Coronoid process morphology in subjects with different vertical jaws dysplasias

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Abstract

Objectives:This retrospective cephalometric study was carried to evaluate and correlate the coronoid process morphology in three groups of subjects exhibiting different vertical jaws discrepancies

Materials and Methods: Each group consisted of 25 subjects, five cephalometric measurements for coronoid procress and 9 linear and angular measurements were used to evaluate coronoid process, craniofacial and mandibular rotation morphology.

Results:There were statistically significant differences in coronoid process morphology between normodivergent subjects and both hypodivergent and hyperdivergent subjects($P<0.05$),and coronoid process measurements were significantly correlated with mandibular rotation measurements

Conclusion: coronoid process morphology was found to be related to mandibular morphology and to the function of the temporal muscle.

Introduction

Craniofacial complex is an important part of the whole human body, and its growth is necessary for orthodontists to know so that they can identify any abnormality in the facial profile and provide optimal treatment modalities that accepts the esthetic and functional demands of each patient.[1,2]

Coronoid process projects upwards and slightly forwards. Its margins and medial surface are attachments for most of temporalis, it's covered laterally by the anterior part of masseter descending to its attachment on the ramus. [3]

It has been shown that there is a direct relationship between the development of the coronoid process and the function of the temporal muscle.[4,5] , and was suggested that the temporal muscle may likely play an etiologic role in reactive coronoid process enlargement.[6]

The coronoid process angle was measured on posteroanterior cephalograms in patients with normal occlusion, class II division 1 and class III malocclusions and the result concluded that the coronoid process angle was greater in patients with class III than those with normal occlusion and with class II division 1 subjects and this variation in the coronid process angle was related to prognathism, may represent adaptation of temporal muscle function to a variety of alternations in mandibular morphology[7], another study carried to verify the relationship between the angle of the coronoid process and

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electromyographic activity of the anterior part of the temporal muscle found that the angle of the coronoid process may be influenced by the electromygraphic activity of the temporal muscle in class III malocclusion patients when compared with class I.[8]

Virgilio etal [9] reported that mandibular shape was different in girls aged 11-15 years with hyperdivergent than girls with normodivergent mandibles mostly at gonion, the coronoid process ,and posterior border of the ramus.

Very few studies are reported in the literature regarding the relationship of coronoid process and craniofacial morphology, in one of them Coronoid process morphology was related to mandibular morphology and position and to the position of maxilla and the relationship of dentition[10]

This study was conducted to assess the morphology of the coronoid process in patients with vertical facial discrepancies and to correlate coronoid process morphology with vertical facial form and mandibular rotation in a sample of adult Iraqi patient

Materials and Methods

Cephalometric radiographes of pretreated Iraqi individuals aged 18-25 years, were taken from the files of the patients who attended the orthodontic department in college of Dentistry, University of Baghdad. Subjects with gross facial asymmetry, facial abnormality, or under orthodontic treatment was excluded. The type of molar relationship and sagittal jaw relationship were not considered and the sample division was based on SN-mandibular plane angle(SN-MP°) ([11]) that was used to assess the vertical facial problem, its normal range is from(28-36.5°)[12,13],the patients were included into 3 groups as follows:

1-hyperdivergent subjects (Group 1):with increased value of SN-MP angle>36.5°[12,13]

2-hypodivergent subjects (Group2):with decreased value of SN-MP angle<28°[12,13]

3-normodivergent subjects (Group3):with normal value of SN-MP angle 28<SN-MP>36.5° ([12,13])

So that the final sample size of the three groups was comprised of 75 subjects, each group consisted of 25 subjects (13males, 12females),5 cephalometric measurements were used to evaluate the coronoid process morphology and 9 linear and angular measurements to evaluate the mandibular rotation and facial morphology.

Digitization: every lateral cephalomertic radiodgraph was analyzed on a computer using Autocad -2007 program, after points were located on each radiograph lines joined between these points to form planes and angles (fig 1 and fig 2), the linear and angular measurements were divided by scale to overcome magnification factor.

