CORRELATION OF ADDUCTOR METACARPOPHALANGEAL SESAMOID OSSIFICATION STAGES WITH DENTOFACIAL PROFILE CHANGES

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Abstract

This study aimed to correlate facial growth velocity of certain parameters with ossification stages of adductor metacarpophalangeal sesamoid as a maturity indicator. 59 mixed longitudinal lateral cephalograms and left hand-wrist radiographs for Lebanese school children (Males 23, females 23) between 9 and 15 years of age were randomly selected from the records of the out-patient clinic of the Faculty of Dentistry at Beirut Arab University. Participants have had acceptable facial profile and class I skeletal relationship. The collected data were tabulated and statistically analyzed; one way analysis of variance (1- way Anova) was performed to detect the level of significant changes in facial profile parameters with respect to ossification stages. Pearson correlation test was employed to determine whether significant differences were present between the craniofacial profile parameters and ossification stages of adductor sesamoid for males and females. The results revealed that not all the parameters measured showed correlation with the adductor sesamoid ossification stages ($P < 0.05$) significance level, the mandibular dimensions (**Ar-Go**) (r=0.758) females, (r=0.655) for males & (**S-Gn**) (r=0.687) males, (r=0.518) females showed the highest correlation with ossification of the adductor sesamoid at stage 3; thus if adductor sesamoid is not ossified, mandibular growth is still to come.

Keywords: Adductor Sesamoid, Maturity Indicators, Facial Profile, Lebanese Children.

Introduction

Skeletal maturity indicators of the hand and wrist were considered by many investigators as a reliable evidence to assess individual physiologic maturity, to understand the percentage of growth remaining and assess maturational status and whether the pubertal growth spurt of that patient has been reached or completed. These indicators have a considerable influence on diagnosis, treatment goals, treatment planning, and the eventual outcome of orthodontic treatment.

In their investigations of the sesamoid bones of the hand (Joseph, 1951) and (Krailassir et al, 2002) revealed that ossification of the sesamoids is similar to that of the rest of the skeleton as they ossify in certain order. There is sex difference in their time of appearance, and a very close relationship with the onset of secondary sex characters (Onat, 1976). There is individual variation in the time of their appearance and they usually appear bilateral, their appearance cannot be related to any known external environment factors such as pressure or muscular power (Chapman, 1979).

Onat (1976) encountered in every subject that the metacarpalppharayngeal sesamoid was a better maturity indicator than the other sesamoids of the hand. The age, height, weight, percentage of adult height and skeletal age attained at appearance of the sesamoids showed the smallest variation with this sesamoid and with the ages at initiation and peak height velocity. Usually it became visible radiographically 0.5 years after the onset of pubic hair development, 0.75 years after the initiation of height spurt and 0.7 years before peak height velocity. It indicates that puberty has already started and that height velocity is in the accelerating phase and that 88% of adult height is reached.

Several studies have shown that the maximum height increment was always recorded after the Adductor Sesamoid commenced ossifying and usually at the time the typical seed shape was radiographically manifest. (Grave, 1979) in agreement with similar studies, stated that carpal radiographs can be used as a guide to determine the onset of the adolescent growth spurt (Buehl, 1942); (Chapman, 1979); (Onat, 1976); (Bjork & Helm, 1967); (Bergersen, 1972); (Hagg and Tanager, 1982) ; (Zhang et al, 2008) and (Demirjian et al, 1985)

It was possible to estimate the time of onset of the adolescent growth spurt in the face by observing the time of onset of the preceding similar acceleration in body height (Bambha and VanNatta, 1963). It has been concluded in number of studies that maximum growth facial dimensional changes was coincident with maximum height (Hunter, 1966); (Krogman, 1951); (Bishara and Jacobson, 1985); (Arat et al, 2001) and Bergersen, (1972); or after height growth by few months (Nanda, 1955); (Fishman, 1982). Flores-Mir et al, (2004) revealed overall horizontal and vertical facial

growth velocity were related to SMI determined by analysis of hand-wrist radiographs.

If growth factors were critical for the success of treatment, then treatment should be started early, well before the growth rate peak occurs; waiting for the growth rate peak before commencing ,will result in failure to utilize a period of relatively high growth period leading up to the peak , and as a consequence the treatment may be carried out after growth has fallen to a low level (Cohen, 1980) and (Pileski et al, 1973) evaluated mandibular growth (Co-symphysis point), Peak mandibular growth velocity was preceded by the appearance of the sesamoid; if the ulnar sesamoid bone is not visible on a radiograph, then maximum acceleration of mandibular growth is still to come.

In view of the literature review, clinicians who expect more orthopedic effect should consider starting treatment during the MP3 stage, the S stage (in female patients), and the MP3cap stage (in male patients). Treatment rendered after these stages may result in more dental rather than skeletal effects. This study aimed to correlate facial growth velocity of certain parameters with ossification stages of adductor metacarpophalangeal sesamoid as a maturity indicator in a group of Lebanese School Children to justify the appropriate timing of orthodontic treatment.

Materials and Methods

Sample

59 mixed longitudinal lateral cephalograms, left hand wrist radiographs for Lebanese school children (Males 23, females 23) between 9 and 15 years of age were randomly selected from the out-patient clinic of BAU Faculty of Dentistry, all the children selected have acceptable facial profile and class I skeletal relationship.

