LATERAL CONFIGURATIONS OF SELLA TURCICA

Manuel Flores, D.D.S.

This paper submitted in partial fulfillment of the
requirements for a Certificate in Orthodontics,
University of Oregon School of Dentistry

June 1976

ACKNOWLEDGMENTS

I would like to thank Dr. Douglas L. Buck for his assistance, guidance and work throughout the writing of this study and to Ms. Deborah Shaeffer for typing the manuscript.

TABLE OF CONTENTS

INTRODUCTION

There have been various reports by different authors about normal and abnormal sella turcica configurations. One research approach has been to determine normal sella turcica size from skull roentgenograms. There has been a wide range of individual size variation. Smallness of the sella turcica has not the same pathologic significance as enlargement. Two basic methods have been commonly employed in trying to determine sella enlargement. The first has been the use of a linear measurement or the length and depth of the sella, while the other was based on the area of the pituitary fossa. The first method has been the most commonly used because of the convenience and ease to obtain. For the linear measurements of sella different researchers have used various methods taking into consideration anatomical points for reference in the sella configuration[1]. A common measurement has been tuberculum sella to most distant point of the dorsum. Other authors have used the distance between sella and an oriented horizontal plane within the skull to have relatively constant correlation with the inclination of the sphenoid bone[2,3]. There have also been studies attempting to determine a correlation between sella size and age, sex and stature[4]. The work of Martinez-Farinas[5] has determined a correlation between sella size and cranium size.

The other method of determining sella confirmation has been to determine a volume determination[6]. Di Chiro and coworkers have used the following area formula:

$$\text{volume} = \frac{\tfrac{1}{2}\ \text{length x width x height mm}}{1000}.$$

There are different types of pathology that will cause sellar enlargement and the most common one is the pituitary adenoma. The adenoma usually arises from the anterior lobe which contains the three cell types; chromophobic, eosinophobic, and basophobic. The chromophobic pituitary adenomas are by far the most common.

Craniopharingioma is another cause of sellar enlargement not as common as the adenoma. This tumor arises from remnants of the craniopharingeal duct or Rathke's pouch.

Other causes of enlargement can be intra-cavernous aneurysms of the internal carotid artery producing unilateral enlargement. This is most common from increased intracranial pressures in which there is dilation of the third ventricle.

Little emphasis has been placed in the dental literature on the normal or abnormal sella configurations and the possible radiogaphic pathologies. The use of the lateral head plate cephalogram in the orthodontic practice can be of great value in studying the conformation of sella because of its quality and patient replication technique used which yields little superimposition of the anatomical structures.

It is the responsibility of an orthodontist collecting the records of his patient to be able to recognize and make a decision regarding size or configuration variants in the abnormal looking sella in which a radiology referral would be indicated.

The purpose of this study is to measure the sella turcica on lateral head plates as commonly used in orthodontic practice and attempt to establish a range of normality in the orthodontic age range patient.

REVIEW OF THE LITERATURE

Sella turcica enlargement or pituitary tumors in the presence of some other abnormalities in the sellar region have been the concern of many investigators for a long period of time. There is a difference in the way the sella turcica is affected whether it is a deformity caused by an extra sellar lesion which causes a flattening of the sella due to erosion of the dorsum sella, floor and anterior boundary of the fossa, and the one characterized by uniform circular enlargement produced by a tumor originating within sella. Erdheim[7] in 1909 was among the first to utilize such variations in distinguishing between internal and external lesions.

In 1956 Caffey[8] repeats his previous statement which was published in Pediatric X-ray Diagnosis that "there is little factual basis for a belief that the pituitary fossa is significantly altered in disease other than those associated with expanding lesions of the hypophysis and some types of increased intracranial pressure. In this respect Caffey supports the work of Gordon and Bell[9], Camp[10] and others[11,12,13], who previously had reached the conclusion that the extreme variations of the pituitary size in health precluded recognition of disease by x-ray examination of the pituitary fossa. Other authors[14,15,16] made an association between enlargement and cretinism which suggested that a relationship did at times exist between hypothyroidism and recognizable enlargement of the pituitary fossa.

There are, of course, differences in the contour of the sella in normal individuals.

Jewett[17], 1920, from the study of 100 lateral head plates classified the variations in contour into eight different types. Gordon and Bell[9] in 1922 classified the shape of the sella into three types after studying a number of x-rays of normal children; circular, oval, and flat. The circular type was found in 70 of the cases studied, the oval in 25 and flat in 10.

