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RESEARCH ARTICLE

RADIOGRAPHIC RELATION OF SKELETAL DIVERGENCE AND FRONTAL BONE THICKNESS: A CEPHALOMETRIC STUDY

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ABSTRACT

Objectives: To measure frontal bone thickness in skeletal hyperdivergent and hypodivergent patients and compare with a group of normodivergent patients. **Settings and sample population:** The material comprised of 150 patients divided into three group, 50 patients with skeletal hyperdivergence and 50 with skeletal hypodivergence. They were compared with a control group of 50 patients of skeletal normodivergence. **Materials and methods:** The thickness of the frontal bone was measured on lateral radiographs of patients with skeletal hyperdivergence and skeletal hypodivergence and compared with a control group. Unpaired t- test were used for evaluating differences in thickness. **Results:** Patients with skeletal hyperdivergence had a significantly thicker frontal bone than a normodivergent group. Frontal bone thickness in skeletal hypodivergent patients was comparable to the normodivergent group. **Conclusion:** The most important outcome of this study was increased thickening of frontal bone in patients with skeletal hyperdivergence compared with skeletal normodivergent patients. Deviations in the theca cranii are thus associated with skeletal hyperdivergence.

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INTRODUCTION

Human skull study has been the focus of great interest in different medical specialities. Several studies have been carried out to accomplish relationship between cranial thickness, gender and age (Getz, 1961; Smith, 1885; Ishida, 1990; Ross, 1998). Many studies have described an association between normative cephalometric values and ethnic groups (Smith, 1885) whereas studies on the skull thickness are limited. Among the pathological conditions demonstrating a general thickening of the skull compared with normal standards are acromegaly (Finlay, 1954). Williams syndrome is an example of a pathological condition with a local thickening of the skull (Axelsson, 2005). The interrelationship between thickness of the skull and skeletal malocclusions has not been published until very recently. Normative cephalometric data is necessary to compare the skull bone thickness and skeletal jaw relation. Jacobsen et al (2008). Measured the thickness of the skull in patients with skeletal deep bite and compared this with a control group including 18 profile radiographs. They found that patients with this vertical malocclusion have a general thickening of the skull Similarly Arntsen et al. (2008). Measured the skull thickness in patients with skeletal class II and class III malocclusion and reported the reduced skull thickness in the occipital area and thickening of the frontal bone in patient with skeletal classII malocclusion. Similar studies on other skeletal malocclusions have not previously been published. In severe malocclusion traits, abnormal bone thickness has been observed in different areas of the cranium. Tsunori et al. (1998). found a association between the buccal cortical bone and various craniofacial morphologies. They demonstrated strong relationship between skull bone, gonial angle and vertical jaw relation. Ribeiro et al. (2006) found that the retrognathic patients had a significantly thicker ramus than the prognathic patients. Till date, no study has been done to correlate the cranial bone thickness and skeletal divergence, therefore the aim of the present study is to evaluate the thickness of frontal bone in a group of subjects with skeletal hyperdivergence, hypodivergence and compare

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them with a group of subjects having skeletal normo divergence.

MATERIALS AND METHODS

It consisted of 150 pretreatment lateral cephalograms of 15 to 25 years old individuals who had never undergone orthodontic treatment. The lateral cephalograms were taken with jaws in centric relation position, lips relaxed and the head in the natural head position (Moorrees, 1994).

These cephalograms were traced and sum of posterior angles (rakosi jarabaks analysis), SN-MP angle (steiners analysis), Y-axis(downs analysis), FMA angle (tweed analysis) were measured to categorize the individuals in three respective groups.

Skeletal Hyperdivergent and Hypodivergent group

The inclusion criteria in the study were

- Adult patients aged between 15-25 years.
- No history of orthodontic treatment during childhood.
- Sum of posterior angles larger (hyperdivergent) or smaller (hypodivergent) than one standard deviation, according to the cephalometric standard values described by rakosi jarabaks analysis.
- FMA angle larger (hyperdiverdent) or smaller (hypodivergent) than one standard deviation, according to the cephalometric standard values described by tweed analysis.
- Y- axis as per downs analysis
- SN-MP angle as per steiners analysis
- No craniofacial anomalies or systemic muscle or joint disorder.

Skeletal Normodivergent group: This group comprised of 50 patients selected according to the below mentioned inclusion criteria. The cephalometric mean values of the normodivergent group are shown in Table 1.

Cephalometric methods: The measurement of the frontal bone thickness were defined according to Axelson et al.[12] The cephalometric reference points and lines necessary for measuring the frontal bone thickness including the actual location on the skull are defined and marked according to Bjork[13].(Fig1)

Statistical methods: Differences in the mean thickness of frontal bone of hyperdivergent, hypodivergent and normodivergent groups were assessed by unpaired t-test. The results of the test were considered to be significant at p-values below 0.05. The value above this standard was considered as not significant.