Methods

Cephalometric Analysis

The parameters used in this study were among those most frequently used in similar growth studies; (Bergersen, 1972); (Bishara and Jakobsen,1985); (Bjork and Helm, 1967); (Lai et al**,** 2008); and (Pileski.R et al, 1973) (Fig.1). Their selection was based on the fact that they are among the most commonly used by the orthodontist, in both clinical practice and research, to diagnose and evaluate facial growth and /or orthodontic treatment.

Mandibular measurement

Pileski et al (1973): Three linear Cephalometric measurements will be recorded

Ramus length	**Ar-Go**
Mandibular body length	**Go-Gn**
Total mandibular length	**S-Gn**

Hard tissue measurement

Pileski et al (1973): ***Vertical linear measurement*:**

Anterior facial height	**N-Me**
Posterior facial height	**S-Go**
Posterior / anterior facial height ratio	**N-Me / S-Go * 10**
→ Jarabak facial ratio	

***Vertical angular measurement*:**

Articular angle	**S-Ar-Go**
Gonial angle	**Ar-Go-Me**
Y axis of Jarabak	**N-S-Gn**
Mandibular plane angle	**SN/Go-Gn**

***Sagittal linear measurements*:**

Facial depth	**N-Go**

***Sagittal angular measurement*:**

Anteroposterior position of the maxilla	**SNA**
Mandibular prognathism	**SNB**
Lower face prognathism	**SNPg**
Facial convexity	**N-A- Pg**
Saddle angle	**N-S-Ar**

Soft tissue measurement

(Bishara and Jakobsen, 1985)**:**

***Angular*:**

Total facial convexity	**N'-PR-Pg', N' SLS - Pg'**
Holdaway soft tissue angle	**LS-Pg': NB**
Merrifield Z angle	**FH: Pg' LI**
Linear:	**PR-Pg: LS**
	PR-Pg: Li

Statistical analysis

The data collected were statistically analyzed to correlate the adductor sesamoid ossification stages (tab-1) with facial profile changes.

Stage	Ossification level
Stage 0	No radiographic evidence of ossification
Stage 1	Pinhead size approximately 1mm in diameter , 1st defined indication radiographically
Stage 2	Ossification progressed past stage 1, but indefinite outline
Stage 3	Distinct outline, usually seed-shaped In females of small stature it is about 3x2 mm In males of tall stature it is about 5x3mm

Tab. 1 – ossification stages as stated by Chapman

- For each stage of adductor sesamoid ossification mean age for males and females is calculated.

Male					
	N	Min	Max	Mean	SD
stage 0	13	9.4	12.1	10.55	0.81
stage 1	3	11.8	12.6	12.23	0.40
stage 2	3	12.1	15.0	13.43	1.46
stage 3	4	13.9	15.5	14.48	0.73

Female					
	N	Min	Max	Mean	SD
stage 0	5	9.1	9.2	9.16	0.05
stage 1	5	9.1	10.9	10.22	0.69
stage 2	6	10.8	12.4	11.62	0.62
stage 3	7	11.7	15.0	13.26	1.29

Tab. 2- Median age at each stage of adductor sesamoid ossification of males and females

A one way analysis of variance (1-way ANOVA) was performed to detect the level of significant changes in facial profile parameters with respect to ossification stages as stated by Chapman (1979) (Tab. 3-26)

Descriptive statistics, including the mean, standard deviation, minimum and maximum values were calculated for each parameter at each adductor sesamoid ossification stage. (Tab. 27-30)

Pearson correlation test was employed to determine whether significant differences were present between the craniofacial profile parameters and ossification stages of adductor sesamoid for males and females.(Tab-31) significant differences were given following designation

NS no significant difference is found between tested parameters
* A significant difference
** A highly significant difference

Results

Using Pearson correlation test for all selected craniofacial parameters, the results revealed that not all parameters showed correlation with the adductor sesamoid ossification stage at ($P < 0.05$) significance level (tab- 31).

The following parameters only were correlated at different ossification stages of the Adductor Sesamoid.

Correlated mandibular linear measurement:

Total mandibular length (S-Gn) FS3 MS3
Ramus length (Ar-Go) FS3 MS3

Correlated hard tissue vertical linear measurement:

Posterior facial height (S-Go) FS2, 3 MS3
Jarabak facial ratio (S-Go/N-Me) * 100 FS3 MS2

Correlated hard tissue vertical angular measurement:

Mandibular plane angle (SN/Go-Gn) FS0 M0, 1
Y-axis of Jarabak (N-S-Gn) MS1 FS0

Correlated hard tissue sagittal linear measurement:

Facial depth (N-Go) FS3 /MS2

Correlated hard tissue sagittal angular measurement:

Lower facial prognathism (SN-Pg) MS3 FS3
Mandibular prognathism (SNB) MS3 FS3
Facial Convexity (N-A-Pg) MS0 FS0

Correlated soft tissue angular measurement:

Total facial convexity (N'-SLS-Pg') MS3 FS2, 3
Merrifield Z-Angle (FH: Pg'LI) MS3 FS2

- Anova test (tab. 3- tab. 26) was performed on all correlated parameters to test at which stage of adductor sesamoid the means correlate significantly (fig.1- fig. 24)
- Descriptive statistics (tab.27 – tab.30)
- Pearson correlation test(tab.31)

Discussion

The purpose of this study was to correlate the changes in facial profile parameters with the stages of adductor sesamoid ossification in a group of Lebanese School Children between 9 and 15 years of age. **(**Grave and Brown, 1976) Indicated that the ossification events can be used by orthodontists to assess a child's growth activity. The question here is how will the adductor sesamoid helps to assess facial profile growth changes?

