Roentgenographic Study of the Volume of the Sella Turcica
Part 2. Measuring Points

By

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トルコ鞍容積のX線学的研究（第2報）
計測点の撰定

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単にトルコ鞍の計測のみでなく，計測学的研究における計測点の重要性は今更云々する迄もない．本論文は，著者の計測点及びその撰択理由を述べた．即ち，著者は，計測点を容易，客観性，正確の3点を基本として撰定し，測定誤差を可及的小にし高い再現性を得る様に心がけた．側面像では基準線を定め，これに鞍隔膜線を使用し，トルコ鞍の巾に関しては多くの研究者が使用している Chamberlein-Towne 氏法による鞍背を再検討し，本法では，拡大率が不定という計測学上では決定的な欠点のある事が判明した．従つて，著者の計測点は，以下の如くである．

1. 長さ：鞍隔膜線（鞍結節－鞍背上端）に平行な最大前後径．
2. 深さ：鞍隔膜線に垂直な鞍床に至る最大径．
3. 巾：常位後前径像で鞍床の最大横径．

Pertaining on the size of the sella turcica, numerous studies of linear and/or area measurements have been undertaken, and many measuring methods also, have been proposed by various workers. The selection of bony landmarks is obviously of great importance in sellar measurements, and the difference of the measuring methods is a large loss for medical investigations, because it is impossible and insignificant to compare one data with the others which are based on diferent methods. The prominent cause of confusion in measurements is probably due to the difference of choosing landmarks. The author believes, that the reproducibility and preciseness are of the greatest importance not only in the sellar measurement, but also in all occasions. Therefore, great care should be taken as to the choice of landmarks. The landmarks used have to be easily and objectively determined on the roentgenogram.

The purpose of this paper is to present the author's measuring points and to interpretate the reasons why the author chose them.

Measuring Points

The length, depth and lateral profile area of the sella turcica are determined from the lateral views of the skull. In this series, the diaphragma sellae has been chosen as a standard line on the lateral view,

and for the sake of clarity, a line from the tip of the tuberculum to the top of the dorsum sellae is represented as the diaphragma.

The length of the sella is represented through the greatest anteroposterior diameter parallel to it. The depth is taken to be the greatest perpendicular distance from this line to the sellar floor.

The sellar area is defined as the area enclosed by the sellar osseous tissue below the diaphragma sellae.

The width of the sella turcica is obtained by measuring the transverse diameter of the sellar floor on the straight postero-anterior view. These measuring points were already shown in the diagram. [43][44]

Length and Depth

The length and depth are obtained from the lateral skull view and various measuring methods have been proposed as shown in Table 1. In this series, consideration has be given to constant orientation of the skull or sphenoid bone with respect to the horizontal and vertical planes.

The author[42-45] chose the diaphragma sellae as a standard line on the lateral view, for it is the most proper and suitable for the upper limit of the sella turcica. Many authors have agreed on it, although there is no complete agreement with its position.[45] The advantage of choosing the diaphragma as a

Table 1. Measuring points used by various authors in sellar measurements

Author	Year	Length	Depth
Jewett[25]	1920	longest a-p. diameter	from line between a.c.p. and p.c.p. to perpendicular deepest point of floor
Enfield[11]	1922	widest point	from line between superior surface of clinoid processes to perpendicular deepest portion of sellar outline
Royster and Rodman[37]	1922	longest transverse diameter	from line jointing lower border of clinoids to most remoter part of base of sella
Gordon and Bell[16]	1922	from m.c. to farthest posterior part of sella	from line jointing a.c.p. and p.c.p. to deepest portion of sella
Knox[29]	1923	from anterior to posterior part at its longest diameter	from mid-point of line between a.c.p. and p.c.p. to deepest part of sella
Camp[6]	1924	from most dorsal point of t.s. to anterior edge of d.s.	from a.p. line (Length) to deepest part of sellar floor
Royster and Moriarty[38]	1930	from m.c. to farthest part of d.s.	from line jointing lower limits of curves of a.c.p. and p.c.p. to floor of sella
Chaumet[8]	1930	from t.s. to most distant point of anterior wall of d.s.	from middle of line between t.s. and top of p.c.p. to floor
Kornblum[30]	1932	greatest a-p. diameter	from line between t.s. and d.s. to perpendicular greatest depth of fossa
Gordon and Bell[17]	1936	longest a-p. diameter	from a-p. line of camp or its extension to perpendicular dropped to deepest part of sella
Acheson[1]	1954	from most dorsal point of t.s. to superior surface of d.s.	from line correspond with length to deepest part of floor
Di Chiro and Nelson[10]	1962	greatest a-p. diameter	from line between tip of t.s. to top of d.s. to perpendicular deepest point in floor
Oon[35]	1963	greatest distance parallel to nasion-tuberculum line	from line jointing t.s. and most anterior convexity of c.p. to sellar floor

a-p. anteroposterior a.c.p. anterior clinoid process t.s. tuberculum sellae
m.c. middle clinoid d.s. dorsum sellae p.c.p. posterior clinoid process

standard line is to be more objective and reproducible than others for the measurements of the length (parallel) and the depth (perpendicular), and that the personal difference and error of the recognition may be, perhaps, prevented most easily. In 1960, Joplin and Fraser[27] proposed the nasion-tuberculum line as a standard line, which provide an orientation of the skull prior to measurement. The author believes that their suggestion is superior, but however, for measurements, measuring points are more preferable to be in few number as possible to reduce the measuring error.

