Importance of the temporal venous drainage to the petrosal approaches of the skull base

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ABSTRACT

Objectives: The temporal venous drainage is essential to the favorable prognosis of the patients whose require subtemporal and petrosal approaches to the skull base. To obtain adequate exposure of the middle and posterior fossae the tentorial split is an important step. The aim of this paper is discuss the anatomical aspects of the venous patterns of the temporal lobe stressing the relevant correlations with the petrosal and tentorial approaches. Methods: The authors review the anatomic, surgical and radiological aspects of the temporal venous drainage with special concern about the preservation of the temporal lobe integrity during the transtentorial and petrosal approaches. Results: The vein of Labbè is the most important vein of the lateral group of veins and it is present in almost 100% of the cases. The inferior system of veins is composed by three different groups of veins in the anterior, medial and posterior portions of the temporal lobe. The anteroinferior veins can be present in 70% of the temporal lobes, the medial-inferior veins in 40% and the posteroinferior in 90% of the cases. The anteroinferior and the posteroinferior groups of veins drain in an independent pattern of the lateral group in more than 10% of the cases. Conclusions: Despite of the preservation of the vein of Labbè during the transtentorial and petrosal approaches, temporal infarction has been observed as a complication of such approaches. The patterns of the venous drainage at the inferior temporal surface should be observed carefully in order to avoid temporal infarction. Angiographic preoperative studies are crucial to evaluate such venous anatomy. The correct positioning of the tentorial incisions according with the temporal venous anatomy and the intermittent gentle temporal retraction are the technical aspects, which permit the better final results. Key-words: Skull base surgery, petrosal approaches, temporal venous anatomy.

SUMÁRIO

Objetivos: A drenagem venosa temporal é essencial para o prognóstico favorável dos pacientes que necessitam abordagens subtemporais e petrosas para a base do crânio. Para obter uma exposição adequada das fossas média e posterior a abertura do tentório é uma etapa importante. O objetivo deste artigo é discutir os aspectos anatômicos da drenagem venosa do lobo temporal, com especial atenção para suas correlações com os seios e canais venosos do tentório, durante as abordagens petrosas da base do crânio. Métodos: Os autores revisam os aspectos anatômicos, cirúrgicos e radiológicos da drenagem venosa temporal com ênfase na preservação da integridade do lobo temporal durante as abordagens transtentoriais e petrosas. Resultados: A veia de Labbè é a mais importante veia do grupo lateral de veias e está presente em mais de 100% dos casos. O sistema inferior de veias é composto por três diferentes grupos de veias na porção anterior, medial e posterior do lobo temporal. As veias anteroinferiores podem ser presentes em 70% dos lobos temporais, as veias médio-inferiores em 40% e as veias posteroinferiores em 90% dos casos. As veias anteroinferiores e posteroinferiores drenam de forma independente do grupo lateral em mais de 10% dos casos. Conclusões: Apesar da preservação da veia de Labbè durante as abordagens petrosas e transtentoriais têm sido observados infartos temporais como complicações destas abordagens. Os modelos...
de drenagem venosa na superfície inferior do lobo temporal devem ser observados com atenção com o objetivo de evitar o infarto temporal. Estudos angiográficos pré-operatórios são fundamentais para a avaliação da anatomia venosa. O correto posicionamento das incisões tentoriais de acordo com a anatomia venosa temporal e a retração suave e intermitente do lobo temporal são aspectos técnicos que permitem os melhores resultados finais. Palavras-chave: Cirurgia da base de crânio, abordagens petrosas, anatomia venosa temporal.

**INTRODUCTION**

The lateral skull base techniques promote important alternatives to deal with petrosal and petroclival tumors. During the development of such techniques the literature described the importance of the preservation of the vein of Labbè to avoid temporal infarction. Despite of such preservation numerous cases have been described of temporal infarction during the petrosal and subtemporal approaches, especially when the tentorium is divided during the procedures. The importance of the understanding of the anatomy of the temporal venous system has been discussed in order to obtain the radical removal of the tumors with preservation of the temporal integrity.

