21 in a well-detailed anatomical description of the approach to the “posterior space” of the LSC, advocated using an inferior approach along the floor of the middle fossa or a subtemporal–infratemporal fossa exposure; however, the width of the corridor achieved was minimal. Recently Sekhar and colleagues20 have reported a partial labyrinthectomy–petrous apicectomy approach that provides a sufficiently wide access to the clivus, petrous apex, and posterior cavernous sinus. Taha, et al.23 have suggested the subtemporal extradural–intradural approach combined with an anterior petrosectomy, thus entering the Parkinson triangle and the posterior cavernous sinus.

Dolenc5 has divided the petroclival area into two triangles: inferomedial and inferolateral. The inferomedial triangle of the cavernous sinus is the triangular space bordered by the posterior clinoid process superiorly, the sixth nerve inferiorly, and the fourth nerve superolaterally. The inferolateral triangle is bordered inferiorly by the sixth nerve, superomedially by the fourth nerve, and laterally by the petrosal vein opening into the superior petrosal sinus.

All these descriptions are still under discussion and remain controversial. Perhaps the lack of clear three-dimensional anatomical borders in the surgeon’s perspective is the reason this area remains under debate and explains the differences in descriptions from paper to paper. In our opinion the concept of the SPCVG can be helpful in clarifying some doubts that one could have reading the pertinent literature: the three-dimensional geometrical construct we describe corresponds to what, in previous studies, has been defined as the posterior cavernous sinus.

Another important anatomical controversy is related to the boundaries of the Dorello canal within the SPCVG. Dorello, in his original paper,6 described the canal as a “bony cove, concave on its upper and lateral part, covered by a special fibrous band named petrosphenoidal ligament of Gruber, forming an osteofibrous canal.” According to Dorello, who performed his pioneering dissections without the aid of a microscope, the petrosphenoidal ligament arises from bundles of fibers of the tentorium listed in its lateral portion. These bundles, which are deeply situated, cross the ones located more medial and superficial in a transverse manner, turn medially and forward, are inserted at the posterior clinoid process, and form a lodge for the gasserian ganglion. The deepest fibers, inserting at the lower portion of the posterior clinoid process, named by Dorello the “accessory posterior clinoid process” at the lateral border of the lamina quadrilatera medially, and at the petrous bone laterally (4–5 mm more lateral to the apex), form the petrosphenoidal ligament of Gruber. An extremely important micromorphological study on the Dorello canal was performed in 1991 by Umansky, et al.24 In their study it was suggested that the Dorello canal is located inside a “venous confluence” formed by the posterior portion of the cavernous sinus, the inferior petrosal sinus, and the basilar sinus. Therefore, the petrosphenoidal ligament is immersed in the venous confluence. The ostium of the inferior petrosal sinus was found within the venous confluence in a lateral (80%) or medial (20%) position related to the sixth nerve, outside the Dorello canal in all examined specimens. The diameter of the canal varied from 0.5 to 3 mm and its length from 4 to 13 mm.

Destrieux and associates,4 in their study on the Dorello canal, described the “petroclival venous confluence.” To our knowledge, their paper was the first in which this area was examined from a different anatomical point of view, compared with previous studies. Those authors consider the petroclival venous confluence to be a small space through which the abducens nerve runs from its dural porus to the LSC. Among 28 specimens examined in one (3.5%) they observed the nerve running on top of the Gruber ligament, outside the canal. Based on previous descriptions, the authors considered the term Dorello canal to be inappropriate and capable of generating confusion. For this reason Destrieux and associates suggested a larger space, located between the cerebral and periosteal layers of the dura mater, which is named the petroclival venous confluence instead of the Dorello canal. They described three virtual planes limiting the confluence medially, anteriorly, and inferiorly. It is an osteodural, inextensible venous compartment containing the abducens nerve; it is limited superiorly by the posterior clinoid process fold, anteroinferiorly by the posterosuperior aspect of the lateral border of the upper clivus and posterior clinoid process, laterally by the medial aspect of the petrous bone apex, and posteriorly by the cerebral layer of dura mater that also forms the posterosuperior wall of the inferior petrosal sinus and the basal sinus of the clivus.

