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Comparative Study of Male and Female Lip Dimensions and Relevance to Lip Reconstruction in Tennison Randall's Technique for Cleft Lip Repair

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Abstract

Background:

Cleft lip is a congenital deformity -a gap in the upper lip and is one of the most common birth defects worldwide. Tennison Randall's method of cleft lip repair creates a more naturally looking conserving the natural curves and contour of the lip. Lip reconstruction in cleft lip repair aims to restore the normal appearance and function of the lip with lesser scarring.

Aim:

This study aims at comparing the lip dimensions in males and females and assessing their significance to create a normal range of dimensions that will serve as a reference range in lip repair. Method: This is a gender-based, cross-sectional study. Measurement of normal lip dimensions from male and female subjects data covers 220 females and 220 males from 0.5 to 55 years, Measured lip parameters include: cleft width, lip height, vermillion width, and nostril sill width. Information was entered in and analyzed using Statistical Package for Social Sciences, version 23.

Result:

There was a progressive increase in the inter soft tissue gape (ISG) from 4.00 – 4.22 ± 4.80 cm in the 10.1 to 12.0 years age group, with a peak between 6.1 – 8.0 years for the males while minimal increase in inter soft tissue gape (ISG) in the subjects in the 10.1 to 12.0 years age group, although both decreases in a fairly constant pattern thereafter.

Conclusion:

Male lip dimensions have greater values from birth to 6 to 8 years, peaks at 1have greater values from birth to 6 to 8 years, peaks at 14 yrs to be fairly constant. These dimensions provide a baseline for use in he Tennison Randall's unilateral cleft lip repair which has less scarring and a more aesthetically and naturally positioned cupid's bow.

Introduction

Lip dimensions play a crucial role in lip reconstruction using the triangular lip repair method for cleft lip. The dimensions of the lip, including the width, height, and curvature, affect the outcome of the repair and can impact the aesthetic and functional results[1]

Here are some ways lip dimensions can affect lip reconstruction using the triangular lip repair method (Tennison Randall's method). The lips are one of the most important parts of the human face, playing a vital role in facial expressions, speech production, sensory perception, chewing, physical attraction, and intimacy[1,2].

A cleft is the result of failure in the fusion of the components of the lip and/or palate during the early months of fetal development. Cleft lip/palate is believed to result from multiple factors such as genetic defects, inadequate nutrition, hypoxia of the mother, alcohol abuse, drug intake, etc. Potential causes of cleft palate include genetic factors passed on by the parents, although most are isolated; cigarette smoking or alcohol use during pregnancy; maternal obesity; folic acid deficiency during pregnancy; and some medications, such as certain anti-seizure drugs, taken very early in pregnancy[3].

Cleft lip repair is a surgical procedure that may be approached with a wide array of different techniques. The ultimate goal of cleft lip repair is to restore the sphincter function of the orbicularis oris muscle and obtain a cosmetically favourable outcome for the developing child[1,3].

Cleft lip is among the commonest congenital anomalies in many persons globally. According to Mossey et al,[1] the failure of the lip to fuse properly during embryonic development can lead to the presence of the deformity; it also renders a nasal defect through the misplaced positioning of the orbicularis oris muscle together with the missing anterior nasal floor[3,4]. Lip reconstruction is a part of the repair of the cleft lip, so it is very important to have a proper understanding of normal anatomy and measurements of the lip for optimum results in surgery[3]. With this knowledge, surgeons can execute the reconstructions in the most accurate and natural way possible. The dimensions of the lip are of special importance in the context of cleft lip repair, as they elucidate the anatomical differences between the male and female lips[4].

In a related study, Raposo-Amaral et al.[5] showed that the lip height increases during the first year after surgery, with an average increase of 16% in cleft patients. Furthermore, asymmetry in the lip height among such patients requires reconstructive methods that achieve symmetrical results. Furthermore, Prabu et al.[6] noted that males tend to have thicker soft tissue structures, suggesting that knowledge of such gender-related anatomical differences is important when designing lip reconstruction surgeries. Lip morphometric analysis is one of the integral parts of orthodontics since it affects facial aesthetics, malocclusion, and general orthodontic results. A number of measurement techniques have been put to use in the measurement of lips, from anthropometry and morphometry to cheiloscopy and Likert scales, the last being the most successful of the newer ways of measuring[7].