A- Cephalometric landmarks

1-Point S (Sella): midpoint of the shadow of the Sella turcica.[14]

2-Point N (Nasion):the most anterior point on the frontonasal suture in the median plane.[15]

3-Point Or (Orbitale):the lower most point of the orbit in the radiograph.[16]

4-Point Po(Porion):the most superiorly poisoned point of the external auditory meatus located by using the ear rods of cephalostat(mechanical point).[17]

5-Point ANS (Anterior Nasal Spine): it is the tip of the bony anterior nasal spine in the median plane .[14]

6-Point Me(Menton): the lowest point of the contour connecting ramus and body of the mandible .[18]

7-Point Ar(Articulare):the point at the junction of posterior border of ramus and the inferior border of posterior cranial base(occipital bone) .[12]

8-Point A: the deepest point of mandibular notch. [10,19]

19-Point B:the posterior point of the coronoid process. ([10,19]

10-Point C: the midpoint of A andB .[10,19]

11-Point Cor:the furthest point on the coroniod process from the coronoid base. [10,19]

12-Piont F: the intersection of the Frankfort plane and Cor-C line. [10,19]

13-Point G:the midpoint of A' and B'. [10,19]

14-Point E :the mid point of Cor-Cline perpendicular to A'-B' line.[10,19]

B-Coronoid process measurements fig1

1-coronoid length: the length of the line C-COR.

2-coronoid width: the length of the line A'-B'

3-coronoid angle:the angle formed by the intersection of Frankfort horizontal plane and Cor-C line.

4-coronoid notch depth:was defined as the perpendicular distance between lines P and P'.

5-coronoid curvature: the angle formed at point G.

C-Measurements of mandibular rotation fig2

1-Saddle angle(NSAr)

2-Articular angle (SArGo)

3-Gonial angle(ArGoMe)

4-SN-Mandibular plan angle(SN-MP).

5-Anterior facial height (AFH): it measured vertically from N point to Me point.

6-Posterior facial height (PFH):it measured from S point to Go point.

7-Lower facial height (LFH):it measured vertically from ANS point to Me point.

8-Mandibular body length: it measured from Go-Me [15].

9-Ramus length: it is measured form Ar to Go[14]

Statistical analysis

All data were subjected to computerized statistical analysis using Spss IBM v.19 package. Descriptive analysis ran on the whole sample. Statistical difference of coronoid process morphology between the studied groups was tested by one way ANOVA(table3) ,Levene test(table 4) was carried out to check for the equality of variance between different groups followed byTamhane post-hoc test to delineate the details of statistical differences between groups. Correlation of coronoid process measurements with craniofacial cephalometric measurements in all skeletal groups was tested using Pearson's correlation coefficients.

Results

Table 1 showed that of 266 cephalometric x-rays coronoid process outline was clear in 112, clarity was determined subjectively; compared with condyle that was clear in only 41. Table 2 demonstrated descriptive statistics for all measurements in all skeletal groups, in table 6 the correlation between coronoid process measurements and other craniofacial measurements were calculated and a positive correlation was found between coronoid curvature and posterior and anterior facial heights, ramus and mandibular body length, and a significant relation between coronoid length and both ramus and mandibular body length in hypodivergent group, the hyperdivergent group showed a negative correlation between all coronoid process measurements and both anterior and posterior facials heights, gonial angle, and both ramus and mandibular body length. in table 3 ANOVA test showed that highly significant differences were found between groups, besides that Tamhane test (table 5) demonstrated that significant differences between both normodivergent and hyperdivergent and hypodivergent and hyperdivergent groups for all coronoid process measurements

Discussion

The literature contains numerous papers on the outcome of coronoid process dimensions and craniofacial morphology and the association of muscles activity and facial form and Despite several articles analyzing electromyographic activity of the temporal muscle attached to the coronoid process little is known concerning the relation between coronoid process morphology and different facial types so that this paper brings some light to an issue that is not yet fully understood nor studied.