All these descriptions, which have to be considered milestones in the understanding of this complex anatomy, have been debated and remain controversial. Furthermore, the consequence of so many different classifications is that the structures contained in the sphenopetroclival area, such as the Dorello canal, the inferior petrosal sinus, the petrosphenoidal ligaments, and the abducens nerve, are not well defined anatomically when considered en bloc and are often not clearly identified intraoperatively, particularly if the surgeon is not very familiar with them. In the classic works of Dorello4 and Gruber,4 the Dorello canal was defined as the small space that is crossed by the abducens nerve and is located between the petrous apex and the Gruber ligament. Dolenc5 has described it as a larger space located between the two dural leaves of the sphenopetroclival area. In our material we found four specimens (10%) in which the fibers of the Gruber ligament were connected to the superior lip of the dural porus of the abducens nerve, thus forming a sort of canal covering the nerve on its superior surface from the porus to its entrance into the LSC. Because the entry point of the abducens nerve often has been named the foramen of Dorello or the Dorello canal, according to the original descriptions posed by Dorello6 and Umansky, et al.23 we consider the Dorello canal to be a bow-shaped canal immersed in the SPCVG through which the abducens nerve courses to reach the LSC.

In the original work of Dorello6 the inferior petrosal sinus was described as an opening inside the Dorello canal, whereas Umansky reported that the sinus does not open in the canal. Destrieux and associates,4 in their series found the
sinus opening to be medial to the dural porus of the sixth nerve in 40% of cases and lateral to this dural porus in 60% of cases.

All the aforementioned authors have studied some extremely important anatomical aspects of this area and furnished different descriptions of it; however, a wholly anatomical construct of the structures related to this region has not been well depicted. In the present study we have provided a microanatomical description of the sphenopetrosclival area in which we have considered the mainly venous nature of this region, which is filled by blood coming from the LSC, basilar plexus and superior petrosal sinus and is drained by the inferior petrosal sinus. The superior petrosal sinus can be affluent or even effluent with respect to the SPCVG in relation to the position of the head and to intracranial pressure conditions; therefore, both petrosal sinuses may have a draining function for LSC blood.

In our opinion the introduction of the concept of the SPCVG furnishes a definition of this complex area from both anatomical and surgical points of view. In fact this definition takes into consideration the prevalent vascular nature of the region and provides a description of all structures contained inside the gulf and constituting the sphenopetrosclival region. The posterior trapezoidal surface, corresponding to the inner dural sleeve of the sphenopetrosclival area, bordered by the fourth cranial nerve superolaterally, the fifth cranial nerve inferolaterally, the posterior clinoid process superomedially, and the sixth cranial nerve inferomedially may represent a surgical corridor through which it is possible to approach, via the posterior fossa, the venous gulf and the LSC. All structures that constitute this corridor are anatomically constant and each one could be used for orientation and as a helpful landmark to enter this corridor (Fig. 14). Drilling of the intradural petrous apex (0.7–10 mm) and removal of a part of the tentorium can remarkably enlarge the surgical corridor to this area; the third, fourth, fifth, sixth cranial nerves, the posterior clinoid process, the posterior cerebral arteries, and, often, the CA and optic nerve become visible, providing a better view of the approach to minimize the risk of morbidity.

Conclusions

This anatomical study should not be interpreted as an attempt to minimize the importance of previous studies that have inspired us. Approaches to the sphenopetrosclival region still represent an important challenge for the neurosurgeon. Surgical approaches to this region require a perfect knowledge of both microanatomy and surgical landmarks to avoid injuring arteries and nerves.

Some authors have described the pertinent anatomy very well, but further research about microtopographic anatomical knowledge is needed to clarify some important doubts and concepts. Searching for new reliable landmarks may only contribute to a reduction in surgical invasiveness.

The concept of the SPCVG is, in our opinion, an attempt to define anatomically the petroclival region in its entirety, to standardize neurosurgical language, and to clarify at least some controversies reported in the literature to date. Furthermore, the structures bordering the SPCVG define a surgical corridor through which it is possible to approach the LSC and the Meckel’s cave via the posterior fossa.

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