VARIATIONS IN THE TRIFURCATION OF THE SEMILUNAR GANGLION AND SURGICAL IMPLICATIONS

HARVEY GASS, M.D., AND WILLIAM P. VAN WAGENEN, M.D.

Department of Surgery, Neurosurgical Division, Strong Memorial Hospital, and The University of Rochester School of Medicine and Dentistry, Rochester, N. Y.

(Received for publication November 10, 1949)

Occasionally, after performing what one considers to be an adequate section of the posterior sensory root of the trigeminal ganglion for tic douloureux by the temporal route, he is surprised that the postoperative examination shows the area of anesthesia on the face to be considerably less than was anticipated.

In 1932 van Nouhuys, on the basis of anatomical dissections, concluded that "the sensory root of the fifth nerve is not composed of the three parts that correspond to the three peripheral branches from the gasserian ganglion" and that because of the interlacing ramifications and anastomoses within it, partial section of the sensory root "cannot be regarded as an absolutely reliable procedure."

The interlacing fibers within the posterior root had been noted by others1,2 yet, aware of that, Spiller and Frazier3 took issue with van Nouhuys, insisting that despite such interlacings, on purely clinical evidence from their own vast experience with this operation, the conclusion was indisputable that the supply of the mandibular division was from the outer portion of the root; of the maxillary division, from the middle portion of the root; and of the ophthalmic division, from the inner portion. In view of the general satisfaction of most neurosurgeons since then with partial section of the posterior root transtemporally, the conclusions of Spiller and Frazier seem justified. Nevertheless, others4 have been impressed with occasional atypical areas of skin anesthesia following operations for which van Nouhuys' observations, if pertinent, may not offer the complete solution. The possibility occurred to us that variations in the topography of the semilunar ganglion, its roots and branches, not appreciated by the surgeon in his limited surgical exposure, were responsible for such results. This matter has prompted the following investigation.

The points at which the semilunar ganglion branches into its three divisions anteriorly (Fig. 1, a and b) are definitive in determining the relationship of the posterior sensory root and the ganglion to commonly used surgical landmarks. If the trifurcation of the ganglion takes place far anteriorly (pre-fixed ganglion), the surgical anatomy would be somewhat different than if it occurs relatively far posteriorly (post-fixed ganglion). In the latter instance, a surgeon could, for example, in orienting himself from the foramen spinosum, readily mistake the fibers of the mandibular division...
for those of the ganglion itself or even for those of the entire posterior sensory root. Accordingly, the purpose of this study was to determine by actual measurements whether such significant variations actually do occur.

Measurements were made in 16 fresh anatomical specimens of the semilunar ganglion of each side *in situ*. Particular attention was paid to the relationship of the points of trifurcation (Fig. 1, a and b) to certain anatomical landmarks. Certain other dimensions were taken also. In each dissection the overlying dura and dura propria of the ganglion were stripped off sufficiently to visualize the borders of the roots and ganglion clearly without disturbing their anatomical setting.

The posterior edge of the petrous ridge at the groove for the trigeminal nerve (Fig. 1, c) and the foramina ovale and rotundum were used as anatomical reference points. From these points measurements were made to determine variations of trifurcation in an anteroposterior direction. Four such measurements were made: A, B, C, and D (Fig. 2).

In a transverse direction variations in the location of points of trifurca-
TRIFURCATION OF SEMILUNAR GANGLION

...tion were determined by 3 measurements: I, J and K (Fig. 3). Reference points for these measurements were the foramen ovale and the medial border of the ganglion at a point opposite to the internal carotid as it ascends from the foramen lacerum (Fig. 1, d). The latter point is not an anatomical constant because of the possible variations in the tortuosity of the artery. Such variations, however, were noted to be slight and not usual.

![Diagram](image)

**Fig. 5.** Semilunar ganglion and roots drawn to actual size of average dimensions.

Certain other dimensions of the ganglion and its parts were also measured. These were distances E, F, G, and H (Fig. 4).

Fig. 5 shows the actual average size of the ganglion and roots.

All measurements involving the foramina were uniformly made at the lateral anterior edge of each foramen.

RESULTS

In the anteroposterior direction, distance A (Fig. 2) varied from 16 to 26 mm., B from 13 to 20 mm., C from 14 to 22 mm., and D from 9 to 19 mm.

Anteroposterior variations in the location of the points of trifurcation in different specimens can perhaps be more easily visualized by considering the ratio of B to A and C to A. B/A varied from 0.63 to 1.00 whereas C/A varied from 0.62 to 1.18. The average value for B/A for the entire series was 0.778. The average value for C/A for the entire series was 0.821.

Analysis of these ratios by sex revealed that in this series females were more apt to have a pre-fixed ganglion, with trifurcation taking place an-
teriorly, whereas males were more apt to have post-fixed ganglions, with posteriorly placed trifurcations. The average value of B/A for females was 0.807 compared to 0.761 for males and the average value for C/A in females was 0.857 compared to 0.799 in males.

Analysis by age failed to reveal any significant correlation between age and type of fixation of the ganglion.

In the transverse direction the dimension K varied from 16 to 24 mm., J, from 9 to 16 mm., and I, from 3 to 9 mm. Variations in the transverse direction, therefore, were somewhat less than those in the anteroposterior direction.

The width of the roots at their origin (E and F, Fig. 4) showed only slight variation. E and F each varied only from 6 to 10 mm.

Considerable variation was found to exist in the separation of the foramina. Thus distance G (Fig. 4) was found to range from 4 to 13 mm. Moreover, the foramen spinosum in particular showed considerable variation in its size in different specimens, being in one instance hardly larger than the size of a pin-point and in another as large as the eraser on a pencil.

It is noteworthy that while measurements on one side of a specimen were usually matched by measurements of a similar magnitude on the opposite side, this was not invariably so. Substantial differences were rarely present between the two sides, especially in the anteroposterior direction.

**SUMMARY**

Significant variations in dimensions of the semilunar ganglion and its roots, of as much as 1 cm., especially in the anteroposterior direction, have been found in 32 fresh postmortem dissections. The points where the ganglion trifurcates into its roots may thus be relatively far forward in one instance or far posterior in another. In women, it appears that one might expect an anteriorly placed trifurcation more commonly, whereas in men a posterior trifurcation would be more apt to be the rule.

In the surgical exposure of the ganglion and its posterior root via the temporal approach, the surgeon frequently finds it difficult to obtain wide visualization of these structures. In view of the aforementioned variations, with a minimal operative exposure the operator subjects himself to possible errors in obtaining a good differential section of the posterior root. It is suggested, therefore, that before cutting what he takes to be the posterior root, the surgeon strive to obtain visualization of these structures for not less than 1 cm. in the anteroposterior direction unless the points of trifurcation of the ganglion are otherwise clearly in view for his orientation. If this is not feasible and there is doubt as to exact orientation, it might probably be wise to make his incision through the fibers in a slanting direction posteriorly so as to get behind the trifurcation of the ganglion.

**REFERENCES**