The coronoid process outline was more clearly visible than the condyle in most cephalometric radiographs so that the relation between the coronoid process and the mandible was used in this study instead of that between the condyle and mandible.

Coronoid angle

A negative correlation was found between the coroniod process angle and the gonial angle, anterior and posterior facial height, ramus and mandibular body length in hyperdivergent group , in those patients there is certain backward rotation of facial complex and particularly the mandible, as the posterior edge of the ramus (Ar) moved anteriorly the coronoid process became more vertical and the coronoid angle decreased in size and was accompanied by an increase in coronoid process curvature [20].

Lowe [21]; and Niide et al[22] found a significant negative correlations between temporal muscle activity during clenching and gonial angle, in addition to that Lowe[21] reported that the anterior portion of the temporalis is especially active during biting and that the posterior portion of the temporalis is involved in maintaining mandibular positions, and When the mandible was positioned anteriorly, the posterior part of the temporal muscle pulled the mandible posteriorly, providing mandibular stability, as functioning of temporal muscle attached to the coronoid process influences craniofacial morphology the tension of this muscle resulted in the coronoid process becoming more vertical, with an increase in coronoid process curvature and decrease in coronoid process angle, and this is in correspondence with the result of this study and those published by Petrofsky and Lind[24]

Sassoni [20] gave a simple explanation that a reduced moment arm of the temporalis might reflect a reduced width of the ramus, which is, like an obtuse gonial angle, a morphological characteristic of the long-face mandible, which support the negative correlation of the coronoid angle in hyperdivergent subjects.

coroniod notch depth

The results showed that coronoid notch depth became deeper with an increase in gonial angle, facial height, and ramus and mandibular body length in hyperdivergent group who have a high gonial angle and low masticatory activity. EMG studies have stated that gonial angle is negatively correlated with activity in the anterior part of the temporal muscle during maximum clenching [(21),(23)] . So it is obvious that morphological changes including a deeper coronoid notch depth is a result of weak temporal muscle activity.

The anterior part of the temporal muscle is attached to the anterior part of the coronoid process which is active during maximum clenching ([21,23,24]). Therefore, it is reasonable to hypothesize that in subjects with decreased muscular activity during maximum clenching, bone formation on the anterior marginal surface of the coronoid process decreases, resulting in an decrease in anterior coronoid notch depth which come in correspondence with results of this study.

coronoid width

The result showed that the coronoid width decreased negatively in proportion to the increase in mandibular and ramus length, gonial angle and anterior and posterior facial heights in hyperdivergent group . There was Significant decrease of overbite reported in hyperdivergent subjects and this decrease is expected due to increase in the divergence of the jaws anteriorly ([25]), beside that the EMG studies of Petrofsky and Lind[(24)] and Enlow and Harris [(26)], have revealed that a negative relationship between overbite and activity in the anterior part of the temporal muscle and the masseter muscle during maximum clenching , so it seems that both overbite and coronoid process width decrease in relation to the decrease in activity of the anterior part of the temporal muscle, this support the data of correlational studies describing the relationships between jaw muscle orientation and human craniofacial morphology by Bakke and Michler[(27)] who stated a negative association between temporalis and masseter muscles activity and anterior face height, mandibular inclination, vertical jaw relation and gonial angle, and concluded that long-face morphology were associated with weak elevator muscle activity.