These authors also reported that there is no relation between the size of the head and the size of the sella which is contradictory to the statements of Fitzgerald[18], 1909-1910, in which he states that the length of the fossa is proportional to a posterior measurement in the cranial base. Fitzgerald in his study had two measurements: anterior, from the tip of ethmoidal spine of the sphenoid to the anterior limit of the optic groove, and posterior, from the opisthion to the middle of the dorsum sella. In his conclusions he mentions that the length of the cranial base influences the size, and to a lesser extent the shape of the pituitary fossa. He found that the antero-posterior dimension of the pituitary fossa shows a co-relationship with the length of cranial base, primarily related to the posterior length varying directly, while an inverse relation exists between it and the anterior cranial base measurement. Therefore, a long fossa was associated with a short anterior measurement of cranial base and a long posterior measurement.

Using the same classification as Gordon and Bell[9], Camp[19], 1923, studied 110 skulls. He found the oval type pituitary fossa in 66%, the round in 21% and the flat in 13% of the sample. He also found bridging in 5.5% of the study.

There have been numerous studies of the sella concerned with its growth. Francis[20], 1948, used four different groups. He measured fetal skulls, a longitudinal study in healthy white children, a cross-sectional study of healthy negro children and gave a report on the dimensions in adult skulls as well. Gordon and Bell[21,22], 1921, 1923, reported on an x-ray study of 104 normal children from the ages of one to twelve. They found a rapid increase in size during the first two years from birth and a gradual but irregular growth to age twelve. Their results and that from Francis[20] had a general agreement that during the growing period girls tend to have a longer sella than boys.

Camp[10], in 1924, made another roentengenogram study which was restricted to adults. He used linear measurements and reported an average length to be 1.60 cm and an average depth 0.81 cm. Tavaras and Wood[23] in their study used linear measurements from the tuberculum sella to the most posterior and centric points on the dorsum and reported a figure for the upper limit of normal being 17 mm. Film enlargement was not mentioned.

Measurements of sella have been made using areas and volumes instead of linear measurements. Di Chiro and Nelson[6], in 1962, found the radiologic volume of sella ranged from 233 to 1092 mm^3 in 173 normal adults. Oon[3], in 1962, measured the pituitary fossa in 250 normal adults. For his measurements he employed the method used by Joplin and Fraser[2] in 1960 that is an orientation of the skull in the x-rays prior to measurement. The measurements for the transverse dimensions of the sellar floor were the measurements employed by Di Chiro[24] in 1960 and Oon, Lavander and Joplin[25] in 1962. The volume was calculated by using the formula of lateral area X width. The volume he found was different from that of Di Chiro and Nelson[6] in 1962. His volume was reported as 700-1960 mm^3.

Acheson[26], 1955, described a method which estimated error by replication of x-rays in his technique of measuring the pituitary fossa. In his paper he gives figures for the mean increment of the sella turcica during the first five years of life in a group of children from the Oxford Child Health survey. In the same paper the means of sella size for males was 13.5 mm and 13.4 mm for females. He studied a group of 80 males and 49 females.

Ottaviani[27] in 1938 showed that the size of the pituitary gland has no relation to the size of the pituitary fossa, and that the gland can get considerable lateral enlargement without interfering with the morphology of the fossa. Corroborative evidence of the independence of size of the two structures lies in the striking difference in shape of the growth curve of the gland shown by Rasmussen[28], 1948. Royster and Redman[13], 1922, tried without success to find a correlation between the size of a child's fossa and clinical evidence of an over or under active gland.

Therefore, it can be seen that an active interest in quantitating the size of sella has been ongoing for a number of years. Nevertheless, there is little descriptive data published with regard to the normal variation of the size of sella turcica in normal individuals.

MATERIALS AND METHODS

A pilot study was run on data taken from lateral head plate cephalograms from the files of the University of Oregon Dental School Department of Orthodontics. Twenty-one individuals were measured to determine antero-posterior sella size and maximum antero-posterior cranium size to the nearest 0.1 mm. This was done to determine study feasibility, identification of landmarks, possible measurements and reproducibility parameters. All x-rays were taken in a standard cephalometric set-up with a midsagittal plane enlargement of 9.8% (fig. 1).

The primary study was done from a random selection of 236 individuals taken from treatment files in the Orthodontics Department of both sexes ranging in age from 10-13½ and where orthodontic records contain x-rays of suitable radiographic quality.

The greatest antero-posterior horizontal dimension of the pituitary fossa was taken directly from the lateral head plate by a needle point Bull caliper reading to the nearest 0.1 mm. Great care is necessary to take the most posterior and centric outline of dorsum sella at the time of the reading avoiding the mistake of measuring the lateral outline of sella dorsum. (fig. 2)

The classification of Gordon and Bell[9] was used to subdivide the sample into circular, oval and flat conformations. Percentages were calculated as well as sellar bridging noted.

Age of the patients was transformed to the nearest one tenth year to facilitate statistical computation.