**ANATOMY OF THE TEMPORAL VENOUS SYSTEM**

The anatomy of the temporal venous system was described according different criteria. In the anatomical descriptions of such system the veins are organized in the superficial venous system and the deep venous system. They drain to the dural sinuses of the tentorium, transverse and sigmoid, and to the great vein of Galen respectively. The superficial venous system drains the outer 2cm of the cortex and white matter. The three largest veins of the lateral surface of the brain are the superficial middle cerebral vein (superficial sylvian vein), the vein of Labbè and the vein of Trollard. The veins of the inferior surface of the temporal lobe are divided in the anteroinferior, medial-inferior and posteroinferior groups

**VEIN OF LABBÈ**

Charles Labbè first described the vein of Labbè in 1879. He called a vein behind the vein of Trollard, which connected the superior and lateral sinuses, the great anastomotic posterior cerebral vein. Gillot, in 1964, called such vein the vein of Labbè. Nowadays, the literature refers to the largest vein that connects the superficial sylvian vein and the transverse sinus as the vein of Labbè or the inferior anastomotic vein. In a study of 20 specimens, Sakata et al. found that the vein of Labbè was seen in 100% of the cases. It was originated at the level of the middle temporal vein in 9 and at the level of the posterior temporal vein in 12 specimens. In one case they found the double vein of Labbè as described by Di Chiro. The vein of Labbè drained into the transverse sinus in 74% and in the tentorium in 19%. The dominant vein of Labbè was noted in 40% of the cases and equally distributed in both sides. The majority of veins of Labbè drained in the transverse sinus more than 1cm posterior to the sinodural point (point of the junction of the superior petrosal sinus and the lateral sinus). In other study of 40 temporal lobes Guppy et al. found the vein of Labbè in all cases, and the average distance of the point of drainage into the transverse sinus and the junction of the transverse, sigmoid and superior petrosal sinuses was 2.31cm. Gusmão et al. observed that in 29% of the specimens the vein of Labbè drained to the lateral sinus formed by the union of Labbè and other lateral veins. The vein of Labbè is included in the group of the lateral complex of veins that drains the lateral surface of the temporal lobe. FIG. 1

**ANTEOINFERIOR TEMPORAL VEINS**

The study of Guppy et al. found that 70% of the temporal lobes were drained in the anterior inferior portion by a specific group of veins. Such veins drained to the lateral complex of veins (Labbè) in almost 40% of the cases and to the superior petrosal sinus and to the lakes of the tentorium in the remaining cases.
The importance of the basal groups of the temporal veins is being described in those cases that the Labbè vein is preserved and the temporal infarction still is observed15. FIG 2, FIG 3.

**Figure 2**: Cerebral angiography: The small vein of Labbè draining to the transverse sinus. (Blue arrow) Note the far posterior point of drainage of the posteroinferior vein into the transverse sinus. (Red arrow)

**MEDIAL-INFERIOR AND POSTERIOR INFERIOR TEMPORAL VEINS**

In 40 specimens, Guppy et al. observed that the medial-inferior temporal lobe was drained by a specific group of veins in 38.5% of the cases. The majority of medial-inferior temporal veins were tributaries of the lateral system of veins (vein of Labbè). The posteroinferior temporal lobe presented its own system of veins in almost 90% of the cases. In half of cases the posteroinferior veins drained to the lateral veins (Labbè). The posteroinferior veins were the most common group, which drained into the lakes of the tentorium7. FIG 2, FIG 3.

**SPHENOPETROSAL SINUS**

The sphenopetrosal sinus is one of the four types of drainage of the superficial sylvian vein (cavernous, sphenobasal, sphenopetrosal and cortical). In such model, the superficial sylvian vein drains to the middle fossa dural and forms a dural sinus called sphenopetrosal sinus and then drains to the superior petrosal sinus or the lateral sinus. This modality of drainage is important to the approaches where is intended to cut the tentorium, because of the drainage of the temporal lobe could be seriously damage and the infarction developed13-16. FIG 3

**SUPERIOR PETROSAL SINUS**

The superior petrosal sinus connects the posterior portion of the cavernous sinus and the junction of the transverse and sigmoid sinus. It courses within the attachment of the tentorium to the petrous ridge. Besides the most relevant veins which drain into the superior petrosal sinus are originated from the cerebellum and the brainstem, the inferior temporal lobe veins can drain into such sinus directly through the bridging temporal veins or through the sphenopetrosal sinus13,16,20.