As some orthodontic treatment is dependent on facial growth, the period of adolescent growth can be coordinated with the initiation of orthodontic treatment through proper prediction with the aid of skeletal maturation estimate.

The present data reveal a correlation between some of the craniofacial parameters and ossification stages of the Metacarpophalangeal Adductor Sesamoid.

The age related changes in this study were divided into three major craniofacial parameters:

I. Mandibular measurements
II. Hard tissue measurements including sagittal and vertical, linear and angular
III. Soft Tissue Measurements including sagittal and vertical, linear and angular

Subsequently these results were correlated with adductor sesamoid ossification stages of Chapman and compared with other similar published data.

Data interpretation

Among all the parameters studied **mandibular measurements** revealed the most highly correlated parameters with ossification stages of adductor sesamoid. Ramus length (Ar-Go) (r=0.758) females, (r=0.655) for males, and total mandibular length (S-Gn) (r=0.687) males, (r=0.518) females. (Hunter, 1966); (Pileski et al, 1973); (Lewis et al, 1982) and

(Flores-Mir et al, 2004) confirmed these results and stated that the mandibular length showed the most consistent change in relation to adductor sesamoid ossification, if the adductor sesamoid is not ossified, mandibular growth is still to come.

Among **Hard tissue** vertical measurement; Mandibular plane angle (SN/Go-Gn) (r= -0.434) female
(r= -0.560)male; Y axis of Jarabak (N-S-Gn) (r=-0..499)male(r= -.0561)female ; Posterior facial height (S-Go)(r=0.618) male (r= 0.478)female and Jarabak facial ratio (S-Go/N-Me) * 100(r= 0.588) male (r=0.504)female.

The above findings coincide with those of (Arat el al, 2001) were he stated that skeletal maturation was found effective in vertical facial dimension hard tissue sagittal parameters facial convexity (N-A-Pg)(r=-0.689)female (r=-.447) male; Facial depth (N-Go)(r=0.479)male (r=0.454); Lower facial prognathism (SN-Pg)(r=0.546) female (r=0.522); Mandibular prognathism (SNB) (r=0.492)male (r=0.318) females show non-significant correlation. (Bergersen, 1972) and (Flores-Mir et al, 2004) reported that facial growth velocity were related to SMI determined by analysis of hand-wrist radiographs and thus matching with the above results.

Among **soft tissue parameters** Total facial convexity (N'-SLS-Pg') (r=0.427) males shows a significant correlation, the female show a non-significant correlation (r=0.327) this result coincides with that of (Bishara and Jakobsen,1985) where they stated that significant increase in the angle of total facial convexity occurs in the period of adolescent growth spurt.

Merrifield Z-Angle (FH: Pg'LI) shows a significant correlation (r=0.493) males, the female show non-significant correlation (r=-0.019) females. This result may be a reflection to the mandibular correlation and thus the soft tissue contour of lower lip is also correlated to the ossification of adductor sesamoid.

At **stage 0** and **stage 1**, the most significant parameters showing their peak means were Mandibular Plane Angle (SN/Go-Gn); Facial Convexity (N-A-Pg) & Y- axis of Jarabak (N-S-Gn)**.** Little amount of change in their rate of growth is suspected after the first appearance of the adductor Sesamoid; these above findings coincide with those of (Hunter, 1966) where he concluded that in 88.3 % of males a small amount of vertical facial growth occurred after skeletal maturation and that of (Arat el al, 2001).

At **stage 2** Posterior facial height (S-Go) shows the peak mean changes.

At **stage 3** the following parameters show their peak mean: Facial depth (N-Go); Lower facial prognathism (SN-Pg); Mandibular prognathism (SNB); Total facial convexity (N'-SLS-Pg'); Merrifield

Z-Angle (FH: Pg'LI); Total mandibular length (S-Gn); Ramus length (Ar-Go) and Jarabak facial ratio (S-Go/N-Me) * 100.

This reveals that before the onset of Sesamoid ossification and its appearance on the radiograph, maximum growth of these parameters is still to come. Such facts coincide with (Pileski et al, 1973) who stated that if the Ulnar sesamoid bone is not visible on a radiograph, then maximum acceleration of mandibular growth is still to come. (Pileski et al, 1973) stated that peak mandibular velocity was preceded by the appearance of the sesamoid. Although statistically significant, the correlations were weak, if the sesamoid bone is not visible on a radiograph, then maximum acceleration of mandibular growth is still to come. (Lewis et al, 1982) agreed on the fact that pubertal spurts in mandibular dimensions occurred after ulnar sesamoid ossification and before menarche.