Tennison described his reconstruction of a unilateral cleft, the first to record and preserve the cupid's bow by allowing the tip to drop along the cleft border. A medial incision into the cleft was made and a lateral triangular flap used to close the resulting

gap[7]. Our modification of the Tennison repair takes its basis in the vertical height of the normal side, for Randall and Hagerty's approach also does that. We intentionally reduce the vertical height of the lip by 1 mm below normal side, as in part of the former repairs, it caused too much length[8]. Other adjustments involve a 1-mm advance at the vermilion, and where the newborn's lip is too long, a triangular piece is removed below the alar base to gain the required vertical height. There are extremely precise instructions on incision planning and surgical technique. V-to-Y closure was required in some patients to correct a deficiency of the vermilion, but none needed a secondary procedure. This underscores the need for careful planning to make sure that the primary repair is successful[10]. The procedure is suitable for cases from incomplete to very wide clefts, and no patient needed lip adhesion. We have also abandoned nasal surgery at the time of the primary repair[9].

Accurate closure of the orbicularis oris muscle, rotation of the cleft segment, and cutaneous closure are significant in minimizing variability in lip height. As much as surgery strives for symmetry, there will always be some degree of asymmetry of the lips since non-cleft individuals have been found to possess the same indices of asymmetry. These results highlight the complexity of lip reconstruction and the need for greater understanding of lip size and type in the male and female populations[10].

One of the surgical techniques of cleft lip repair is through the use of a traction suture between the cupid's bow crests on the medial and the lateral segments of the cleft. The deeper superior medial portion is subsequently sutured to the anterior nasal spine for further stabilization of the lateral advancement flap.

Aim: This study was undertaken to compare the lip dimensions of males and females, and also to investigate the implications of the findings on lip reconstruction in cleft lip repair in the population of Enugu Metropolis.

Methods: This study was a gender-based, cross-sectional study that involved the taking of normal lip dimensions from male and female subjects through anthropometric measurements in Enugu Metropolis[8]. The inhabitants of Enugu are predominantly from the Igbo ethnic group which is one of the three major ethnic groups in Nigeria. Enugu Metropolis consists of three Local Government Areas: Enugu-North, Enugu-East, and Enugu-South, with a combined population of about 722,664, and is the capital of Enugu State[9]. The minimum sample size was calculated based on the formula: $Z^2 \times P(1-P)/d^2$, where n represents the sample size, Z is the standard normal deviation typically assumed as 1.96 for the confidence level of 95%, P denotes an estimate of the proportion of a population with a particular trait or characteristic, that is, prevalence, $q = 1 - p$, and d is the desired degree of accuracy, usually 0.05. A total of 220 females and 220 males, ranging in age between 0.5 and 55 years old were recruited to participate in this study.

Persons aged less than 18 years comprised 77.40% of the study participants. All information was analysed using SPSS, v.23: for each variable, mean as well as standards deviations were obtained.

Results: There was a progressive increase in mean values of the intercommissural distance with the lips relaxed and measured in a straight line (ICD – Sc) with increasing age (6 months to 12 years). There was progressive increase in the mean values of the intercommissural distance with lips voluntar-

ily retracted maximally laterally, from 6.1 to 12 years, reaching a maximum at 10.1 to 12.0 years. The value became constant from 12.1 years. The height of the upper lip demonstrated a progressive increase from 6 months to 8 years. There was a minimal increase in inter soft tissue gape (ISG) in the subjects in the 10.1 to 12.0 years age group, which subsequently decreases in a fairly constant pattern thereafter.

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The analysis showed no significant differences in lip dimensions between male and female subjects in Enugu Metropolis. The similarities of gender-specific dimensions of the lips have important implications in lip reconstruction during cleft lip repair, since better appreciation of these dimensions might be helpful to the surgeon in an attempt to restore a more natural appearance. The results of this work are hereby presented based on gender from the data obtained from the population of Enugu Metropolis in Nigeria. The parameters obtained from male and female individuals of Enugu origin were compared side by side.

Mean intercommissural distance measured along the arc of the upper vermillion with lips in a relaxed position was analyzed with respect to age in both male and female subjects from Enugu Metropolis.

It was observed that mean intercommissural distances showed progressive increases with all age groups from 0.5 to 20 years and beyond. The rate of increase was relatively modest within the age range of 12.1 to 20.0 years amongst male subjects in Enugu Metropolis. In the contrary, the mean intercommissural distance of the lips, in females from Enugu, measured with the lips in a relaxed condition and in a straight alignment, shows an upward trend with age, peaking between 12.1-14.0 years and generally maintaining that level from 14.1 years onward into adulthood.