**TECHNICAL ASPECTS**

**PRESEVING THE VEIN OF LABBÈ**

Is widely described the importance of the preservation of the vein of Labbè during the lateral approaches to the skull base. Numerous methods for preservation of the vein of Labbè have been described to perform the splitting of the tentorium. Al-Mefty et al. described the approach opening the dura of the temporal and posterior fossa along the anterior edge of the
The temporal dura was incised parallel to the transverse sinus and the vein of Labbé was dissected from the cortical surface, enabling posterior temporal retraction without tension on the venous wall\textsuperscript{1,14}.

If the vein of Labbé drains into the superior petrosal sinus the drilling of the petrous ridge should be extended and the tentorium is divided at the portion anterior to the entry point of the Labbé at the superior petrosal sinus or the lake into tentorium\textsuperscript{1,6}.

Numerous authors had described the transtentorial petrosal approaches cutting the tentorium with the preservation of the vein of Labbé. The superior petrosal sinus is ligated in different positions and the point of drainage of the vein of Labbé is preserved in the transverse or other sinuses\textsuperscript{2,6,11,18}.

**TENTORIUM CUTTING**

The tentorial incision is the key step during the exposition of the petroclival region allowing to the visualization of the middle and posterior fossa as unique operative field. However, the split of the tentorium is crucial to the preservation of the venous drainage of the temporal lobe. The preservation of the vein of Labbé is one of the goals of such incision and the point where such vein is draining should be identified and preserved, even if it means that the tentorium incision should be modified or avoided. The preservation of the lakes of the tentorium can be achieved if the angiogram indicates their presence. A fashion where the tentorium is incised more anteriorly creating a triangular tentorium flap with medial base is an interesting alternative to preserve the bridging temporal veins of the inferior face of the temporal lobe an the lakes of the tentorium\textsuperscript{3,9}.

The sphenopetrosal sinus as described above should be carefully evaluated before to perform the tentorial approach. If there is a dominant sphenopetrosal sinus the tentorium should not be divided in order to avoid serious complications in the temporal venous drainage. In such cases, alternative approaches should be used and the tentorium should be preserved\textsuperscript{17}.

Some authors had described the ligation of the sigmoid or the transverse sinuses during the exposition of the petroclival tumors\textsuperscript{1,6}. Hwang et al. described that the important aspects were the ligation proximal to the superior petrosal sinus and distal to the vein of Labbé, considering the patency of the sinuses of both sides. The tentorium is incised after such ligation to expose the clival region\textsuperscript{2}. Al-Mefty considers that the drilling of the bone in the region of the jugular bulb during the posterior petrosal approach leads to an additional mobilization of the sigmoid sinus, improving the presigmoidal working space making the sigmoid sinus ligation unnecessary\textsuperscript{1,6}.

**TEMPORAL LOBE RETRACTION**

The temporal lobe retraction is another point that should be stressed in order to prevent temporal infarction. The techniques of microscopic transoperative fluorescence permit to observe how serious is the effect of the cerebral retraction to the microcirculation, in special to the veins. During the use of the fluorescence in vascular surgery is possible to visualize the disappearance of the veins during the cerebral retraction or even in the areas of cerebral touching by the surgeon instruments. In the subtemporal retraction applied during the transtentorial approaches the use of prolonged retraction can lead to the thrombosis of the microcirculation and the vein of Labbé as well. The correct positioning of the retractor, observing the pattern of the temporal venous drainage avoiding retract the region of the most important venous channels is crucial. It means that in each case the position of the retractor should be moved to more anterior or posterior position according to the venous anatomy. The intermittent relaxing of the temporal lobe is one important technical aspect, leaving the inferior temporal surface reorganizes the venous flow during the approaches. It can be very helpful in preserving venous infarction.