Median age of Adductor Sesamoid appearance

Female patients showed their median age of appearance of adductor sesamoid at 10y2m (Tab.6), were the appearance of ossification event, male patients showed their median age of appearance of adductor sesamoid at 12y2m (Tab.6). This result is near to that of (Garn and Rohmann, 1962) were they mentioned the median age of appearance was 10.5 years in girls and 12.6 years in boys. (Krogman, 1951) stated a tendency for females to grow at a slightly faster (earlier) rate; they are, as a rule, about one dental stage in advance of the boys. (Lewis et al, 1982) also concluded that spurts in facial dimensions are common, they occurred 1.5 years earlier in the girls.

Pileski et al, (1973) and Hagg and Tanager, (1980) believed that if sesamoid has just become visible, most children are in the acceleration period of the pubertal spurt. If the ulnar sesamoid bone is not visible on a radiograph, then maximum acceleration of mandibular growth is still to come. (Lewis et al, 1982) stated that spurts in mandibular dimensions were common but not universal; they were common in the boys but occurred 1.5 years earlier in the girls. Pubertal spurts occurred after ulnar sesamoid ossification.

Summary And Conclusion

This study aimed to correlate specific craniofacial parameters with ossification stages of adductor sesamoid for a sample of Lebanese school children between 9 and 15 years of age.

The sample comprised of 23 subjects, 11 males and 12 females all had a clinically acceptable normal occlusion and facial harmony. Mixed longitudinal data is collected from lateral Cephalometric records. The data collected statistically analyzed and interpreted.

In the light of the findings, the following conclusions could be drawn:

- Several parameters included in this study showed different levels of correlation with adductor sesamoid.

- Amongst all parameters included in the study, the mandibular dimensions (Ar-Go) &(S-Gn) showed the highest correlation with ossification of the adductor sesamoid at stage 3, and thus if adductor sesamoid is not ossified, mandibular growth is still to come
- Since multiple craniofacial parameters are correlated with adductor sesamoid ossification stages at different stages, if adductor sesamoid is not on the radiograph, facial spurt is still to come, including vertical and sagittal dimensions.
- Median age of the first appearance of adductor sesamoid on the radiograph is 10.2 y for females, and 12.2 y for males, concluding that before this age, facial growth spurt is still to come.
- Females do precede males in their facial growth spurt, as also stated by other investigators, by almost 2 years.

The clinical significance of these findings implies that some cases would benefit from early interventions to redirect growth vectors in the maxilla and predict mandibular potential. These also may suggest appropriate treatment and planning for the type and duration of retention to be used specially for each case after treatment.

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Mandibular Linear Measurements

ramus length

Ar-G0

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence		Min	Max
					LB	UB		
0	5	38.56	3.397	1.519	34.34	42.78	34	43
1	4	40.63	4.473	2.237	33.51	47.74	34	44
2	6	45.20	3.648	1.489	41.37	49.03	39	49
3	7	47.13	1.374	.519	45.86	48.40	46	49
Total	22	43.47	4.622	.985	41.42	45.52	34	49

Tab . 3 - Descriptive statistics showing correlation of the parameter N-Go with stages of ossification of the adductor sesamoid of females

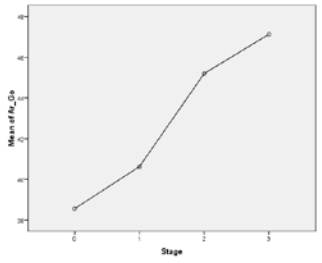

Fig.1 - mean significant at stage 3

ramus length

Ar-G0

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence		Min	Max
					LB	UB		
0	13	44	4.228	1.17	41.28	46	41	52
1	3	41	2.066	1.19	36.07	46	39	43
2	3	50	2.730	1.58	42.78	56	48	53
3	4	53	3.638	1.82	47.01	59	49	57
Total	23	46	5.350	1.12	43.49	48	39	57

Tab . 4- Descriptive statistics showing correlation of the parameter N-Go with stages of ossification of the adductor sesamoid of males

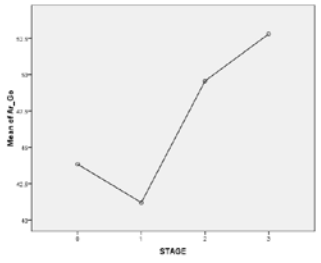

Fig.2 - mean significant at stage 3

Mandibular Linear Measurements

Total Mandibular Length

S- Gn

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	113.20	4.778	2.137	107.27	119.13	108	119
1	4	113.38	2.689	1.344	109.10	117.65	110	116
2	6	117.67	6.014	2.455	111.36	123.98	111	129
3	7	119.57	4.439	1.678	115.47	123.68	115	129
Total	22	116.48	5.254	1.120	114.15	118.81	108	129

Tab . 5 - descriptive statistics showing correlation of the parameter S-Gn with stages of ossification of the adductor sesamoid of females

Total Mandibular Length

S- Gn

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	10	118	4.622	1.46	115.14	122	112	124
1	3	118	3.753	2.17	108.84	127	115	122
2	3	123	3.969	2.29	113.14	133	120	128
3	4	130	6.421	3.21	120.16	141	121	135
Total	20	121	6.584	1.47	118.39	125	112	135

