Objective: Our study emphasizes the relationship between the temporal bone structures and the mastoid portion of the facial nerve.

Material and methods: Thirty-two temporal bones taken from adult cadavers of both sexes subjected to tympanoplasty were used to make reference measures of the mastoid portion of the facial nerve. Appropriate instruments were used for measurement and statistical analysis was subsequently performed.

Results: The digastric ridge presented a positive correlation with the stylomastoid foramen in comparison with the sigmoid sinus ($P = 0.03$). There was a correlation between the position of the short apophysis of the incus and the position of the facial nerve ($P < 0.001$). The distance from the sigmoid sinus to the mastoid portion of the facial nerve presents a positive linear relationship throughout its length ($P < 0.001$). The tympanic membrane presented a positional correlation with the distal portion of the facial nerve ($P < 0.008$).

Conclusions: The mastoid portion of the facial nerve is proportional to reference structures in the temporal bone and this may help us to define measures prior to surgical otologic procedures.

Key words: Facial nerve. Morphometry. Temporal bone.

INTRODUCTION

The mastoid segment is the longest of the intrapetrosal facial portion, with a length of 9-11 mm and a mean diameter of 1.5 mm. The upper half of the third portion almost always runs vertically, medial to the horizontal semicircular canal. Posteriorly, the facial nerve is separated from the posterior fossa by a distance from 4-11 mm. This space is generally occupied by retrofacial mastoid cells.

Medially, the vertical portion of the facial nerve is in relation with the jugular bulb, which is nevertheless highly variable. The facial nerve canal may be 8 mm outside of the jugular foramen or may adhere to it. The third portion of the facial nerve is in front of the tympanus and the external auditory canal. At its upper limit, it follows the posterior wall of the tympanus, with a diameter of between 2 and 4 mm. Hence, the tympanic annulus constitutes a good reference for the facial canal, at an almost constant distance of 3 mm. Inferiorly, the digastric ridge will be the anatomic structure that will guide us in the location of the stylomastoid foramen, which opens up close to the petrosal base between the mastoid and the styloid process. It is considered the end of the bone portion of the facial canal. The digastric ridge is located in the region of the mastoid tip and divides it into 2 groups of cells: the group of

Estudio morfométrico del tercer segmento del nervio facial

Objetivo: Enfatizamos en este estudio la relación entre las estructuras de referencia del hueso temporal y su relación con la tercera porción del nervio facial.

Material y método: Nuestro estudio se ha realizado con 32 huesos temporales humanos, provenientes de cadáveres de adultos de ambos sexos a los que se practicó timpanoplastia con el objetivo de hacer mediciones de referencia de la porción mastoidea del nervio facial. Luego se las midió con instrumentos adecuados y se practicó análisis estadístico.

Resultados: La cresta digástrica presenta una relación positiva con el agujero estilomastoideo en relación con el seno sigmoideo ($P = 0,03$). Existe relación entre la posición de la apófisis corta del yunque y la posición del nervio facial ($P < 0,001$). La distancia del seno sigmoideo respecto a la tercera porción del nervio presenta una relación lineal positiva por todo su recorrido ($P < 0,001$). La membrana timpánica presenta una relación de posición con la porción distal de nervio facial ($P < 0,008$).

Conclusiones: La porción mastoidea del nervio facial presenta relación proporcional con estructuras de referencia del hueso temporal, lo que nos ayudará a definir medidas previas a intervenciones quirúrgicas otológicas.

mastoid cells proper on the most external side and on the more medial side, the group of subsinus cells that continues backwards with the retrosinusal group.

Alterations along the course of the facial nerve in this segment can be subdivided into three categories: a) the facial nerve courses posteriorly, laterally, or anteriorly; b) the facial nerve divides into two or three in the posterior portion or distally to the oval window; and c) hypoplasia of the facial nerve.

The most common facial abnormality is the lateral or posterior course of the facial canal, after the prominence of the lateral semicircular canal. In this case, the nerve is located more laterally than usual and closer to the surgeon. Pou4 reported the case of a patient with agenesis of the mastoid segment of the facial canal. The facial nerve made an anterior bend similar to the course normally followed by the tympanic chorda. Belluci5 reported that in 71 patients with congenital aural dysplasia, the facial nerve presented an abnormal course in the hypotympanus, coursing anteriorly at the level of the round window.

Several otologists6,7 have described bifurcations of the mastoid portion posterior or distal to the oval window, with two branches in separate canals from the mastoid process of a single foramen. Hawley8 and Tobeck9 found patients who presented with the main trunk of the facial nerve that ended in a sack in the area of the mastoid process, with a small branch that followed its normal course. The objectives of the following study are to collect information about the morphometry of the third portion of the Fallopian canal with respect to the morphometry of the anatomic references in the temporal bone and to compare anatomic references in the temporal bone between themselves and temporal bone anatomic references with the third portion of the facial nerve, to see if there is any relation between the points of reference of the temporal bone and of the third portion of the facial nerve.