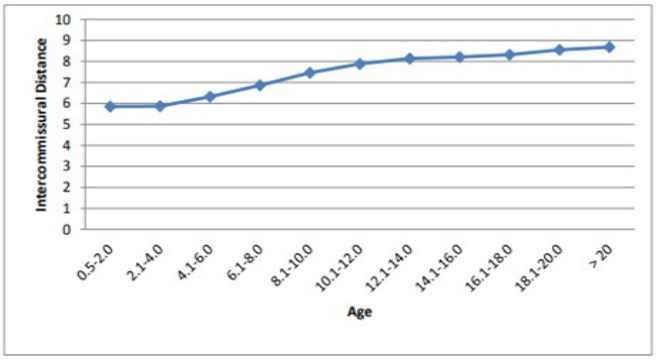


Fig1. Mean intercommissural distance Among male Enugu subjects against their age

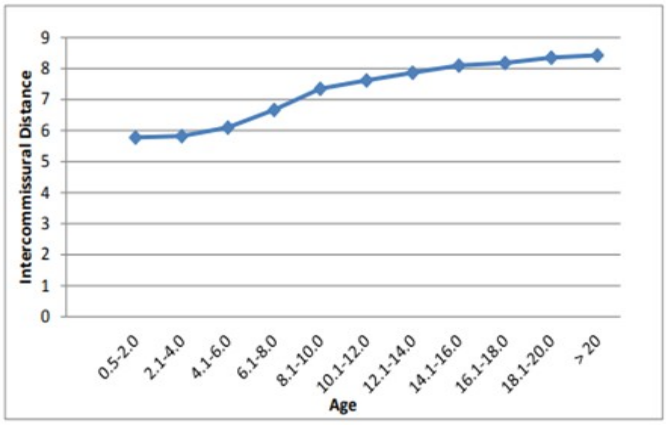


Fig 2. Intercommissural distance of Enugu female subjects according to their ages

Intercommissural Distance of Enugu Male and Female Subject with the Lip Relaxed and Measured in a Straight Line (ICD-Sc):

The intercommissural distance of the lips, measured with the lips in a relaxed state and in line straight, showed a progressive increase with increasing age, peaking in the 12.1 to 14.0 years age group. The measurement remained relatively stable from 14.1 years into adulthood among male subjects from Enugu. The intercommissural distance of the lips, again measured with the lips relaxed and in a straight line, showed a similar trend in female subjects from Enugu, showing progressive increase with age and peaking between 12.1 and 14.0 years, after which it continued at a fairly constant value into adulthood from 14.1 years.

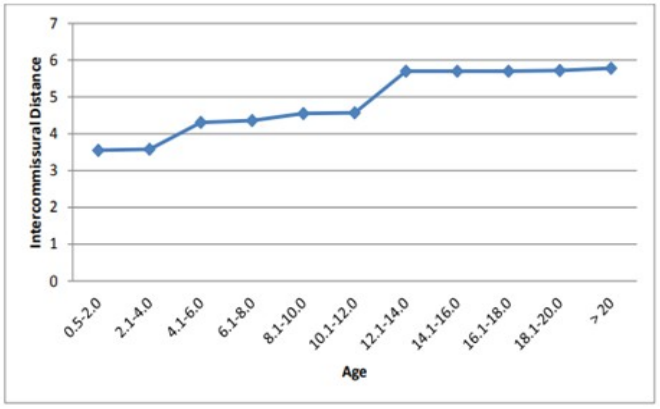


Fig3.Mean intercommissural distance with lips relaxed in a straight line among male Enugu subjects against their age

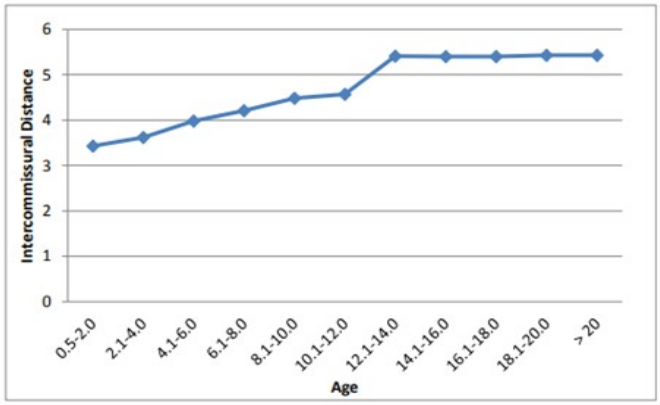


Fig 4. Mean intercommissural distance (cm) with lips relaxed in a straight line among female Enugu subjects according to their ages

Intercommissural Distance (ICDr) with the Lip Retracted Maximally, Laterally and Voluntarily.