Tab . 6 - descriptive statistics showing correlation of the parameter S-Gn with stages of ossification of the adductor sesamoid of males

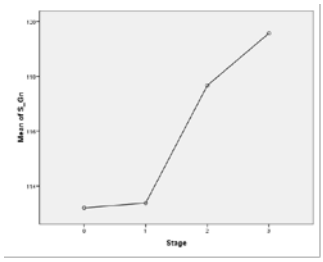

Fig.3 - mean significant at stage 3

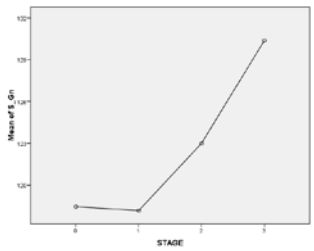

Fig.4 - mean significant at stage 3

Vertical Linear Measurements

Posterior Facial Height

S-Go

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	67.20	5.420	2.424	60.47	73.93	58	72
1	4	69.28	6.883	3.441	58.32	80.23	59	74
2	6	73.13	4.954	2.022	67.93	78.33	65	78
3	7	73.30	2.956	1.117	70.57	76.03	70	77
Total	22	71.14	5.268	1.123	68.80	73.47	58	78

Tab . 7- descriptive statistics showing correlation of the parameter S-Go with stages of ossification of the adductor sesamoid of females

Posterior Facial Height

S-Go

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	74	3.962	1.10	71.77	77	70	81
1	3	72	2.452	1.42	65.41	78	69	74
2	3	83	9.115	5.26	60.46	106	74	93
3	4	84	6.990	3.50	72.95	95	74	88
Total	23	77	6.804	1.42	73.76	80	69	93

Tab . 8- descriptive statistics showing correlation of the parameter S-Go with stages of ossification of the adductor sesamoid of males

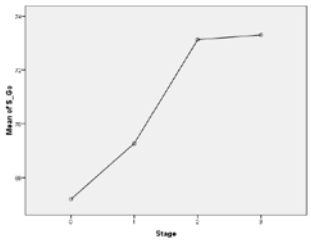

Fig.5 - mean significant at stage 2 to 3

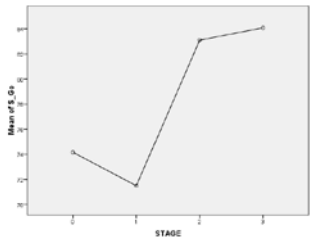

Fig.6- mean significant at stage 3

Vertical Linear Measurements

Posterior facial height / Anterior Facial height Ratio

N-Me / S-Go

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	60.18	4.496	2.011	54.60	65.76	52	64
1	3	61.27	6.783	3.916	44.42	78.12	54	67
2	6	63.38	4.065	1.659	59.12	67.65	58	69
3	7	65.93	3.008	1.137	63.15	68.71	60	68
Total	21	63.17	4.576	.999	61.08	65.25	52	69

Tab . 9 - descriptive statistics showing correlation of the parameter N-Me/S-Go with stages of ossification of the adductor sesamoid of females

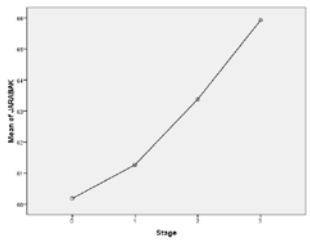

Fig.7- mean significant at stage 3

Posterior facial height / Anterior Facial height Ratio

N-Me / S-Go

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	61	2.227	.62	59.84	63	58	65
1	3	61	4.038	2.33	50.64	71	57	65
2	3	67	6.536	3.77	51.13	84	60	73
3	4	67	4.301	2.15	59.96	74	61	72
Total	23	63	4.301	.90	61.04	65	57	73

Tab . 10 - descriptive statistics showing correlation of the parameter N-Me/S-Go with stages of ossification of the adductor sesamoid of males

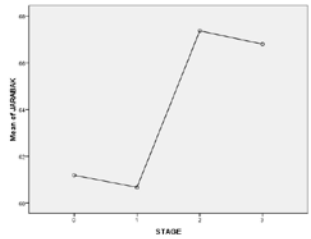

Fig.8 - mean significant at stage 2

Vertical Linear Measurements

Posterior Facial Height

S-Go

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	67.20	5.420	2.424	60.47	73.93	58	72
1	4	69.28	6.883	3.441	58.32	80.23	59	74
2	6	73.13	4.954	2.022	67.93	78.33	65	78
3	7	73.30	2.956	1.117	70.57	76.03	70	77
Total	22	71.14	5.268	1.123	68.80	73.47	58	78

Tab . 7- descriptive statistics showing correlation of the parameter S-Go with stages of ossification of the adductor sesamoid of females

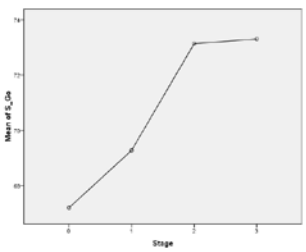

Fig.5 - mean significant at stage 2 to 3

Posterior Facial Height

S-Go

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	74	3.962	1.10	71.77	77	70	81
1	3	72	2.452	1.42	65.41	78	69	74
2	3	83	9.115	5.26	60.46	106	74	93
3	4	84	6.990	3.50	72.95	95	74	88
Total	23	77	6.804	1.42	73.76	80	69	93