A standard error of the measurement was recalculated by replicate measures after a 7-day interval using the following formula:

$$\text{S. E. Meas} = \sqrt{\frac{\Sigma d^2}{2n}}$$

Enlargement was calculated taking an x-ray in the same cephalostate with a millimeter scale in the patients midsagittal plane and computed by the following computation: $\frac{x}{y} = \frac{a}{a + b}$

a = distance between anode and midsagittal plane of subject,

b = distance from midsagittal plane of subject to the film,

x = true dimension of subject,

y = the enlarged dimension on the film.

FINDINGS

The results on the preliminary study of 21 individuals were as follows. The standard error of the measure was done on double determinations of sella size taken at the same day and was calculated as 0.225 mm. Using the criteria of Martinez-Farinas[5] (1966) measuring cranium as the greatest antero-posterior dimension from the inner table of frontal bone to inner table of occipital bone and the sella as the greatest antero-posterior dimension a Pearson Correlation Coefficient revealed a r = +.3722 which was not significant (p .05). A scattergram of the raw data was constructed. (fig. 3)

For the primary study a histogram of frequency of sella size in the combined sample was constructed (Graph 1). Means, variances and standard deviations were derived for the males and females. Means were tested by the Student's t test for unpaired samples. (Table 1) The age range was from 10-13½ and the mean was 12.43 for males and 12.00 for females. A linear regression was calculated for the data. (Table 2)

Scattergrams of this data are also available. (fig. 4,5). The standard error of the measure calculated by double determinations 7 days apart revealed a figure of 0.3966 mm with a sample size of 30. The sample was broken down to oval shape 70.8%, round 19.9% and flat 9.3%. Bridging was found in 5.1% of the subjects. (Table 3)

DISCUSSION

Measurements of the pituitary fossa have been made in the past to assess different objectives. Studies in which increments on the size of the fossa have been studied longitudinally. There have been others in which a correlation has been made between the size of the fossa and other anatomical structures in the skeletal system. Lastly, normative studies have been attempted in various populations.

The results in the various studies available do not agree on a specific size of sella because of measurement technique differences. Many of the papers in the past fail to report information on the methodology of the study. Many studies do not report error in the measurements, enlargement of the x-ray image, the age range of the population or sample size.

In this report linear measurements on the sella turcica were done. The standard error of the measurement was calculated twice and two different figures are reported. In the pilot study 0.225 mm and that one used for the primary study 0.396 mm. The big discrepancy in these results is thought to be due to the difference in time in which the double determination measurements were done. In the first case they were done within an hour time difference and in the second the measurements were repeated one week apart from one another. Percentage of enlargement was calculated as well to allow magnification corrections.

The age range of the patients as well as the sex was taken into consideration. All patients for the study were in good general health and with no known pathologies that would have an influence in the sellar region. All measurements were done in millimeters.

The pilot study consisted in the measurement of the cranium and measurement of sella in the same individual to see if there was a correlation between the two anatomical structures. Martinez-Farinas[5] presented an index that determined sella size "normality". The results of our study gave us a low correlation ($r = .3722$) which was not significant at p .05 level of significance. As we found no correlation between size of cranium and sella, the index of Martinez-Farinas was no longer considered for our study.

In Table 1 means, variances and standard deviations for the sample are shown. The means are tested by a Student's t test in which a statistical difference in sella size between males and females was determined at p .05 level of significance. The female group demonstrated the larger sella size. This tends to have a general agreement with the reports of Gordon and Bell[21,22] and Francis[20] that during the growing period girls tend to have bigger sellas than boys.

In our paper we have a wide range in sella size from 8.2 to 15.2 mm. (Fig. 4,5) If one adds our technique error to the sella size a rather wide range of normality exists. Therefore, the presence of a sella larger than that which we have reported would not necessarily indicate the presence of an abnormality because the growth variable was not taken into consideration. Also the age range in our sample is rather narrow, 10 to 13½.

The sample data of the males and females in the study was computed by means of a linear regression. The results are shown in Table 2 and Figures 4,5. A very low regression coefficient was found in both the female and male samples testing chronological age and sella turcica size. Possibly a more close correlation could be found using dental or skeletal age but this was not attempted.

The sample was also divided by differences in countour of sella into oval, round and flat, by the classification of Gordon and Bell[9] and Camp[19]. The results are shown in Table 3. Our results are in agreement with those of Camp[19] with the oval shape most common, 61.9% males and 74.3% females, round 23.8% males and 17.1% females and flat 14.3% males and 8.6% females. Bridging as found in 5.5% of the sample is not an unusual or abnormal finding.

