

Co-relation between cranial & facial circumference as an anthropometric ratio - an insight

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Abstract

The aim of this study is to differentiate cases to be treated orthodontically only or surgical intervention is needed with a simple diagnostic procedure. On examination of patients visiting orthodontists, often a question arises whether to go for orthodontic correction solely or surgical procedures are required. Efforts are made to give an ideal co-relation of cranium with the face so that the appearance of the person looks acceptable. Thus determining a relationship between cranial circumference and facial circumference. The study was conducted using lateral cephalographs of 33 subjects. Only eugnathic cases were considered.

1. Cranial Circumference (CC) – Na-Ba
2. Facial Circumference (FC) – Na-Me-Go. Results achieved were CC:FC ratio derived was 2:1. As CC cannot be changed, so keeping the CC constant as 2 a formula was derived to find out the X value (where $X = FC$ when $CC = 2$). The formula is as follows – $FC/CC*2 = X$. CC to FC was evaluated as 2:1 for eugnathic cases, i.e it can be orthodontically treated adequately without any any surgical intervention.

Keywords – cranial, facial, anthropometry, surgery, orthodontics.

Introduction

Anthropometry is taking measurements of the human body⁴. Measuring parameters of the skull and face specifically is known as craniofacial anthropometry⁴. These measurements are used for studies of human growth population variation, forensic research, also used as a guide for clinical treatment and surgical repairs of any anomaly associated with the head region⁴. Amongst all head circumference or the cranial circumference is one of the most important anthropometric parameter⁷. It gives an indication of the cranial volume which in turn gives an idea about growth and development of brain¹.

It is known that cranium & face are derived from embryologically distinct regions namely the basicranium, neurocranium & splanchnocranium respectively but these regions grow in morphologically integrated manner through numerous developmental and functional interactions². Anthropometrically volume of brain size i.e. cranial size has kept on increasing throughout the human evolution from siminoid to anthropoid apes to early hominids and finally the modern man, ranging from 275 – 500 cc for orangutans & chimpanzees, 340 – 750 cc for gorillas, 1500 – 1800 cc for Neanderthals, 1484 cc for modern humans⁸ – Scandinavians i.e. the cranium size has kept on increasing, also the facial size and number of teeth has kept on decreasing.

On examination of patients visiting orthodontists, often a question arises whether to go for orthodontic correction solely or it should be surgically treated followed by an orthodontic correction. In this study efforts are made to give an ideal co-relation of cranium with the face so that the appearance of the person looks acceptable. Thus, pro-

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viding a guideline to the operator so as to change the facial circumference accordingly.

Previously studies were based on cranial volume & facial volume which required new technological advances such as Magnetic Resonance Imaging (MRI), Cone Beam Computed Topography (CBCT) for live human beings¹. Although, such techniques minimize errors in superimposition & magnification which occurs on conventional cephalograms but it has certain drawbacks namely – not easily available in every medical set up, high radiation exposure & add up to the treatment cost.

Cephalometry is an important form of X-ray imaging, which acts as a significant means of diagnosis, planning & follow-up for orthodontic treatment. Cephalometric analysis plays a major role in evaluating the craniofacial growth, dentofacial deformities & treatment planning, retention etc. Comparatively, it is easily available, cost effective with less radiation exposure & is routinely done before any orthodontic/orthognathic treatment.

This study will be useful in various fields like orthodontics, maxillofacial surgery, anthropology, forensic science and so on⁴. The aim of the study is to investigate the relationship between cranial circumference and facial circumference.

Materials And Methods

This study was carried out at the Department of Orthodontics A. C. P. M. Dental College, Dhule¹. It was conducted using lateral cephalographs of 33 subjects. Only eugnathic cases were considered. The age of the subjects ranged from 11-30 years³.

Materials

1. 33 Lateral Cephalograms
2. Ligature Wire
3. Ruler
4. Divider
5. Tracing box

Methods

The following variables were measured –

1. Cranial Circumference (CC) - Na-Ba Nasion to Basion¹.(see fig no. 3)

2. Facial Circumference (FC) - Na-Me-Go Nasion to Menton to Gonion¹.(see fig no. 3)

1. Cranial Circumference (Cc)

It is measured as the distance from Nasion to Basion point along the outer cortical plate of cranium using a ligature wire. It is measured by placing the free end of the ligature wire at the nasion point while allowing the rest of the ligature wire to coincide with the curvature of the outer cortical plate of cranium terminating at the basion point as in fig 1. Appraisal of Basion point probably often rely upon subjective, visual examination².

2. Facial Circumference (Fc)

It is the linear measurement of the face on the lateral cephalograph starting at the Nasion point passing through Menton, finally ending at the Gonion.