Tab . 8- descriptive statistics showing correlation of the parameter S-Go with stages of ossification of the adductor sesamoid of males

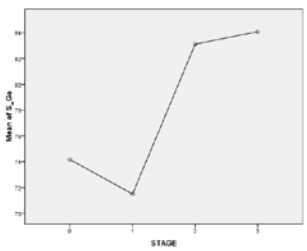

Fig.6- mean significant at stage 3

Vertical Linear Measurements

Posterior facial height / Anterior Facial height Ratio

N-Me / S-Go

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	60.18	4.496	2.011	54.60	65.76	52	64
1	3	61.27	6.783	3.916	44.42	78.12	54	67
2	6	63.38	4.065	1.659	59.12	67.65	58	69
3	7	65.93	3.008	1.137	63.15	68.71	60	68
Total	21	63.17	4.576	.999	61.08	65.25	52	69

Tab . 9 - descriptive statistics showing correlation of the parameter N-Me/S-Go with stages of ossification of the adductor sesamoid of females

Posterior facial height / Anterior Facial height Ratio

N-Me / S-Go

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	61	2.227	.62	59.84	63	58	65
1	3	61	4.038	2.33	50.64	71	57	65
2	3	67	6.536	3.77	51.13	84	60	73
3	4	67	4.301	2.15	59.96	74	61	72
Total	23	63	4.301	.90	61.04	65	57	73

Tab . 10 - descriptive statistics showing correlation of the parameter N-Me/S-Go with stages of ossification of the adductor sesamoid of males

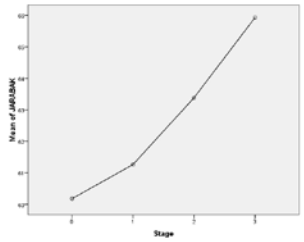

Fig.7- mean significant at stage 3

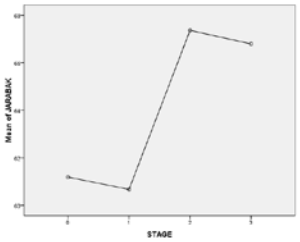

Fig.8 - mean significant at stage 2

Vertical Angular Measurements

Y-axis

N-S-Gn

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	10	70.26	1.442	.456	69.23	71.29	67	72
1	3	69.33	2.103	1.214	64.11	74.56	67	72
2	3	68.53	3.239	1.870	60.49	76.58	65	71
3	4	67.65	2.398	1.199	63.83	71.47	64	70
Total	20	69.34	2.148	.480	68.33	70.35	64	72

Tab . 11 - descriptive statistics showing correlation of the parameter N-S-Gn with stages of ossification of the adductor sesamoid of females

Y-axis

N-S-Gn

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	69	3.234	1.45	65.46	73	66	73
1	4	71	5.504	2.75	61.82	79	65	78
2	6	68	2.715	1.11	64.83	71	65	70
3	7	65	1.002	.38	63.69	66	63	66
Total	22	68	3.723	.79	65.99	69	63	78

Tab . 12 - descriptive statistics showing correlation of the parameter N-S-Gn with stages of ossification of the adductor sesamoid of males

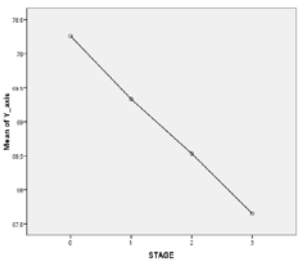

Fig.9 - mean significant at stage 0

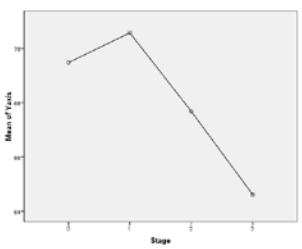

Fig.10- mean significant at stage 1

Vertical Angular Measurements

Mandibular Plane Angle

SN/Go-Gn

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	36.28	5.119	2.289	29.92	42.64	33	45
1	4	35.95	7.278	3.639	24.37	47.53	27	45
2	6	34.63	5.961	2.434	28.38	40.89	29	45
3	7	30.24	2.493	.942	27.94	32.55	27	35
Total	22	33.85	5.436	1.159	31.44	36.26	27	45

Tab . 13- descriptive statistics showing correlation of the parameterSn-GoGn with stages of ossification of the adductor sesamoid of females

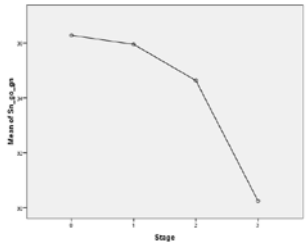

Fig.11- mean significant at stage 0

Mandibular Plane Angle

SN/Go-Gn

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	37	2.346	.65	35.57	38	34	41
1	3	37	4.806	2.77	25.00	49	32	42
2	3	31	6.413	3.70	14.60	46	26	38
3	4	32	4.868	2.43	23.90	39	25	36
Total	23	35	4.432	.92	33.30	37	25	42

Tab . 14- descriptive statistics showing correlation of the parameterSn-GoGn with stages of ossification of the adductor sesamoid of males