The intercommissural distance with the lip maximally retracted laterally and voluntarily was measurable only in male subjects from Enugu who were above 6.1 years old. The mean intercommissural distance revealed slight increases through all the age groups.

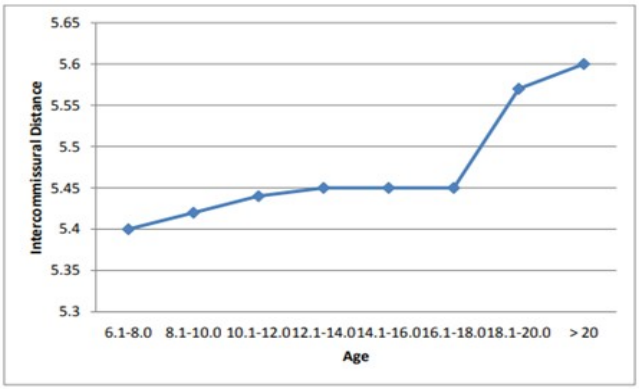


Fig5. Mean intercommissural distance with the lips grinning maximally, laterally and voluntary among male Enugu subjects against age

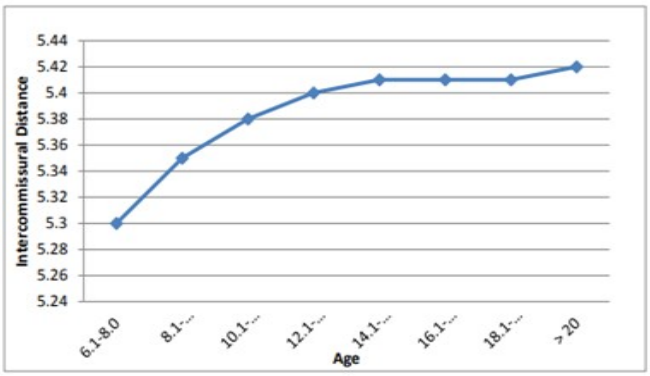


Fig 6. Mean intercommissural distance (cm) against age with the lips grinning maximally, laterally and voluntarily among female Enugu subjects

Intercommissural Distance (ICDc) with the Lip Contracted

The measurement of the Intercommissural distance with the lips contracted was only feasible in those aged 6.1 years and above. Its mean value increased from 3.40 cm ± 1.55 for the 6.1 to 8.0 age group years to 6.07 cm ± 1.22 in the group aged 20.1 years and above, in the study population of Enugu

females. Hence, the Intercommissural distance could only be measured in those 6.1 years and above.

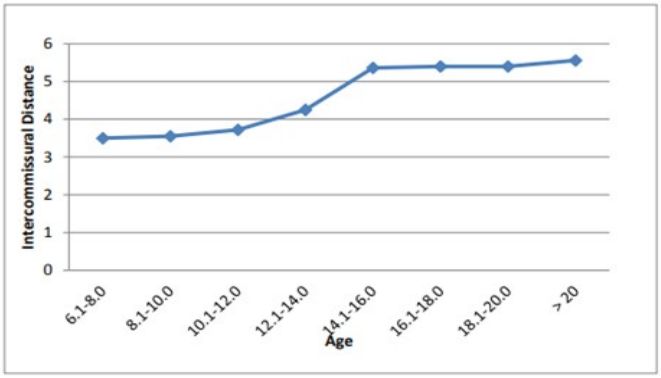


Fig7. Mean Inter-commissural Distance (ICD_SC) with the lips maximally contracted against age among Enugu male subject

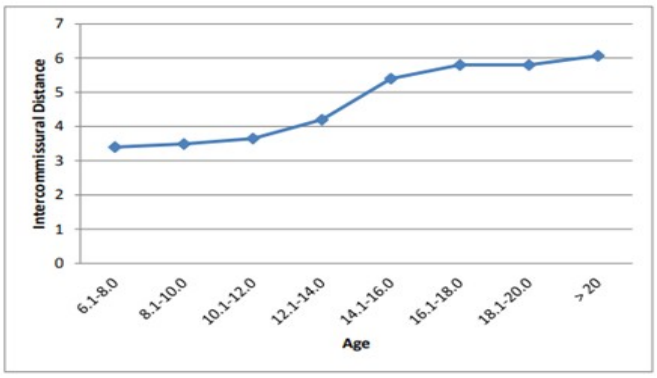


Fig 8. Mean Inter-commissural Distance (ICD_SC) with the lips maximally contracted against age among Enugu female