Speaking of author's landmarks, the tuberculum sellae is one of the most easily recognizable landmarks. On the contrary, the top of the dorsum sellae is not so easy to determine[2], but it is more reasonable and easier than the posterior clinoid processes.

Contours of the sellar floor and the dorsum sellae are not always one dense curve on the lateral view. Not infrequently double and rarely triple contours are demonstrated on the normal roentgenograms, because neither the sellar floor nor the dorsum sellae is a flat plate.[10][31] They are slightly concave, and/or they slope toward one side or to the other. The author chose the intermid portion as the measuring point when there is a double contour, and chose the middle line, when a triple contour was noted (Fig. 1). We must remember that the double contour itself does not mean any pathological changes.

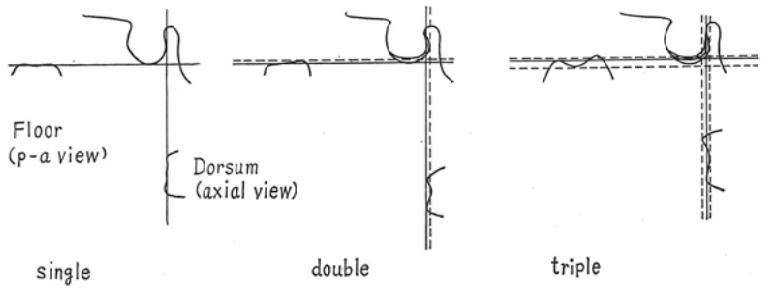
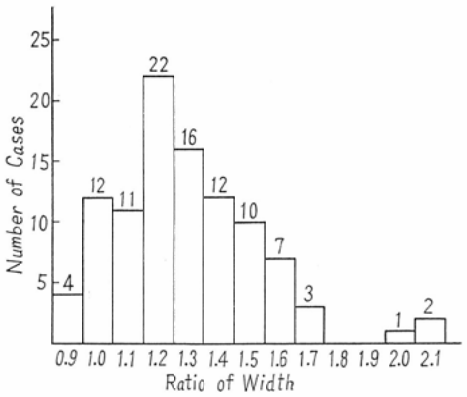


Fig. 1. Type of contour in lateral view

Width

The width of the sella turcica, the third dimension, is obtained from several positions of roentgenograms; the straight postero-anterior view, Caldwell's postero-anterior view, Granger's postero-anterior view, Chamberlein-Towne's antero-posterior view and the axial view. In these views, Chamberlein-Towne's view permits visualization of the dorsum sellae and the posterior clinoid processes as first demonstrated by Busi and Balli[5] in 1910—1911, and this view has been most widely used to observe the dorsum sellae.[13][15][18][19][34][40] Meldolesi and Pansadoro[34] in 1937 first proposed the use of the narrowest transverse diameter of the dorsum for the evaluation of the sellar width. Block and Joplin[3] in 1959, also, suggested the use of the narrowest width, the "waist" of the dorsum. Although this view has an advantage of easiness for the measurements, the author does not use it and the summary of the author's opinion for not using was previously described briefly.[42][43] In this paper, some details of those reasons are to be demonstrated and discussed.

Graph 1 shows the frequency distribution of the ratio o the width from Chamberlein-Towne's view to that from the straight postero-anterior view in the same person. The "waist" is used as the width on Chamberlein-Towne's view. The ratio ranges from 0.9 to 2.1, an average of 1.4. This wide variety of the ratio is, of course, resulted from several factors; measured points are not the same, and the dorsum it-



Graph 1.
Frequency distribution of the ratio of the width from Towne's view to straight postero-anterior view

self varies greatly in its coronal diameter, etc. This result is, however, not only due to the anatomical structure. Mahmoud[32] stated, "The attempt of Farinas (1939) to produce the third dimension (its width) from sagittal skull views is impracticable since the rays used are oblique and the resulting picture distorted." Haas,[21] also, described, "The practical value of the measurement of the roentgenological width is limited."