**DISCUSSION**

The concept of the preservation of the vein of Labbé to avoid venous temporal infarction is largely described in the literature. Except in the cases of large temporal lobe resection during epilepsy surgery which the preservation of the vein of Labbé has no difference in the final results, the goal is to avoid the Labbé sacrifice in all circumstances\textsuperscript{10,19}. However, it has been described venous infarctions postoperatively during the resection of the skull base tumors through the petrosal and transtentorial approaches even if the vein of Labbé was anatomically preserved. FIG 4, FIG 5

Actually, it points to the importance not only for the lateral but to the infero aspects of the venous system of the temporal lobe and the patterns of drainage of such area.

In the Guppy et al. study, the temporal veins were divided in lateral and inferior venous drainage complexes. They found the lateral complex, which comprises the vein of Labbé in all 40 temporal lobes analyzed. The inferior complex was divided in anteroinferior, medial-inferior and posteroinferior complexes. The anteroinferior complex was presented in 70% of specimens. In 39% of the specimens this complex joined to the lateral complex before draining to the transverse sinus. In 14% of the cases, the anteroinferior complex drained to a tentorial lake before entering the transverse sinus. The medial-inferior complex...
complex was presented in 38.5% of the cadavers and in 93% of them it joined to the lateral complex before draining to the transverse sinus. The posteroinferior complex was present in 87.5% of the cases. In 57% it drained to the lateral complex and in 17% it drained to a tentorial lake before draining to the transverse sinus. The temporal veins presented three configurations before entering the transverse sinus: the candelabra, defined as multiple veins forming one single vein before termination; multiple veins draining independently; and the tentorial venous lake draining to the transverse sinus.

In the study of Sakata et al. the petrosal bridging veins accounted for 19% of all temporal bridging veins. The petrosal bridging veins drained into the superior petrosal sinus in 55% of the cases, into the junction of transverse sinus and sigmoid sinus in 18% and in the lateral tentorial sinus in 27% of the 20 specimens of the study. The petrosal bridging veins correspond to the anteroinferior venous complex described in the study of Guppy, mentioned above. It’s very important to observe that the petrosal bridging vein existed in 62.5% of the specimens with the dominant vein of Labbè presented as well.

Which lessons should be learned from these data? First, the lateral complex and vein of Labbè are responsible for the drainage of the lateral surface and medial portion of the inferior face of the temporal lobe. Second, the anterior and posterior portions of the inferior face of the temporal lobe do not depend of the venous lateral complex in the majority of the cases. Third, the tentorial cutting can define a venous infarction in the temporal lobe even if the vein of Labbè is preserved, because of the tentorial venous lakes and the superior petrosal sinus and its relations with the anterior and posterior veins of the inferior surface of the temporal lobe.

Bigelow et al. observed that 16.7% of the patients have one atretic transverse sinus in the angiography. The angiographic studies suggest that in patients with absent transverse sinus and vein of Labbè draining directly to the sigmoid sinus the risk of venous infarction is higher during the lateral skull base approaches.

Actually, Al-Mefty proposed that the transtentorial route should be altered if the preoperative venography recognizes the vein of Labbè draining into the superior petrosal sinus far from the transverse sinus or if the venous lakes are responsible for the predominant venous drainage. Furthermore, in the cases that the sinus drainage occurs through the tentorium, the resection of the tumors should be performed above and below that sinus with preservation of the tentorium.

The techniques of the lateral skull base approaches improved the immediate surgical results and the prognosis of the patients with lesions, which require transtentorial routes to be treated. Nevertheless, avoiding the temporal infarction still represents a challenge and the venous temporal anatomy should be evaluated beyond the vein of Labbè. The careful analysis of the angiographic studies concerning about the venous drainage of the temporal lobe should be the most important step to define how
the surgeon should manipulate the tentorium and the temporal lobe during the petrosal approaches. The correct positioning of the tentorial incisions according with the temporal venous anatomy and the intermittent gentle temporal retraction are the technical aspects, which permit the better final results.

**REFERENCES**


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