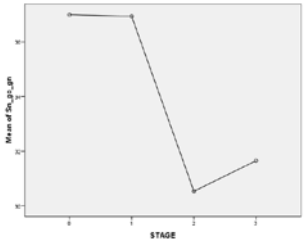

Fig.12 - mean significant at stage 0

Sagittal Angular Measurements

Lower Face Prognathism

SNPg

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	77.78	1.677	.750	75.70	79.86	76	80
1	4	78.03	1.520	.760	75.61	80.44	76	80
2	6	79.10	2.334	.953	76.65	81.55	76	82
3	7	80.57	1.582	.598	79.11	82.03	79	83
Total	22	79.07	2.058	.439	78.16	79.98	76	83

Tab . 15- descriptive statistics showing correlation of the parameter SNPg with stages of ossification of the adductor sesamoid of females

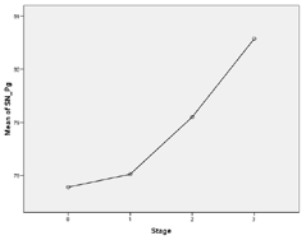

Fig.13 - mean significant at stage 3

Lower Face Prognathism

SNPg

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	76	1.698	.47	75.00	77	74	80
1	3	77	2.237	1.29	71.81	83	75	80
2	3	78	4.115	2.38	67.78	88	74	82
3	4	80	3.886	1.94	73.64	86	74	83
Total	23	77	2.789	.58	75.91	78	74	83

Tab . 16- descriptive statistics showing correlation of the parameter SNPg with stages of ossification of the adductor sesamoid of males

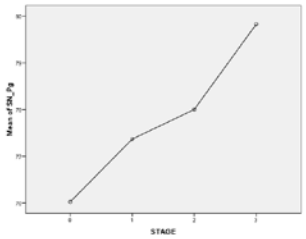

Fig.14 - mean significant at stage 3

Sagittal Angular Measurements

Mandibular Prognathism

SNB

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	77.60	1.407	.629	75.85	79.35	76	79
1	4	76.78	2.351	1.176	73.03	80.52	74	79
2	6	77.95	2.596	1.060	75.23	80.67	75	82
3	7	79.11	2.017	.762	77.25	80.98	77	82
Total	22	78.03	2.161	.461	77.07	78.99	74	82

Tab. 17 - descriptive statistics showing correlation of the parameter SNB with stages of ossification of the adductor sesamoid of females

Mandibular Prognathism

SNB

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	75	1.260	.35	74.51	76	74	78
1	3	76	2.234	1.29	70.75	82	75	79
2	3	77	4.062	2.35	66.98	87	73	81
3	4	78	3.219	1.61	73.10	83	75	83
Total	23	76	2.365	.49	75.13	77	73	83

Tab . 18- descriptive statistics showing correlation of the parameter SNB with stages of ossification of the adductor sesamoid of males

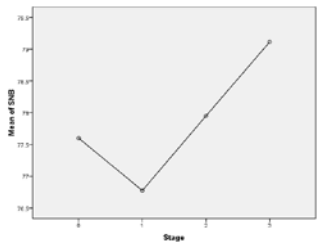

Fig.15 - mean significant at stage 3

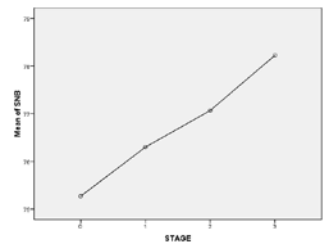

Fig.16 - mean significant at stage 3

Sagittal Angular Measurements

Facial Depth

N-Go

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	105.22	5.620	2.513	98.24	112.20	95	109
1	4	106.23	7.031	3.515	95.04	117.41	97	114
2	6	111.23	5.942	2.426	105.00	117.47	99	114
3	7	111.49	4.496	1.699	107.33	115.64	105	117
Total	22	109.04	5.967	1.272	106.39	111.68	95	117

Tab . 19 - descriptive statistics showing correlation of the parameter N-Go with stages of ossification of the adductor sesamoid of females

Facial Depth

N-Go

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	115	4.901	1.36	112.11	118	106	124
1	3	111	4.623	2.67	99.65	123	106	114
2	3	123	8.962	5.17	100.74	145	116	133
3	4	122	3.735	1.87	115.76	128	116	125
Total	23	117	6.324	1.32	114.01	119	106	133

Tab . 20 - descriptive statistics showing correlation of the parameter N-Go with stages of ossification of the adductor sesamoid of males

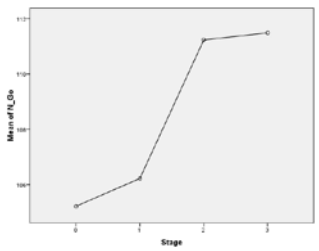

Fig.17 - mean significant at stage 3

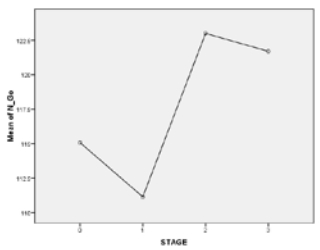

Fig.18 - mean significant at stage 2

Sagittal Angular Measurements

Facial Convexity

N-A- Pg

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	8.34	1.599	.715	6.35	10.33	7	11
1	4	5.10	5.104	2.552	-3.02	13.22	-2	9
2	6	2.67	4.992	2.038	-2.57	7.91	-3	9
3	6	-.37	2.448	.999	-2.94	2.20	-3	3
Total	21	3.61	4.816	1.051	1.42	5.81	-3	11