These distance relationships (the target-to-sella and sella-to-film) depend to great extent on the shape of the skull. Therefore, the roentgenological enlargement of the width is not uniform. That is to say, the magnification rate is not constant roentgenographically. This is the greatest reason why the author does not prefer the Chamberlein-Towne's view. Hare et al.[22] measured the width of both the sellar floor and the dorsum sellae on the sagittal view, and gained following results. The width of the dorsum (immediately below the posterior clinoid) ranges from 9 to 18mm with an average of 15mm. The width of the floor ranges from 9 to 23mm with an average of 15.3mm. The author, further, examined the relationship between the width of the floor and that of the dorsum sellae (immediately below the posterior clinoid) on Granger's view. In 100 normaladults, the average width is 13.3 mm in the dorsum and 12.7mm in the floor. The ratio of the width from the dorsum to that of the floor is an average of 1.1, ranging from 0.8 to 1.3.

These data verify that there are no large discrepancy between the width of the dorsum sellae and the sellar floor and that the marked discrepancy between them is mainly due to the inconstant magnification of the Chamberlein-Towne's view. This inconstant magnification rate is a conclusive default in such volumetric studies.

In addition to these facts, this view has a weak point, that it is not so easy to take a proper roentgenogram. Etter[12] has described a method which permits constant visualization of the dorsum, but author's experience on his method only showed an unsatisfactory result.

Moreover, the irregularities in the shape of the dorsum sellae would make the calculation of the actual sellar volume quite difficult from the skull roentgenograms. The great variance in the coronal diameter of the dorsum sellae is also widely understood.

These are the main reasons why the author does not prefer to evaluate the width of the dorsum sellae on Chamberlein-Towne's view.

The length and width of the sella turcica are also able to be obtained from the axial view. However, it is not easy to orientate the sella turcica. Radberg[36] in 1961 reported that,in 70 per cent of the cases, he was able to demonstrate the anterior wall of the sella and in 65 per cent he could recognize the carotid sulci at each side of the sellar wall. In 1962, DiChiro and Nelson[10] stated that the anterior aspect of the dorsum with its slight and smooth anterior concavity was visualized in 66 per cent of 160 cases on the technically satisfactory axial views, and that they found the anterior aspect of the dorsum sellae in the axial view to average 12.4mm in 106 cases, while the average diameter of the floor in the postero-anterior view was 12.9mm in 270 cases. The two values differed from zero to 2mm in 95 per cent of 106 cases. We must remember, that the width of the sella is not precisely the same over its whole length.

The sellar floor is clearly seen as a flat, slightly concave, or rarely convex plateau on the postero-anterior views, either on the straight, Caldwell's or Granger's view. In 1916, Johnston[26] already stated that the floor of the sella appears as a sharply defined white line. Before his statement, Schüller in 1912 commented that the breadth of the fossa would be of importance in deciding as to the shape and size of the sella, and in 1926 he[41] published a straight sagittal view of the skull, in which the floor of the sella was clearly seen. Hare et al.,[22] also, recognized the floor of the sella in the sagittal view. Among these three views, Caldwell's view is the most easily recognizable, and some workers[9][10][35] have used this view. Granger's view is also relatively easy to determine the floor as well as the dorsum sellae. These two views are not routinely taken roentgenograms at the Jikei Hospital. The author has used the straight postero-anterior view to evaluate the width of the sella.

In this view, the floor is occasionally difficult to be orientated, because of the lack of the sphenoid aeration and of the superimposition of the surrounding tissues, especially the ethmoid cells.[9][10] However, in proper roentgenograms, the author could recognize the floor in 95 per cent or more on about 1500 cases examined. Speaking on the shape of the floor (Fig. 2), the flat and concave types are much easier to determine the edges of the plateau. On the contrary the convex type is the most difficult to do so, though this type is the most infrequent among these three types; it is found in 5 per cent of 500 cases in adults. The author measured the distance of two points where the floor transfers the dorsum sellae.

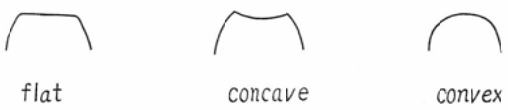


Fig. 2 Type of sellar floor in straight postero-anterior view

Laminography has been used for the observation of the floor by some authors.[4][7][46] Cardillo and Bossi[7] proposed laminography for the usage of the largest width of the sellar floor. The selection of this width corresponded with the recommendation of Hrdlicka,[24] and its value may be more accurate for the true width than that of the plain roentgenographic films. But the author does not prefer this method, because the author aims the use of no special equipment not universally available.

Area

Measuring method of the lateral profile area, also, have been proposed by various workers.

In 1925, Haas[18-21]proposed a method to measure the area in terms of square millimeters.This method is troublesome to count the number of small divisions, but many have used it, because it needs neither special equipments nor special trainings.

Sartorius[39] has recommended eliminating the tracing by placing the millimeter paper directly upon the roentgen film for measurements. Though this is a quicker method, the reproducibility is scant.