RESULTS

Hyperdivergent group compared with Normodivergent: Statistically significant differences were found in patients in the frontal bone (p- value= 0.05) (Table 2). The frontal bone was thicker in hyperdivergent group compared with the normodivergent groups.

Hypodivergent group compared with Normodivergent: The frontal bone thickness in hypodivergent group was comparable to the normodivergent group (Table 3).

Fig .1. Points and lines according to Bjork :bregma (br): the intersection between the sagittal and coronal sutures on the surface of the cranial vault; frontale (f): the point on the surface of the frontal bone determined by a perpendicular to the line joining the nasion and bregma and passing through its midpoint. Skull thickness according to Axelsson *et al.* : the thickness of the frontal bones was defined as the distance from the point where the perpendicular from the midpoint of the cords nasion–bregma intersect the inner and outer contours of the respective bones

Table 1. Mean values of the inclusion criteria angles to differentiate the study groups

Angles	Mean value
Sum of the posterior angles (rakosi jarabaks analysis)	396 degree
FMA angle (Tweed analysis)	25 degree
SN-MP angle (steiners analysis)	32 degree
Y- axis (Downs analysis)	59.4 degree

Table 3. Differences in the frontal bone thickness between hypodivergent and normodivergent group

DISCUSSION

In 1954, Bjork found that men with skeletal sturdiness had a tendency to scissors bite and larger dental arches compared with the slender build male patients. They concluded that thickness of skull bones may play a diagnostic role while orthodontic treatment planning. This could be an indicator for the thickness of the bone in general as this information could also contribute to estimate the orthodontic treatment time. In the study, the sample consisted of 50 hyperdivergent,50 hypodivergent and 50 normodivergent patients. The sample is sufficient to perform an unpaired t-test as the variables are normally distributed. Groups were divided as per the inclusion criteria, the thickness of frontal bone was measured according to Bjork and mean value was determined for each respective group, hyperdivergent and hypodivergent group were compared with normodivergent group seperately and unpaired t-test was performed on it, the p-value of test done on hyperdivergent – normodivergent sample was found less than

0.05 at 5% level of significance and 9 degree of freedom proving it statistically significant (fig 3) whereas the p-value for hypodivergent –normodivergent sample was more than 0.05 at same level of significance and degree of freedom making it statistically non- significant (fig 4).

Table 2. Differences in the frontal bone thickness between hyperdivergent and normodivergent group

Hyperdivergent			Normodivergent			results
N	Mean	SD	N	Mean	SD	p-value
50	6	.395	50	5.8	.309	*

* Statistically significant i.e p < 0.05

Table 3. Differences in the frontal bone thickness between hypodivergent and normodivergent group

Hypodivergent			Normodivergent			results
N	Mean	SD	N	Mean	SD	p-value
50	5.10	.61	50	5.8	.309	NS

NS- Not significant i.e p > 0.05

The result showed increased frontal bone thickness of hyperdivergent group whereas the hypodivergent group was found very comparable to the normodivergent group. The finding of a local thickening in the frontal bone can be interrelated with the finding of a short nasal bone in this malocclusion group. Both areas belong to the frontonasal developmental field[14]. When compared with the skeletal class III malocclusion it is interesting that class III subjects have a normal nasal bone length and a normal thickness of the frontal bone. Differences between skeletal class II and class III malocclusion were also found in the cervical spine where the vertebral fusions in class II were localized more cranially than the fusions in skeletal class III. The present study revealed an association between the frontal bone thickness and hyperdivergent and hypodivergent patients.

This finding signifies the importance of future studies of the frontal bone thickness in other malocclusions. Studies have shown a relation between thickness of the buccal cortical bone and gonial angle. They have determined that the width of the ramus mandibulae varies in retrognathic and prognathic patients. As orthodontists and oral surgeons often have profile radiographs at their disposal for skeletal analysis, a linear measurement of the skull thickness is considered an indicator for the bone thickness in general. As most patient undergo orthodontic treatment before or at the end of the growth period, the skull measuring method will be valid for the orthodontic practice. The present study presents for the first time data for frontal bone thickness in adults with skeletal hyperdivergence and skeletal hypodivergence malocclusion. Similar data for the remaining skeletal malocclusion are still lacking and needed for future diagnostics of normal and pathological skulls.

Conclusion

The most important outcome of this study was the finding of a thickening of the frontal bone in patients with skeletal hyperdivergence compared with normodivergent. The frontal bone thickness in the skeletal hypodivergence group did not deviate from the normodivergent. It shows that differences in skull thickness are associated with skeletal malocclusion.

Clinical relevance: Recent studies on profile radiographs have shown that the spine as well as the sella turcica reveal morphological deviations, which are characteristic of different skeletal malocclusions. The present study on difference in frontal bone thickness in hyperdivergence and hypodivergence adds new morphological insight into the phenotypic characteristics of skeletal divergence, important for early diagnostics and treatment planning.

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