Tavaras and Wood[23] reported that the upper limit of normality of the sella was 17 mm in an antero-posterior non-orientated head plate x-ray. The film they used was taken at 40-inch target film distance with the head on a Bucky table 2 inches from the film tray. Assuming the normal face is 6 inches in diameter we computed the near surface enlargement as 5%, the far surface as 25% and the midsagittal magnification as 14.2%.

For the main part our results agree with results of previous studies on which linear antero-posterior measurements of sella have been employed. The purpose of this paper was to measure cephalograms in an attempt to establish a range of normality in sella turcica size. Although there is a wide range in variation of sella size, 16 mm could be proposed as the upper limit of normality for a sella measured from a standard cephalogram uncorrected for enlargement.

SUMMARY AND CONCLUSIONS

1. A pilot study was done for study feasibility, and for the primary linear measurements on sella turcica for 236 patients, 84 males and 152 females, ranging in age from 10 to 13½ selected from the treatment files of the Department of Orthodontics, University of Oregon Dental School.
2. The same standard cephalometric unit was used for all x-rays with a midsagittal plane enlargement of 9.8%.
3. The standard error of the measure was calculated by means of double determinations and was found to be 0.399 mm. The means for the measurements from the male and female sample were subjected to the Student's t test indicating a significantly larger sella in females. Linear regressions of age vs. size were computed for both samples and they were not significant.
4. The sample was divided into three groups according to the different contour of sella, i.e., oval, round and flat. The oval shape predominated.

5. The purpose of this study was to measure sella turcica on lateral head plates such as those commonly used in orthodontic practice and attempt to establish a range of normality in the orthodontic age range patient. It is suggested that a sella uncorrected for enlargement larger than 16 mm in antero-posterior dimension taken by a standard cephalametric setup should be considered for further study or radiologic referral.

BIBLIOGRAPHY

1. Acheson, R.M.: Radiographic determination of the growth of the pituitary fossa in pre-school children. Brit. J. Radiol., XXVII, p. 268, 1954.

2. Joplin, G.F. and Fraser, R.: The radiological anatomy of the human pituitary. Coloquia on Endocrinology, Ciba Foundation, p. 13-14, 1960.

3. Oon C.L.: The size of the pituitary fossa in adults. Brit. J. Radiol., 36:294-299, April,1963.

4. Silverman F.N.: Roentgen standards for the size of the pituitary fossa from infancy through adolescense. Am. J. Roentgenol. 78:451-460, 1957.

5. Martinez-Farinas, L.: The sellar-cranial index. Radiology 88:264-267, February, 1967.

6. Di Chiro, G. and Nelson, K.B.: The volume of the sella turcica. Amer. J. Roentgenol. 87:989, 1962.

7. Erdheim, J.: Ueber einen hypophysen tumor van ungewohnllhem. Sitz Beitr. 2 Path. Ant. U.Z. Ally. Path., Jena, p. 233-240, 1909.

8. Caffey, J.: Pediatric X-ray Diagnosis,Third edition year book, p. 115, Publishers, Inc., Chicago, Ill., 1956.

9. Gordon,M.B. and Bell,A.L.L.: A roentenographic study of sella turcica in children. New York J. Med.22:54-58, February, 1922.

10. Camp, J.D.: Normal and pathologic anatomy of sella turcica as reviewed by roentgenograms. Amer. J. Roentgenol., 12:143, 1924.

11. Enfield, C.D.: Normal sella. J.A.M.A.79:934-935, 1922.

12. Pancoast, H.K., Pendagras, E.P. and Scheaffer, J.P.: The head and neck in roentgen diagnosis. Charles C. Thomas, Publisher, Springfield, Ill., 1940.

13. Royster, L.T. and Rodman, N.F.: Size of sella in relation to body measurements. Trans. Amer. Pediat. Soc., vol. XIV, p. 451, 1922.

14. Haas, L.: Erfahrugen auf dem gabiete der radiologischen sella diagnostik fortschr a.d., p. 469-494.

15. Hare, H.F., Silvers, E. and Smedal, M.I.: Roentgenologic diagnosis of pituitary tumors. Radiology 52:193-198,1949.

16. Le Coulm, P.: Etude radiologique de la sella turcique normale chez de enfantes. Thesis, 1923, Paris.

17. Jewett, C.H.: Teleroengenographic of the sella turcica with observation in one hundred cases. Amer. J. Roentgenol., 7:352, 1920.

18. Fitzgerald, D.D.: The pituitary fossa and certain skull measurements. J. Anat. and Physiol., p. 231, 1909-1910.

19. Camp, J.D.: The normal and pathologic anatomy of sella turcica as revealed at necropsy. Radiology p. 65-73, 1923.

20. Francis, G.: Growth of the human pituitary fossa. Human Biol., 20:1-20,1948.

21. Gordon, M.B. and Bell, A.L.L.: Roentgenographic study of sella turcica in abnormal children. Journ. Med., 22: 54-58, New York.