MATERIAL AND METHOD

Our study was conducted with 32 human temporal bones, taken from cadavers of adults of both sexes. In order to identify the Fallopian canal, the temporal bones were drilled, exposing the entire course of the intrapetrosal facial nerve, from the geniculate ganglion to the stylomastoid foramen, sparing the external auditory canal and identifying the noble structures of the temporal bone. Eleven measurements were chosen for each bone, with which the subsequent comparative studies were carried out (Figure): length of the third portion of the facial nerve; depth of the proximal portion of the third portion of the nerve (distance between the proximal portion of the mastoid segment and the external mastoid surface); depth of the stylomastoid foramen (distance from the distal portion of the mastoid segment to the external mastoid surface); distance between the lateral sinus and the initial mastoid portion; distance between the stylomastoid foramen and the lateral sinus; depth of the tympanic membrane (with respect to the external mastoid surface); distance from the mastoid tip and the stylomastoid foramen; distance between the sinodural angle and the initial portion of the mastoid segment; depth of the incus (relation between the short apophysis of the incus and the external mastoid surface); medial portion of the digastric ridge with the lateral sinus, and distance from the proximal part of the third portion to the inferior region of the external auditory canal (EAC).

We performed a comparative statistical study between quantitative variables by means of Pearson's correlation. A positive correlation value indicates that a measurement that increases one variable increases the other one or that a measurement that decreases one variable also decreases the other. A negative coefficient indicates that a measurement that decreases one variable increases the other and vice versa.

Measurements for the morphometric study were made between the third portion of the facial nerve and the noble structures by means of a simple, easily reproducible system, the pachymeter. It consists of a calibrated rule equipped with a rod of one foot in length, with a fixed limit on one end. A descriptive study of all the measurements found was conducted first followed by a comparative study of the different variables.

RESULTS

Descriptive Study

With respect to the morphometric results, the following measurements were taken:

1. Length of the third portion of the facial nerve: it has a mean value of 13.34 mm; typical deviation, 1.43.
2. Depth of the proximal portion of the third portion of the nerve: reaching a mean value of 12.21 mm; typical deviation, 2.29.
3. Depth of the stylomastoid foramen: with a mean value of 10.78 mm; typical deviation, 2.48.
4. Distance between the lateral sinus and the first mastoid portion: its mean value is 5.65 mm; typical deviation, 2.08.
5. Distance between the stylomastoid foramen and the lateral sinus: with a mean value of 6.30 mm; typical deviation, 2.27 mm.
6. Depth of the tympanic membrane: the mean value was 10.16 mm; typical deviation, 2.32 mm.
7. Distance from the mastoid tip to the stylomastoid foramen: it reaches a mean value of 15.04 mm; typical deviation, 2.89 mm.
8. Distance between the sinodural angle and the initial portion of the mastoid segment: mean value of 20.15 mm; typical deviation, 4.24 mm.
9. Depth of the incus: its mean value was 11.86 mm; typical deviation, 2.72 mm.
10. Medial portion of the digastric ridge with the lateral sinus: with a mean measurement of 5.13 mm; typical deviation, 1.89 mm.
11. Distance from the proximal part of the third portion to the inferior region of the EAC: it has a mean value of 11.67 mm; typical deviation, 1.70 mm.

**Comparative Study**

Correlation between measurements 1 and 11: a positive relation (Pearson’s $r$) was encountered between the length of the third portion and the lower limit of the external auditory canal ($r=0.495; P=.04$).

Correlation between measurements 2 and 3: between the different depths of the facial nerve in its mastoid portion, both the proximal as well as the distal portion (the stylomastoid foramen), an important positive relation was observed between both positions ($r=0.828; P<.001$).

Correlation between measurements 2 and 6: nevertheless, no relation was encountered between measurements 2 and 6 ($P=.119$), which implies that the distance of the proximal mastoid portion was unrelated to the depth of the tympanic membrane.

Correlation between measurements 3 and 6: a positive relation was in fact revealed between the distances of the depth of the stylomastoid foramen and the depth of the tympanic membrane in the proximal mastoid region ($r=0.459; P=.008$).

Correlation between measurements 4 and 5: comparing the distances between the proximal and distal ends of the lateral sinus at the level of the third portion, a significant positive linear relationship was detected ($r=0.828; P<.001$).

Correlation between measurements 4 and 10: in making a comparison between the distance from the lateral sinus and the proximal portion of the facial nerve, and from here to the digastric ridge, no statistically significant relation was found ($r=0.169; P=.43$).