Tab . 21 - descriptive statistics showing correlation of the parameter N-A-Pg with stages of ossification of the adductor sesamoid of females

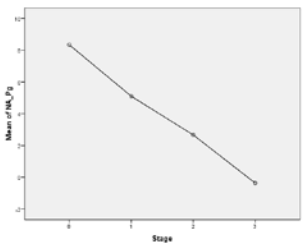

Fig.19 - mean significant at stage 0

Facial Convexity

N-A- Pg

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	6	7.668	2.13	1.64	11	-7	18
1	3	3	5.281	3.05	-9.65	17	-1	9
2	3	0	3.775	2.18	-9.31	9	-3	4
3	4	-1	3.767	1.88	-6.99	5	-3	5
Total	23	4	6.895	1.44	.85	7	-7	18

Tab . 22 - descriptive statistics showing correlation of the parameter N-A-Pg with stages of ossification of the adductor sesamoid of males

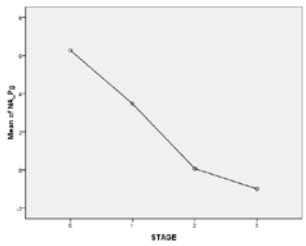

Fig.20 - mean significant at stage 0

Soft Tissue Angular Measurements

Z angle of Merrifield

FH: Pg' LI

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	71.20	4.672	2.089	65.40	77.00	66	76
1	4	72.75	11.579	5.790	54.32	91.18	63	89
2	5	79.50	12.400	5.545	64.10	94.90	63	92
3	7	69.29	28.043	10.599	43.35	95.22	7	87
Total	21	72.83	17.531	3.826	64.85	80.81	7	92

Tab . 23 - descriptive statistics showing correlation of the parameter FH: Pg' LI with stages of ossification of the adductor sesamoid of females

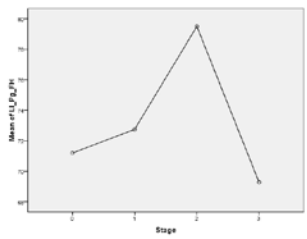

Fig.21 - mean significant at stage 2

Z angle of Merrifield

FH: Pg' LI

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	72	7.734	2.14	67.37	77	61	80
1	3	71	3.500	2.02	62.31	80	69	75
2	3	76	9.094	5.25	53.44	99	68	86
3	4	83	4.768	2.38	75.29	90	77	87
Total	23	74	7.915	1.65	70.89	78	61	87

Tab . 24 - descriptive statistics showing correlation of the parameter FH: Pg' LI with stages of ossification of the adductor sesamoid of males

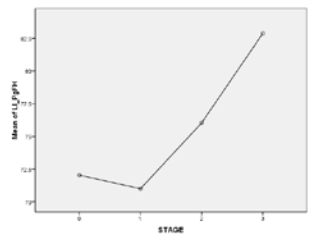

Fig.22 - mean significant at stage 3

Soft Tissue Angular Measurement

Total Facial Convexity

N-SLS-PG

Descriptives Anova Test

Females

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	5	132.00	3.791	1.696	127.29	136.71	128	137
1	4	132.38	1.887	.944	129.37	135.38	131	135
2	5	131.12	6.699	2.996	122.80	139.44	123	139
3	7	129.43	2.207	.834	127.39	131.47	127	134
Total	21	131.00	3.917	.855	129.22	132.79	123	139

Tab . 25 - descriptive statistics showing correlation of the parameter N'-SLS-Pg' with stages of ossification of the adductor sesamoid of females

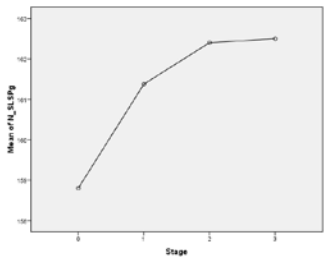

Fig.23 - mean significant at stage 2 to 3

Total Facial Convexity

N-SLS-PG

Descriptives Anova Test

Males

Stage	N	M	SD	SD Er	95% Confidence Interval for M		Min	Max
					LB	UB		
0	13	160	6.366	1.77	156.38	164	148	169
1	3	162	4.163	2.40	151.32	172	157	165
2	3	163	5.774	3.33	148.99	178	160	170
3	4	167	4.442	2.22	160.06	174	161	170
Total	23	162	6.024	1.26	159.42	165	148	170

Tab . 26 - descriptive statistics showing correlation of the parameter N'-SLS-Pg' with stages of ossification of the adductor sesamoid males

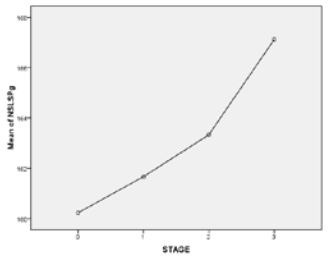

Fig.24 - mean significant at stage 3