22. Gordon, M.B. and Bell, A.L.L.: Roentgenographic study of sella turcica in normal children. Endocrinology &;52-56, 1923.

23. Tavaras, J.M. and Wood, E.H.: The sella turcica. Diagnostic neuroradiology, Baltimore, Williams and Wilkins, Co., 1964.

24. Di Chiro, G.: The width of the sella turcica. Amer. J. Roentgenol., 84:26, 1960.

25. Oon, C.L., Lavander, J.P. and Joplin, G.F.: The width of the normal pituitary gland. Brit. J. Radiol., 25:418, 1962.

26. Acheson, R.M.: Measuring the pituitary fossa from radiographs. Brit. J. Radiol., vol. XXIX, p. 76, 1955.

27. Ottaviani, G.: Arch. Ital. Anat. Embriol., p. 194, 1938.

28. Rasmussen, A.T.: Quantitative study of human hypophysis cerebri or pituitary body. Amer. J. Anat., p. 95, 1948.

Sex	n	Mean	S.D.	Variance
Male	84	11.00	2.258	1.502
Female	152	11.37	1.460	1.208

Table 1. Mean, standard deviation and variance from antero-posterior measurements of sella turcica in mm.

	Male	Female	Combined
m	.0334	.0080	.0560
b	10.588	11.277	11.924
r	.0138	.0039	.0266

Table 2. Linear regression calculations from the data of 236 individuals measured.

m = slope of the line

b = y intercept

r = correlation coefficient

	Round	Oval	Flat	n
Male	23.8%	61.9%	14.3%	84
Female	17.1%	74.3%	8.6%	152

Table 3. Difference in contour of sella turcica for the male and female sample expressed in percentages applying the criteria of Gordon and Bell 1922.