- The distance between Nasion to Menton was measured by using the ligature wire starting from Na to Me point.
- The distance from Menton to Gonion was measured using ligature wire starting from the menton, coinciding the wire along the curvature of lower border of mandible finally ending at the Gonion as in fig 2.

3. Lateral Radiographs were taken using an ADVAPEX X-ray machine on Kodak XTL-2 film².
4. Table no.I shows all the measurements, recorded placing the lateral radiographs on a tracing box².
5. Ratio of CC: FC was evaluated as seen in table no. II.
6. Data was recorded to the nearest millimetre².
7. All the measurements were repeated twice³.
8. The measurements were recorded by the same person to minimize the errors in the methodology³.
9. The statistical analysis was accomplished through the SPSS 21.0 program version. The gained data were analysed³.

Ratio of CC: FC for all patients was approximately 2:1. Ratio of mean values of CC: FC also gave a ratio of 2:1. Thus keeping Cc as 2, Fc can be calculated, as follows - $FC/CC*2$.

Statistical Analysis

All measurements were entered and analyzed using SPSS (Statistical Package of Social Sciences) PROGRAM VERSION 21.0. Consistent with the intended purpose of this report, Statistical summaries of the described data base include 33 anthropometric measurements of head and face. The measurements included cranial circumference and facial circumference. Table no.III shows the descriptive statistics with each measurement are the minimum and maximum values, mean, standard deviation, range, median, lower and upper quartile and standard error. Mean \pm SD is 0.99 ± 0.04 . Standard error is 0.01. A positive correlation between the C.C and F.C. is seen showing significant difference which is statistically significant. The p value is $p < 0.00001$ at 95% confidence interval as seen in table no. IV .

Results

1. CC: FC ratio derived was 2:1.
2. As CC cannot be changed, so keeping the CC constant as 2 a formula was derived to find out the X value (where X = FC when CC =2)
3. The formula is as follows – $FC/CC * 2 = X$

Discussion

Although it is considered that the skull and face are separate regions by virtue of their distinct, embryological origins, their dimensions exhibit considerable inter co-relation². The primary aim of the study was to evaluate and report the co-relation between the cranial and facial circumferences, thus this study provides a valuable new data co-relating the cranial circumference to facial circumference³. Cranial circumference to facial circumference was evaluated as 2:1 for eugnathic cases, that is, it can be orthodontically treated adequately. As it is a known fact that cranial circumference cannot be changed so changing the facial circumference will result in an acceptable appearance of the subject. So keeping the cranial circumference constant, facial circumference will be increased or decreased surgically accordingly if the ratio exceeds or is less than 2:1 and orthodontic correction will be opted for if the ratio falls within the range of $2:1 \pm 0.1$. Our study has derived a ratio for the same which is formulated as 2:1 where CC is 2 so FC should be 1 ± 0.1 . This ratio gives an idea to the operator whether to decrease or increase

the facial circumference so that the appearance of subject looks satisfactory.

If this ratio exceeds then the FC has to be increased and if the ratio is below the formulated one then the FC has to be decreased. Thus, if the circumference of the subject falls within the ratio of 2:1 then it is considered a eugnathic case i.e. it can be orthodontically treated satisfactorily. If the ratio varies significantly then it has to be considered for surgical correction and subsequently FC is increased or decreased to make the subject look eugnathic.

Cephalometry is reliable, relatively easy and quick to apply. Furthermore, this approach has the added advantage as it does not require any sophisticated techniques³. It continues to be the more versatile technique in the investigations of the craniofacial skeleton³.

Although varieties of methodologies have been proposed to predict the orthodontic treatment alternatives, co-relation between cranial circumference and facial circumference seems to be the easiest and the most reliable method³.

It is a pilot study; however, these results need to be tested further using large number of samples¹ of different ethnic groups to establish the usefulness of this method⁷. Variety of factors such as age, race, gender and nutritional status affect human development and growth and therefore, different nomograms are required for different populations. The present study does not document such norms for cranial and facial dimensions³.

Conclusion

In the present study an attempt has been made to correlate the cranial and facial circumference and hence for a subject to be considered a eugnathic case i.e requiring orthodontic correction only without any surgical intervention , the ratio of cranial to facial circumference has been proposed i.e. 2:1 approximately.

Figure 1. Measurement from Na-Ba indicating Cranial Circumference.

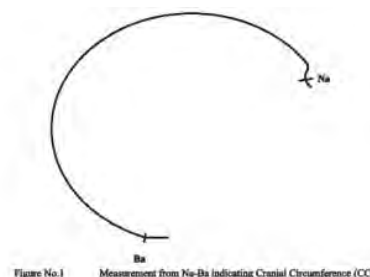


Figure No.1 Measurement from Na-Ba indicating Cranial Circumference (CC)

Figure 2. Measurement from Na-Me-Go indicating Facial Circumference.