Heights of the upper lips

The height of the upper lips showed a steady and progressive increase, starting from 0.5 years to reach its maximum in the age group of 14.1 to 16.0 years. Following this peak, from the age of 14.1 years into adulthood, the height remains relatively stable among male subjects in Enugu. Similarly, the height of the upper lips also showed a normal and progressive increase from 0.5 years and reached their peak within the 14.1 to 16.0 years age group. After 14.1 years, this height stabilizes among the female subjects in Enugu.

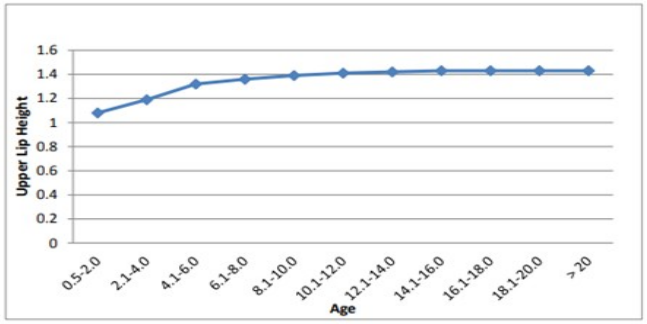


Fig9. Mean height of the upper lips among the Male study population according to their ages

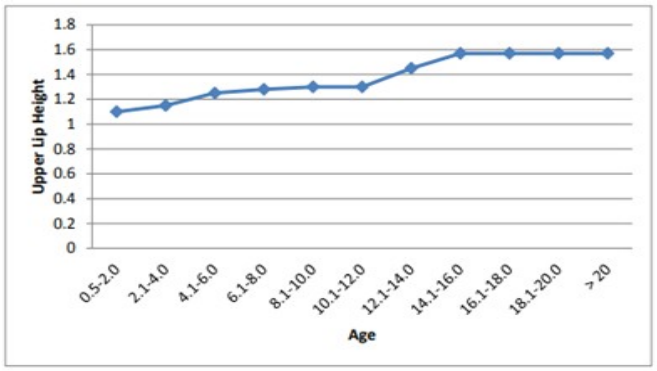


Fig 10: Mean height of the upper lips among the females according to their ages

The Midline Thickness of the Upper Lip

The mean midline thickness of the upper lip in males progressively increases from 0.93 cm at 6 months to 1.26 cm by the age of 14.1 to 16.0 years, as evidenced by the mean measurements. The thickness stabilizes from the age of 14.1 years onwards into adulthood. In contrast, mean values and standard deviation (cm) of midline thickness of the upper lip amongst female subjects in Enugu showed an increase from 0.88 cm at 6 months to a peak of 1.27 cm at 14.1-16.0 years. Thereafter, measurements remain constant regardless of further increments in age.

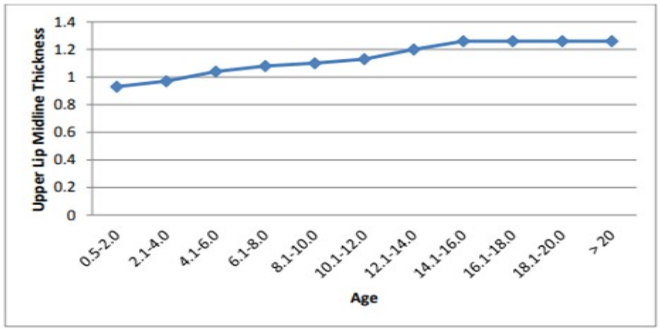


Fig11. Mean of the Midline Thickness of the Upper Lip in male Enugu subjects against Age