Correlation between measurements 5 and 10: a positive linear relation was found when comparing the distance between the lateral sinus with the stylomastoid foramen, and from here to the digastric ridge ($r=0.385; P=.03$).

Correlation between measurements 2 and 9: the comparison between the distance from the proximal portion of the mastoid segment and the depth of the incus revealed a statistically significant relation ($r=0.712; P<.001$).

Correlation between measurements 3 and 9: the comparison between the distance from the stylomastoid foramen and the depth of the incus revealed a statistically significant relation ($r=0.684; P<.001$). Correlation between measurements 2 and 9: a comparison of the distance between the sinodural angle and the mastoid tip failed to reveal a statistically significant relation ($r=0.143; P=.43$).

**DISCUSSION**

If injury to the facial nerve in its intrapetrous course is to be avoided, a good command of the anatomy of the region is essential. The path and complexity of the anatomic course followed by the nerve account for the difficulty in making an accurate anatomic assessment. According to earlier studies, the second and third portions of the facial nerve are acknowledged as being the most susceptible to injury during ear surgery, which motivated us to study the morphometric variables of the third portion of the facial nerve.

The mean length of said portion obtained in our work was 13.34 mm, which is consistent with the studies conducted by Proctor, Miehlke et al, Webster, and Ars; values higher than ours were reported in the study by Kudo et al, who found a mean length of 14 mm.

The measurements corresponding to the third portion of the facial canal with the external mastoid surface can be compared with the laboratory studies of temporal bone dissection carried out by Manrique Rodriguez in 50 temporal bones. Whereas we came to a value corresponding to the proximal portion of 12.20 mm with a typical deviation of 2.29 mm, they found a mean of 14.7 mm with a typical deviation of 2 mm, supporting the similarity of the results. As far as the stylomastoid foramen is concerned, Manrique found a mean of 8.17 mm with a typical deviation of 1.55 mm, whereas we obtained a mean of 10.78 with a deviation of 2.47 mm; that is to say, once again the results are similar. Moreover, we found a statistically significant relation between the depth of both references, which means that any increase in the depth of the most proximal portion will go hand in hand with an increase in depth at the stylomastoid level and vice versa, in a highly significant relationship ($P<.001$). This leads us to infer that, once we know the depth of either of the two variables, we can predict the other without major risks of injuring the facial nerve, with a high probability of being right. The mean distances of the lateral sinus in relation to the mastoid portion found in our work also display a proportional relation in its different portions, which leads us to deduce that at the same distance between the facial nerve and the lateral sinus, we will have a direct relation on both ends, providing additional information about the projection of distances in the structures during surgery. Aslan et al in their study also related the distances of the lateral sinus with the facial nerve, although they compared it with the degree of bone pneumatization,
in other words, that for each increase in pneumatization, the distance between structures is also increased, which makes it possible to conclude that our data agree with prior studies.

The relationship between the depth of the short apophysis of the incus and the facial nerve in its proximal and distal portions supplies us with additional, important data during temporal bone surgery. Whereas the short branch of the incus is located at a mean depth of 11.85 mm, slightly anterior to the proximal portion of the mastoid segment and slightly posterior to the stylomastoid foramen, since both have a positive linear relation with the depth of the incus, it is possible to consider this an important reference in the examination of the facial nerve; once the mastoid antrum has been located and while visualizing the incus, we can safely speculate as to the position of the third portion.17

Another datum worth pointing out has to do with the tympanic membrane at the level of the proximal portion of the facial nerve. While we found no relation to the proximal portion, we did find a relation with the stylomastoid foramen, which serves as accessory information in order to establish the limits of this region during surgery.

In our study, the digastric ridge displayed two important qualities. The first one is that the distance between it and the lateral sinus was treated proportionally to the distance from the lateral sinus to the stylomastoid foramen. The second one is that it constituted an unconditional way of locating the stylomastoid foramen, which we will probably verify using numerical data in other studies.

A new item of information revealed in the study refers to the lower limit of the external auditory canal, which when we drilled, appeared to present a positional relationship with the stylomastoid foramen. The statistical studies enabled us to confirm that there is a relation between both anatomic structures. Nonetheless, more studies are needed to confirm these data.

Therefore, there is a relation between the position of the short apophysis of the incus and the position of the facial nerve. The distance from the sigmoid sinus to the third portion of the nerve presents a positive linear relation along its entire course. The tympanic membrane displays a position relation with the distal position of the facial nerve. The digastric ridge presents a positive relation with the stylomastoid foramen with respect to the sigmoid sinus, such that the descriptive measurements provide guidance as to the mean distances from the reference structures during mastoid surgery, which can predict the location between them and, therefore, make ear surgery safer.

REFERENCES