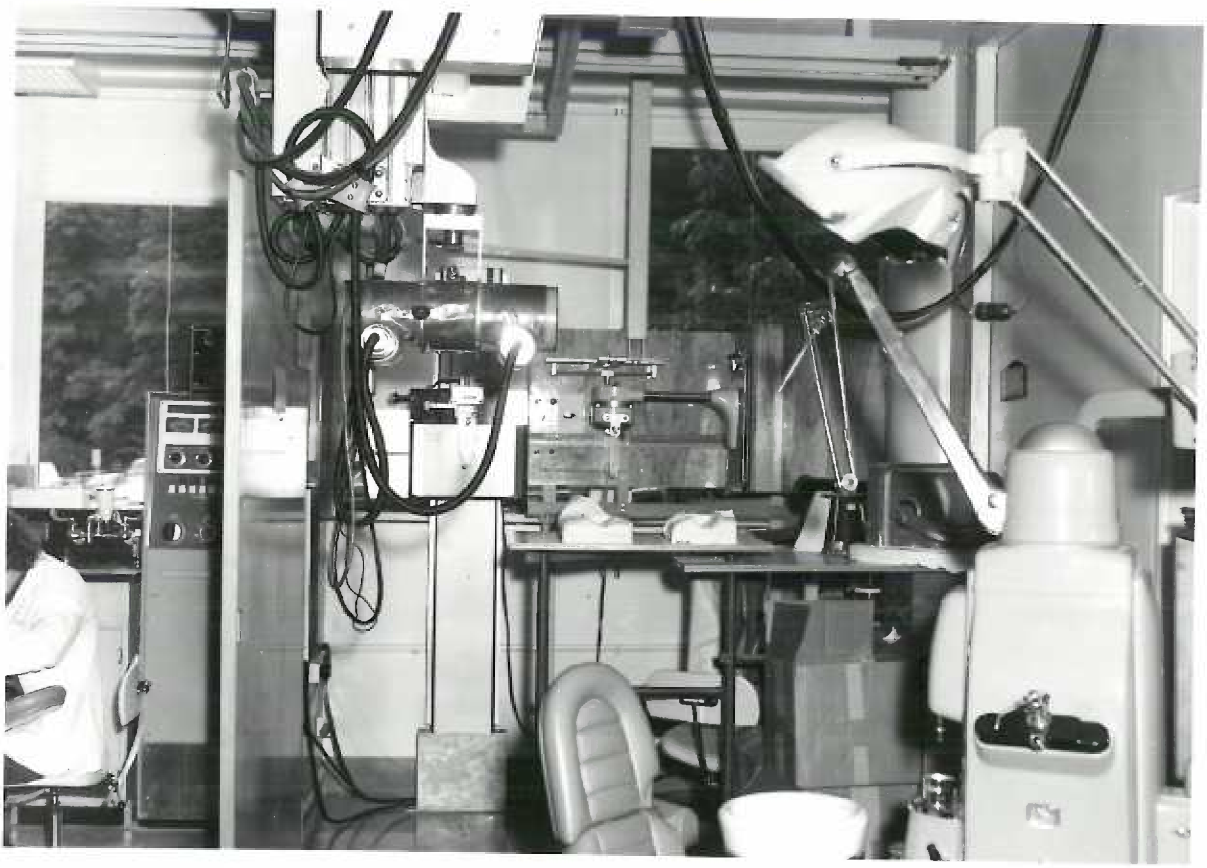


Fig. 1. Cephalometric set up at the Department of Orthodontics, University of Oregon Dental School.

Fig. 2. Standard lateral cephalometric tracing with arrow indicating antero-posterior measurement of sella used in study.