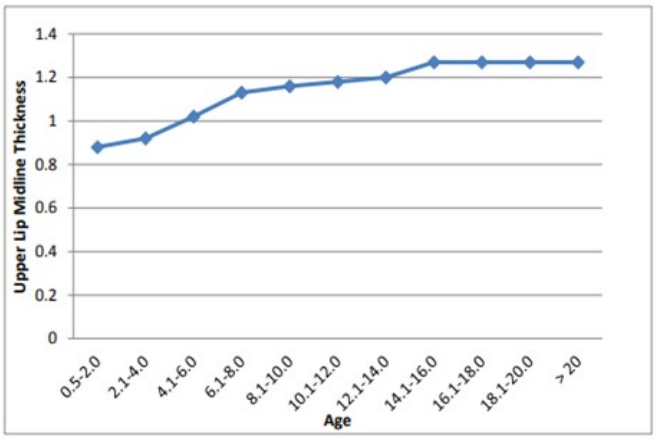
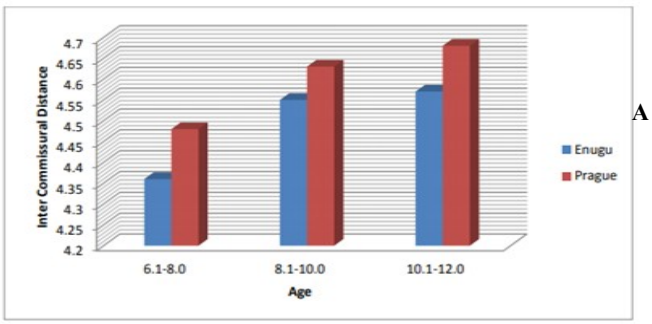


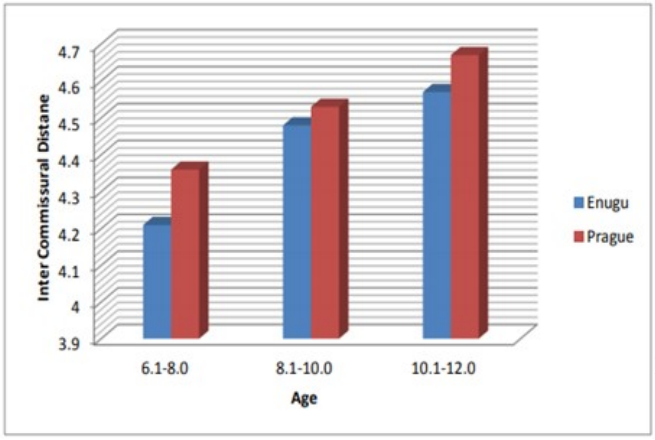
Fig 12. Mean Midline Thickness of the Upper Lip against age among female Enugu subjects

Comparison of Values of Mean Intercommissural Distance between Enugu Male and Female with that of Previous Study

The bar chart showing the intercommissural distance of male subjects from Enugu, obtained from this study, is compared with data obtained from a previous study carried out in Prague, Czechoslovakia. The ICD values for the age groups studied ran from 6.1 to 12.0 years and the measurements in Enugu were between 4.36 cm and 4.57 cm while in the Prague study, the values were between 4.48 cm and 4.67 cm. Besides, while studying the intercommissural distances of the female subjects from Enugu, the results from the present study were compared with that of the Prague study. The mean ICD, for the age group of 6.1 to 12.0 years in this study, ranged from 4.21 cm to 4.57 cm, whereas in the Prague study, the range was from 4.36 cm to 4.67 cm.



A



B

Figure 13. (A) A comparative analysis of the Mean Intercommissural Distance between males from Enugu and data from a previous study. Figure 12 presents bar charts that illustrate the intercommissural distance recorded in this research alongside findings from an earlier investigation conducted in Prague, Czechoslovakia. The mean intercommissural distance for the specified age groups varied from 6.1 to 12.0 years, with measurements ranging from 4.36 cm to 4.57 cm in Enugu, in contrast to 4.48 cm to 4.67 cm in Prague.

Figure 13. (B) A comparison of the Mean Intercommissural Distance (cm) measured in a straight line among female children in Enugu, Nigeria, and Prague, Czechoslovakia, categorized by age.

Discussion

This study is on the dimensions of the lips and its importance in lip reconstruction for cleft lip repair in male and female subjects in the Enugu metropolis. The Millard's Rotation Advancement Flap techniques give no room for meticulous measurements unlike the Tennison Randall's that uses measurements for lip reconstruction.