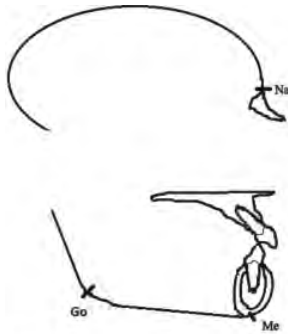


Figure No.2 Measurement from Ba-Me-Go indicating Facial Circumference.

Figure 3. Lateral Cephalogram showing tracing line



TABLE NO.I: Measurements taken using ligature wire – CC, FC

| Sr No. | Cranial Circumference (FC) | Facial Circumference (CC) |
|--------|----------------------------|---------------------------|
| 1 | 361 | 172 |
| 2 | 372 | 185 |
| 3 | 350 | 184 |
| 4 | 348 | 169 |
| 5 | 385 | 202 |
| 6 | 377 | 188 |
| 7 | 364 | 182 |
| 8 | 340 | 174 |
| 9 | 356 | 171 |
| 10 | 349 | 174 |
| 11 | 344 | 187 |
| 12 | 354 | 181 |
| 13 | 352 | 176 |
| 14 | 362 | 174 |
| 15 | 367 | 179 |
| 16 | 352 | 169 |

| | | |
|----|-----|-----|
| 17 | 362 | 186 |
| 18 | 345 | 187 |
| 19 | 379 | 187 |
| 20 | 367 | 188 |
| 21 | 404 | 201 |
| 22 | 395 | 196 |
| 23 | 345 | 171 |
| 24 | 359 | 171 |
| 25 | 372 | 186 |
| 26 | 395 | 181 |
| 27 | 339 | 157 |
| 28 | 320 | 154 |
| 29 | 332 | 159 |
| 30 | 319 | 159 |
| 31 | 308 | 153 |
| 32 | 311 | 150 |
| 33 | 410 | 187 |

Ratio of CC: FC for all patients was approximately 2:1. Ratio of mean values of CC: FC also gave a ratio of 2:1. Thus keeping Cc as 2, Fc can be calculated, as follows - $FC/CC*2$.

Table No. II

| Sr No. | Calculated Fc (keeping Cc at 2) $FC/CC*2$ | Sr No. | Calculated Fc (keeping Cc at 2) $FC/CC*2$ |
|--------|-------------------------------------------|--------|-------------------------------------------|
| 1 | 0.95 | 18 | 1.08 |
| 2 | 0.99 | 19 | 0.98 |
| 3 | 1.05 | 20 | 1.02 |
| 4 | 0.97 | 21 | 0.99 |
| 5 | 1.04 | 22 | 0.99 |
| 6 | 0.99 | 23 | 0.99 |
| 7 | 1.0 | 24 | 0.95 |
| 8 | 1.02 | 25 | 1.0 |
| 9 | 0.96 | 26 | 0.91 |
| 10 | 0.99 | 27 | 0.92 |
| 11 | 1.08 | 28 | 0.96 |
| 12 | 1.02 | 29 | 0.95 |
| 13 | 1.0 | 30 | 0.99 |
| 14 | 0.96 | 31 | 0.99 |
| 15 | 0.97 | 32 | 0.96 |
| 16 | 0.96 | 33 | 0.91 |
| 17 | 1.02 | | |

Table no.III: Summary statistics of Cranial Circumference, Facial Circumference and X-value

| Summary | Cranial Circumference N=33 | Facial Circumference N=33 | Calculated FC value N=33 |
|-----------------------|-------------------------------|------------------------------|-----------------------------|
| Minimum | 308.00 | 150.00 | 0.91 |
| Maximum | 410.00 | 202.00 | 1.08 |
| Range | 102.00 | 52.00 | 0.17 |
| Mean | 357.42 | 176.97 | 0.99 |
| Median | 356.00 | 179.00 | 0.99 |
| Std. Dev. | 24.76 | 13.36 | 0.04 |
| Lower Quartile | 345.00 | 171.00 | 0.96 |
| Upper Quartile | 372.00 | 187.00 | 1.00 |
| Std. Error | 4.31 | 2.33 | 0.01 |

Table No. IV: Correlation between Cranial Circumference and Facial Circumference by Karl Pearson's correlation coefficient method

| | Correlation between | Cranial Circumference with | |
|-----------------------------|---------------------|----------------------------|----------|
| | r-value | t-value | p-value |
| Facial Circumference | 0.8326 | 8.3695 | 0.00001* |

*p<0.05

Positive correlation and significant between Cranial Circumference and Facial Circumference

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