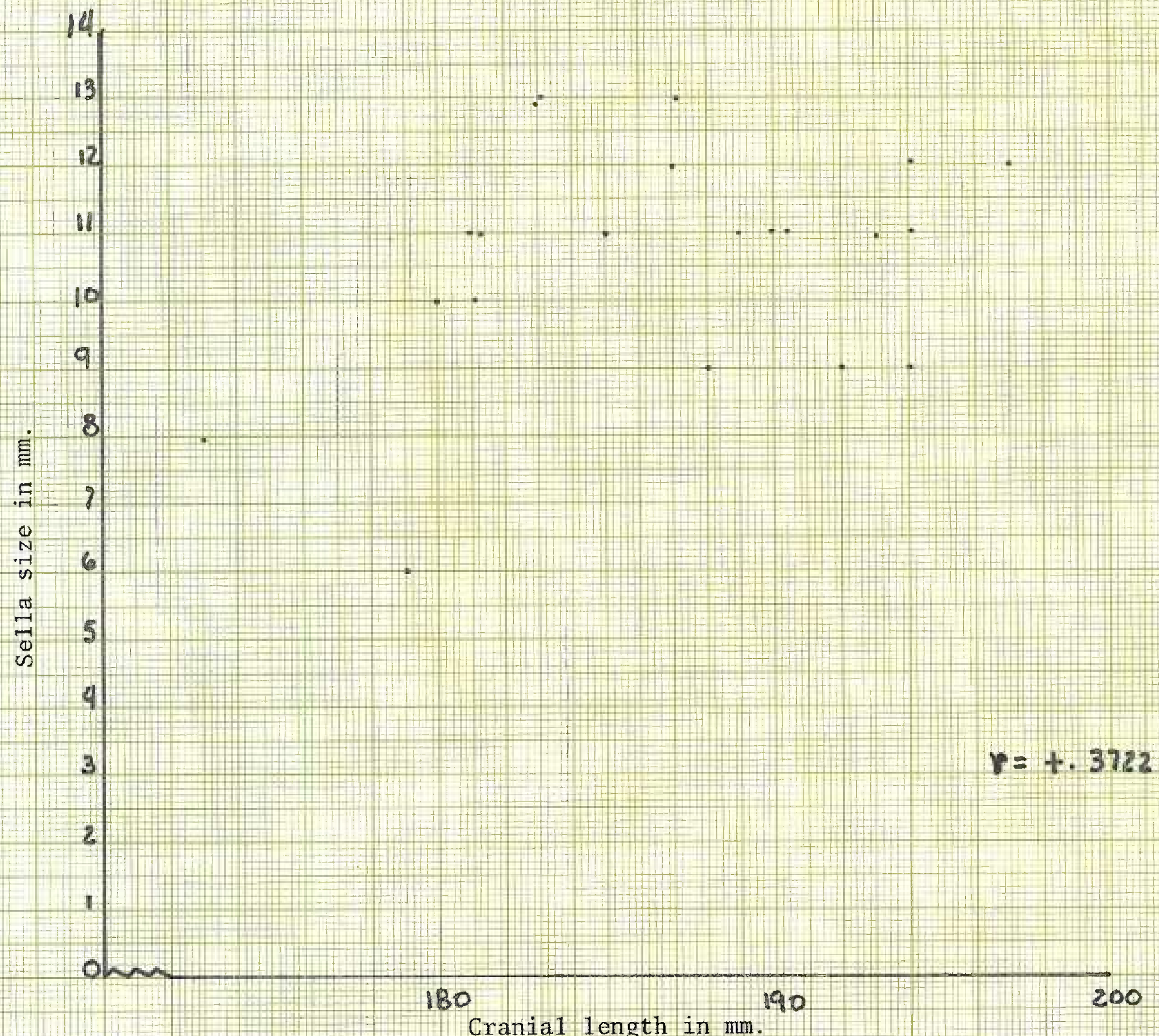


Fig. 3 Scattegram of data correlating sella size with cranial length

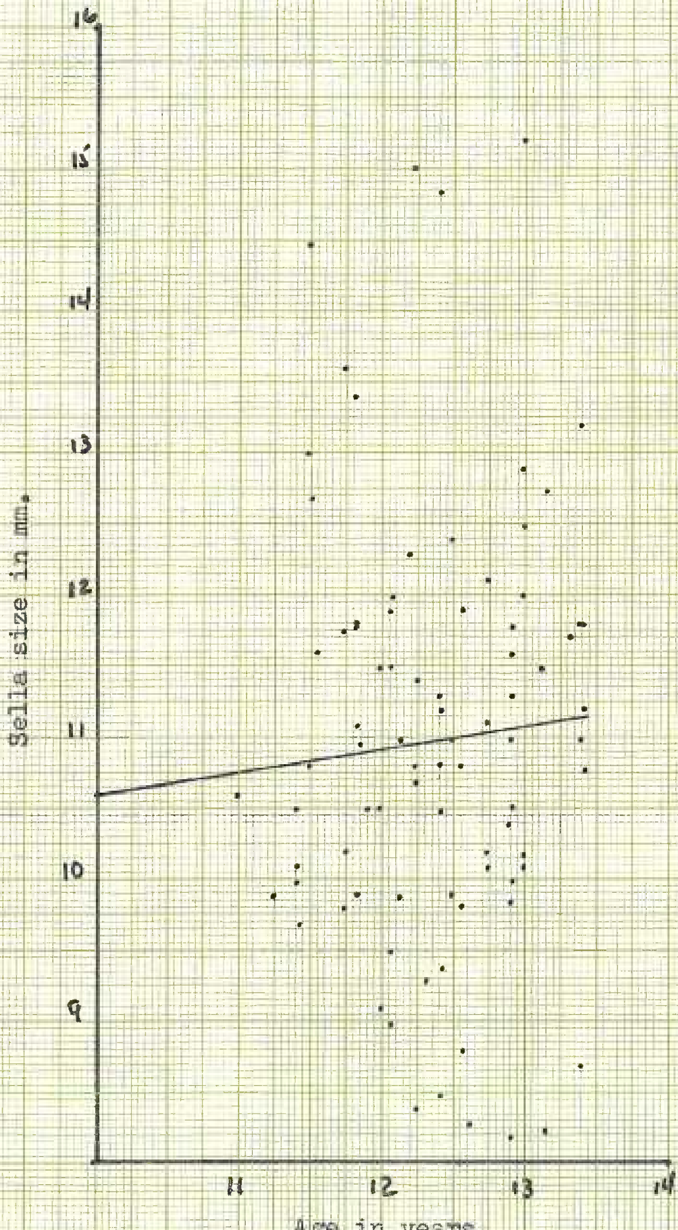


Fig. 4 Regression curve of age vs sella size in the male sample.