Coronoid length

Coronoid length significantly decreased with a increase gonial angle, facial heights and in ramus and mandibular length in hyperdivergent subjects and this probably occurs due to the functioning of the anterior and posterior parts of the temporal muscle, that may reduces bone formation at the anterior, superior, and posterior parts of the coronoid process, because those subjects possess a weak masticutary activity and this possibly explained the authors' recent reports that documented Craniofacial morphology was affected masticatory activity.[(28)]

According to theory of Wolff[(29)], who affirmed that bone morphology and architecture depend on the tension applied to the bone by the muscle inserted in it may explain the positive correlation of coronoid length with ramus and mandibular length in hypodivergent group due to heavier activity of the temporal muscle in those subjects , Because the tension exerted by this muscle can distinctly influence the growth and morphology of the coronoid process [.(30)]

coronoid curvature

Coronoid curvature increased in proportion to the decrease in mandibular plane angle in hypodivergent group . Lowe [(21)] ; and Niide et al. ,[(22)] in Previous EMG studies have demonstrated negative correlations between temporal and masseter muscle activity and the mandibular plane angle, it has been found that the anterior part of the temporal muscle attached to the anterior part of the coronoid process to be active during maximum clenching [(23)] which gives the possibility that in subjects with small mandibular plane angles, bone formation occurs on the anterior part of the coronoid process at the attachment of the temporal muscle. Since the midpoint of the coronoid process width (point G) in the subjects with small mandibular plane angles was positioned more anteriorly, this may have been responsible for the increase in their coronoid curvature, while in hyperdivergent group which have increased in mandibular plane angle, the opposite explanation is true that a decreased in coronoid curvature accompanied by an increase in gonial angle , facial height and ramus and mandibular length this result agreed with the clarification of Yamaoka etal.[(30)] in which the tension exerted by temporal muscle can distinctly influence the growth and morphology of the coronoid process in different skeletal classes

Conclusion

Coronoid process morphology was negatively correlated with mandibular and ramus length in hyperdivergent subjects while coronoid length was positively correlated with mandibular length and gonial angle in hypodivergent subjects

Therefore coronoid process morphology was correlated to the skeletal facial types ,and it obvious that coronoid process morphology meight be related to temporal muscle functioning and its associated craniofacial morphological measurements.

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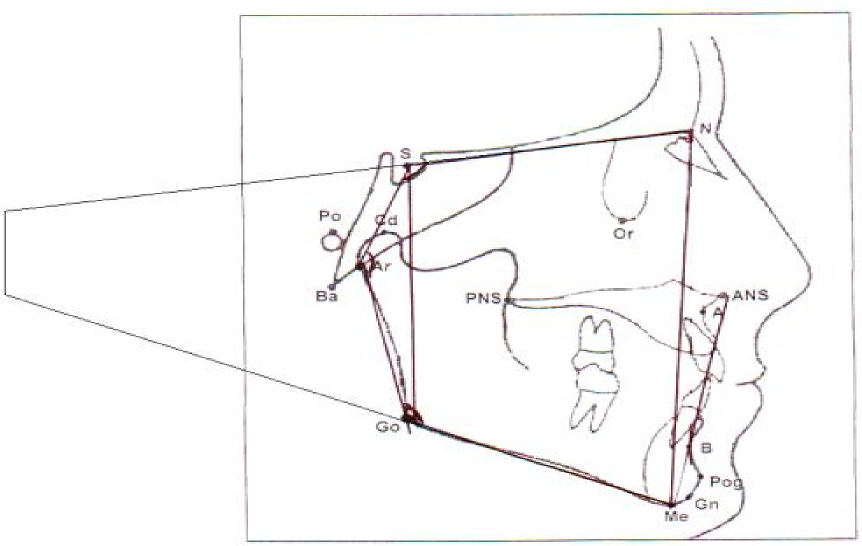

Figure 1 : Cephalometeric measurments: NSAr angle, ArGoMe angle, SArGo angle, SN-MP angle, N-Me, S-Go, ANS-Me, Go-Me, Ar-Go.