Tennison Randall's technique has the advantage of giving a more natural formation of the cupid's bow which is the curved shape of the upper lip. This is because the technique involves a more precise

alignment of the lip tissues, resulting in a more aesthetically pleasing outcome. Several reports have been documented on the lip dimensions of male subjects and its implications for lip reconstruction. Comparing the findings of this study on the Enugu male subjects with the existing literature, the following were noted: the mean intercommissural distance, measured with the lips maximally and voluntarily contracted, was 6.40 ± 0.20 cm and increased with an age range of 6 to 15 years. This finding is in agreement with the results of Gbeneol[10], which show that the intercommissural distance at rest with pursed lips cannot be used reliably to determine the age of a child younger than 6.1 years old. The mean value rose from 3.40 cm ± 1.55 for an age group between 6.1 to 8.0 years to 6.07 cm ± 1.22 for those aged 20.1 years and above. Although few studies have been carried out in this field, a few studies, such as the ones performed by Hajnisova[11] and Fasika et al.[12] were done in Prague and Ibadan respectively with a larger group of children addressing a similar objective. They established that the mouth width or intercommissural distance of the school-aged children aged between 6 – 12 years was shorter when compared to their Czechoslovakian counterparts belonging to the same age group. A comparison of the findings in this investigation between male and female subjects reveals a significant increase for the mean intercommissural distance, taken with the lips maximally contracted and voluntarily, in the 6- to 15-year-old female participant.

Similar studies were also done by Hajnisova[11] and Fasika[12], both on children. In Hajnisova's study she noted that the female children aged between 6.1 to 8.0 years in Prague had an intercommissural distance of 4.36 ±0.16, compared to those in Enugu with a dimension of 4.21 ± 0.50. Likewise, the intercommissural distances recorded for the age groups of 8.1-10.0 and 10.1-12.0 years were 4.48 ± 0.29 for Enugu and 4.53 ± 0.28 for Prague and 4.57 ± 0.23 for Enugu and 4.67 ± 0.22 for Prague, respectively. It can therefore be implied that the width of the mouth or intercommissural distance of school children between 6 to 12 years is always shorter among Nigerians compared to Czechoslovakians of the same age group. There is an overall steady increase in the measurements from male to female subjects in the Enugu metropolis. Conclusively, the findings of this study on the height of the upper lip and intercommissural distance from Enugu male and female subjects were smaller compared to their Israeli counterparts.

These findings are in agreement with the earlier study by Juberget al.,[13] which indicate that such measurements mirror racial differences. The differences in lip parameter measurements have been reported in different studies, and there are several factors that have contributed to these discrepancies. The possible causes include variation in the methods of head and lip posture measurements and the functions of the lip muscles, as reported by Juberget al.[13] and Bardach[14]. The study further indicates the dimensions of lip aperture were also relaxed and contracted. This is attributed to the influence of the underlying anatomical facial structure. The document thus becomes a useful index of bony facial anatomy and the soft tissues lining the oral cavity for the male and female subjects' resident in Enugu metropolis. Although some features, such as the maxilla and mandible projection, are seen in various racial groups, the variation of prognathism can be seen, especially in lip height and thickness dimensions, as reported by Fogel[15] and Hajnis et al.[16] In this study, two-dimensional measurements were subjective because each subject voluntarily con-

tracted and released the circum-oral muscles without any manipulations from outside. The general build and the dietary habits of the individual may also contribute to the development of these muscles, which in turn may play a part in the full development of the circum-oral muscles. This observation agrees with the report of Gbeneol TJ[17], who noted that the size of the alveolar region and teeth, the presence of dental diathesis, and projections may affect the tension or relaxation of the lips, thereby changing their two-dimensional measurements.

Findings on the upper lip elasticity index show a decrease in the elasticity of the upper lip with increased age in both male and female subjects in Enugu metropolis. A high mean value of 0.44 is recorded at the age range 6.1 to 8.0 years. The mean values peak at 6 years and continue to rise, reaching the highest point at 10 years, before they start declining with increasing age. This lends credence to Gbeneol's[17] observation, which states that the circum-oral muscles, being of skeletal origin and made up of permanent cells, may reach maximum pliability between the ages of 6 and 10 years and then lose elasticity with advancing age. Although this study is in line with the work done by Fasika, it brings out the fact that lip elasticity reduces as one grows in age from 4 to 12 years. The elasticity of the lips is credited to the presence of elastic fibers in the dermal layer of the skin and also the muscles that encompass the oral aperture.

Conditions that involve the orbicularis oris, buccinators, zygomaticus major, depressor anguli oris muscles, or their innervation by the mandibular or buccal branches of the facial nerve are likely to influence the lip elasticity index. As observed in the present study, the mean coefficient of upper lip curvature shows some reasonable stability with a little rise from 0.46 at ages 6.1 to 8.0 years to a maximum value of 0.50 at ages 14.1 to 16.0 years.