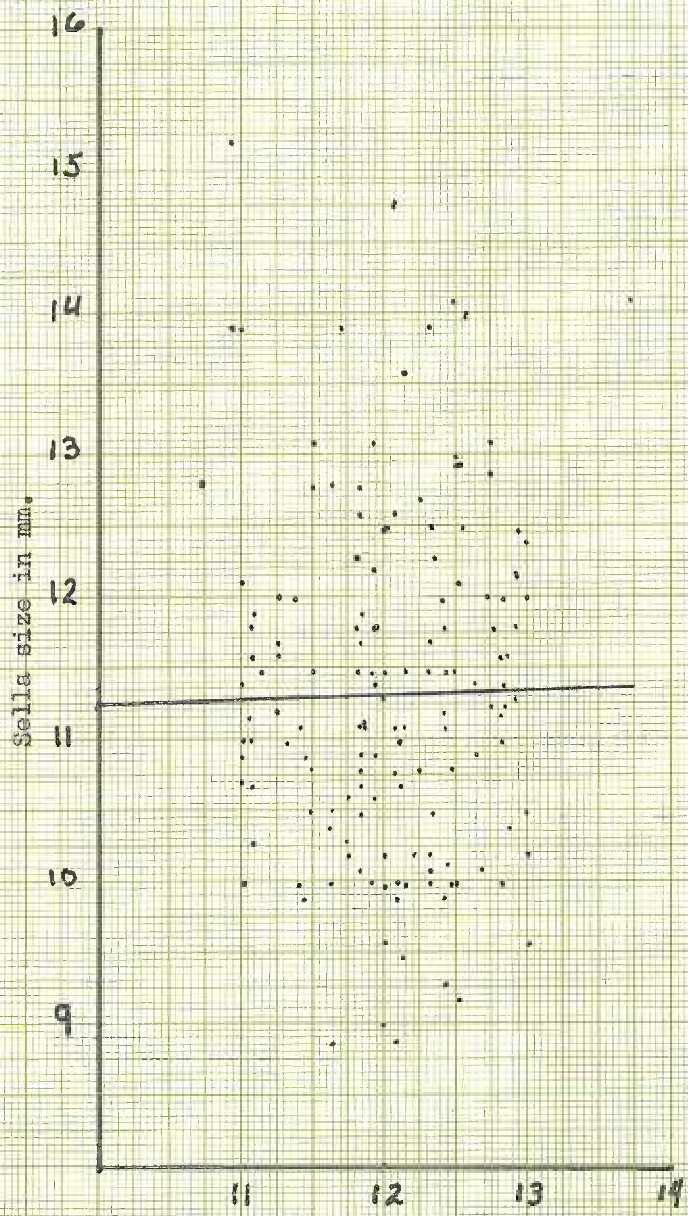
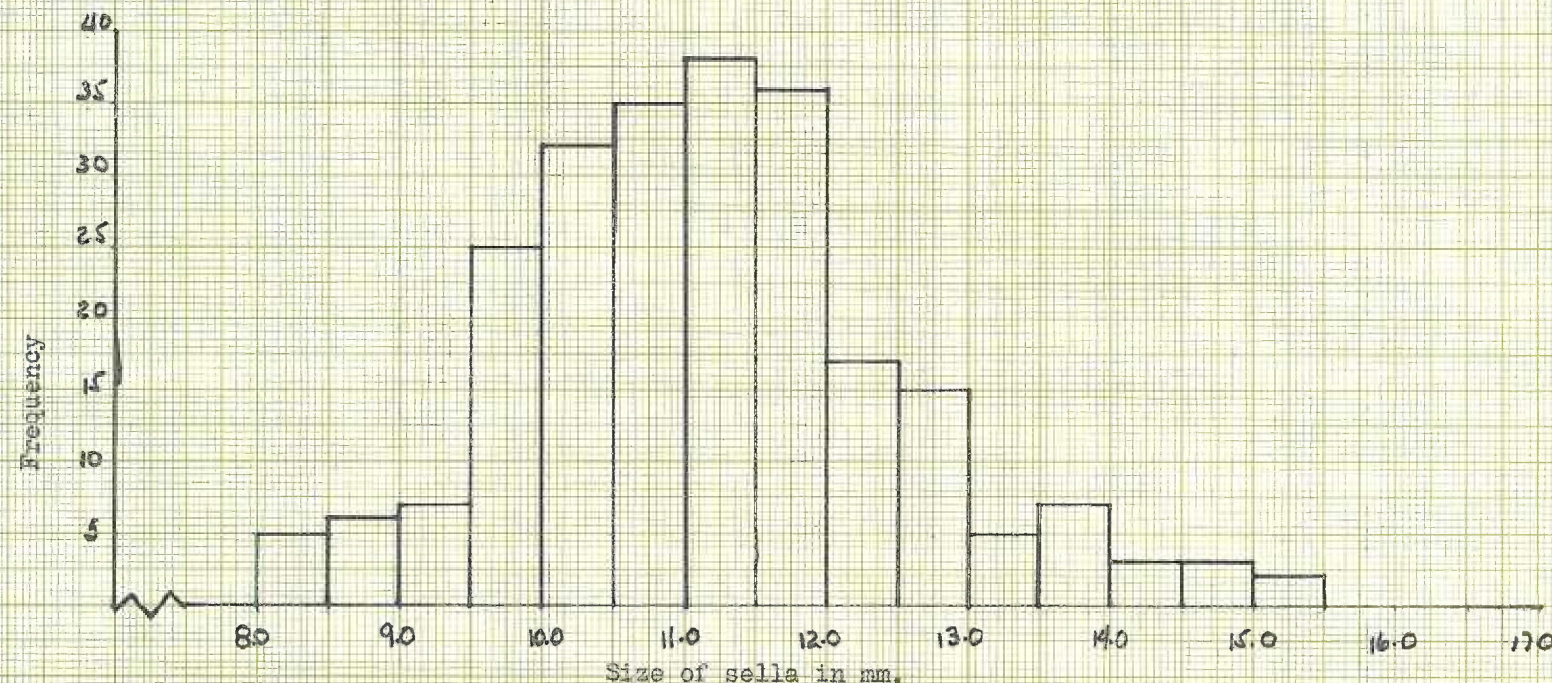


Fig. 5 Regression curve of age vs sella size in the female sample.



Graph 1. Histogram of frequency of sella size in the combined sample.