Karlin[28] was the first to use a planimeter for the area measurement. This is an accurate method, but careful repeated examination is necessary for more accuracy.

Hare et al.[22] have introduced a practical modification of the Haas' method, called a "sellameter". One may quickly know the approximate size, but it is naturally a scant method.

The author has tried to calculate the area from the two linear components; the length and the depth. The details have been already reported,[43] so the description of it is eliminated here.

Summary

1. The author's measuring points were presented.
2. The reasons, why these points were chosen, were briefly showed and discussed.

References

1. Acheson, R.M., Brit. J. Radiol., 1954, 27, 298.
2. Acheson, R.M., Brit. J. Radiol., 1956, 29, 76.
3. Block, H.J., and Joplin, G.F., Brit. J. Radiol., 1959, 32, 527.
4. Bourdon, R., Acta radiol., 1953, 40, 272.
5. Busi, A., and Balli, R., quoted by 10.
6. Camp, J.D., Amer. J. Roentgenol., 1924, 12, 143.
7. Cardillo, F., and Bossi, R., quoted by 10.
8. Chaumet, G., quoted by 40.
9. Di Chiro, G., Amer. J. Roentgenol, 1960, 84, 26.
10. Di Chiro, G., and Nelson, K.B., Amer. J. Roentgenol., 1962, 87, 989.
11. Enfield, C.D., J.A.M.A., 1922, 79, 934.
12. Etter, L.E., Radiology, 1961, 77, 418.
13. Farinas, P.L., Radiology, 1939, 32, 411.
14. Francis, C.C., Human Biology, 1948, 20, 1.
15. Fraser, R., Joplin, G.F., Laws, J.W., Morrison, R., and Steiner, R.E., Lancet, 1959, 1, 382.
16. Gordon, M.B., and Bell, A.L.L., New York St. J. Med., 1922, 22, 54.
17. Gordon. M.B., and Bell, A.L.L., J. Pediat., 1936, 9, 781.
18. Haas, L., Fortschr. a.d. Geb. d. Röntgenstrahlen, 1925, 33, 419.
19. Haas, L., Fortschr. a.d. Geb. d. Röntgenstrahlen, 1927, 36, 1198.
20. Haas, L., Fortschr. a.d. Geb. d. Röntgenstrahlen, 1934, 50, 469.
21. Haas, L.L., Amer. J. Roentgenal., 1952, 67, 197.
22. Hare, H.F., Silveus, E., and Smedal, M.I., Radiology, 1949, 52, 193.
23. Howe, H.S., Neurol. Bull., 1919, 2, 233.
24. Hrdlicka, A., Arch. Neurol. Psychopathol., 1898, 1, 679.
25. Jewett, C.H., Amer. J. Roentgenol., 1920, 7, 352.
26. Johnston, G.C., New York St. J. Med., 1916, 16, 559.
27. Joplin, G.F., and Fraser, R., quoted by 35.
28. Karlin, M.I., Fortschr. a.d. Geb. d. Röntgenstrahlen, 1928, 38, 868.
29. Knox, R., Arch. Rad. & Electrotherapy, 1923, 28, 161.
30. Kornblum, K., Arch. Neural. & Psych., 1932, 27, 305.
31. Kovács, A., Fortschr. a.d. Geb. d. Röntgenstrahlen, 1934, 50, 469.
32. Mahmoud, D.E., Brit. J. Radiol.,1958, Suppl. 8, 15.
33. Marx, H., Hesse, W., and Neumann, H., Klin.Wchenschr., 1947, 24—25, 299.
34. Meldolesi, G., and Pansadoro, E., Policlinico med., 1937, 44, 533.

35. Oon, C.L., Brit. J. Radiol., 1963, 36, 294.
36. Radberg, C., quoted by 10.
37. Royster, L., T., and Rodman, N.F., Tr. Amer. Rad. Soc., 1922, 34, 246.
38. Royster, L.T., and Moriarty, M.E., Amer. J. Phys. Anthropol., 1930, 14, 451.
39. Sartorius, W., Mechr. F. Kinderh., 1929, 45, 259.
40. Scheuermann, H., Acta radiol., 1932, 13, 404.
41. Schüller, A., Amer. J. Roentgenol., 1926, 16, 336.
42. Seki, I., The Annual Meeting of Seiikai (the Jikei University School of Medicine), 1964, Oct. 15th.
43. Seki, I., Nipp. Acta Radiol., 1965, 24, 1231.
44. Seki, I., The 24th Annual Meeting of the Radiological Society of Japan, Tokyo, 1965, April 4-6 th.
45. Seki, I., Nipp. Act. Radiol., 1965, 25, 374.
46. Vallebona, A., and Conte, L., Quoted from 10.