In the male subjects from Enugu, the mean coefficient of upper lip curvature varied between 0.46±0.18 and 0.50±0.12 for the age groups 6.1 to 20.1 years and older. Although there is only a minimal variation in the coefficient value, the mean coefficient for upper lip curvature amongst the female subjects in Enugu ranges between 0.51 cm ± 0.22 and 0.55 cm ± 0.09 within the same age range. This shows a very slight change in the coefficient of upper curvature. Bardach et al.[14] demonstrated that the coefficient of upper lip curvature is determined by the lips, floor of the nostrils, and the age of the patient, which are reflective of the lip elasticity index.

A bar chart showing the ICD of the male subjects in this study and that obtained in a previous study carried out in Prague, Czechoslovakia, shows the dimensions of ICD for age groups 6.1 to 12.0 years to vary between 4.36 cm and 4.57 cm in Enugu, whereas in Prague the variation is from 4.48 cm to 4.67 cm. Also, in comparing the values of intercommissural distance for the female subjects at Enugu to those from Prague study, mean ICD on the age grade 6.1 to 12.0 years ranged in this study between 4.21 cm to 4.57 cm as compared to 4.36 to 4.67 cm recorded in the research from Prague. Cleft palate is a congenital condition which occurs in about 1 in 700 births globally. A study by Gbeneol[18] on the presentation of cleft lip and palate as regards gender shows a higher incidence in males than females.

The most common conditions found in Port Harcourt, Nigeria, are complete cleft of the soft palate

30.51% and incomplete cleft lip 30.51%. Lip reconstruction constitutes an integral part of most repairs, especially in gaining back the function and esthetics of the lip. Cleft palate repair with aphrodite lip reconstruction is still considered technically challenging because it demands perfection both in technique and result. Among the many known techniques are Millard rotation advancement[19], Mohler repair, Noordhoff repair, and Fisher repair; there are variations with regard to their respective successful outcomes. Future innovations, especially in 3D printing, tissue engineering, and minimally invasive procedures, hold a lot of promise for continuing to improve the functional and aesthetic results. Many of the medical practitioners have adapted these techniques, and they have been fairly effective. One such is the Millard rotation-advancement technique: rotation of the lateral lip segment and advancement of the medial lip segment. The Mohler Repair uses a triangular flap from the lateral lip segment to augment the philtrum[20]. The Noordhoff Repair uses a quadrilateral flap from the lateral lip segment for reconstruction of the philtrum[21] and the Fisher Repair uses a combination of rotation-advancement with triangular flaps[22].

In a study by Aranmolate et al.,[23] the research brings into focus the need for symmetry in lip length when performing unilateral cleft lip repair. The main goal of all the established techniques is to make the real lip length on the cleft side equal to that of the non-cleft side, which is usually shorter. For example, the Millard technique uses a rotation flap to be used in lengthening the shorter side by turning around the C flap, while the lower equilateral triangular technique of Tennison and Randall, much like the quadrilateral flap technique of Le Mesurier, tries to lengthen the shorter side on the non-cleft side.

A decreased equilateral triangular and quadrilateral areas have been noted and the study also accepted the fact of sillo–columellar distance (s–c), that is, marks the exact location of the upper boundary of lateral lip and acts as an important point for triangular architecture. All the above methods have shown excellent results in lip reconstruction field. Studies indicate that this technique offers more aesthetic results with the application of the Millard rotation-advancement technique," as noted by Salyer et al.[24]

Greater improvement was noted in this repair in terms of functioning of the lips, particularly for oral competence". On the other hand, Salyer noted that application of Noordhoff Repair guarantees a higher rate of orbicularis muscle preservation. Concurrently, it is more prone to complications, particularly wound dehiscence, and scarring[21]. On the other hand, great patient satisfaction has been associated with Fisher Repair. However, more techniques can be done to ensure maximum success using 3D printing technologies for tailored surgical models and guides, work on tissue-engineered constructs, in order to improve lip reconstructions, along with advancing minimally invasive techniques, to decrease scarring and optimize results.

Conclusion

The study concluded that the approximate reference values for lip parameters in Enugu males for ages ranging from six months to fifty-five years are as follows: The intercommissural distance ranged from 5.85cm for the 0.5 – 2.0 years age group to 9.00cm for the 20.1years and above age group, the lip height ranged from 1.10cm for the 0.5 – 2.0 years age group to 1.60cm for the 20.1years. In nutshell this work has provided values for lip parameters for Enugu males and females which can

also be used as a guide in reconstructive surgery for other Nigerian male and female populations, due to their similar anthropometric and demographic profiles. Tennison Randall's repair uses meticulous measurements in repair but gives less scarring and a more aesthetically positioning of the cupid's bow.

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