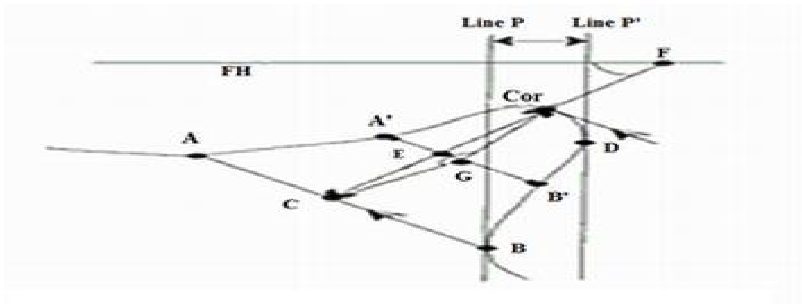

Figure 2
Coronoid process measurements-point A: the deepest point of mandibular notch; point B: the posterior point of the coronoid process; point C: the midpoint of A and B; point Cor: the furthest point on the coronoid process from the coronoid base; line A'B': the length of the line parallel to AB through the midpoint of the coronoid length (point E); point F: the intersection of the Frankfort plane and Cor-C line; point G: the midpoint of A' and B'.

Table 1: Comparison between coronoid and condyle process clarity

Coronoid				
Total	Clear	Unclear		Condyle
202	112	90	Unclear	
64	41	23	Clear	
266	153	113	Total	

Table 2 Descriptive Statistics of Cephalometric measurements in all Skeletal groups

hyperdivergent				**Normodivergnt**				**hypodivergent**				
Males		**Females**		**Males**		**Females**		**Males**		**Females**		**variable**
SD	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	
1.98391	41.4615	4.62126	43.5833	2.23033	33.1538	1.64225	32.8333	2.23033	22.8462	1.97523	25.0833	SNMP
3.46040	135.1538	5.97469	131.3333	3.73136	134.3846	5.38446	133.9167	7.22442	134.7692	3.43335	132.1667	NSAr
6.27878	138.6154	7.01945	144.0000	4.01759	136.1538	6.01702	137.7500	5.80892	130.9231	4.69929	139.5833	SArGo
3.02341	132.8462	5.65418	126.8333	3.14806	123.9231	2.87492	122.5833	1.73944	115.7692	3.39675	116.5833	ArGoMe
4.55811	126.7719	2.57632	115.6090	1.73568	123.7898	2.47938	112.7663	27.28448	107.3974	3.31780	101.6990	NMe
3.54561	80.0121	2.94326	66.1102	3.66360	75.7005	3.06535	72.0054	4.62314	83.5079	4.52913	74.9848	SGo
3.19779	76.4084	2.70934	67.1988	4.34965	66.9537	2.90371	63.2712	4.91373	67.4019	4.06043	54.1853	ANSMe
4.99073	58.1897	3.42045	51.8609	2.24814	54.5443	3.17519	51.6578	3.95348	62.1036	5.18672	55.3800	ArGo
3.51165	71.0016	5.56638	66.9353	2.59852	75.0555	2.35446	72.2848	3.28742	75.2058	2.70433	70.0404	GoMe
2.76887	46.0000	4.31699	54.5000	4.87537	55.4615	4.01040	57.9167	6.30323	50.3077	5.71813	57.8333	coangle
1.27421	15.6138	1.62404	13.4918	2.00041	16.9049	1.81289	15.3495	2.32545	18.6862	1.62126	16.5279	colength
.68231	9.4663	1.64458	8.5683	1.10264	10.4286	1.23617	9.4265	1.98233	11.7169	1.58723	11.9132	cowidth
8.22208	158.5385	6.25409	149.7500	2.72453	171.6154	3.56328	170.1667	6.99817	157.8462	1.94625	158.8333	codepth
.60922	3.6357	1.44276	4.3768	.92929	4.0260	.84290	3.3078	1.39513	5.6637	1.41922	2.8883	cocurvtr

M: mean; SD: standard deviation

Table 3: Coronoid process measurement in three skeletal groups (ANOVA)

Sig.	F	Mean Square	df	Sum of Squares		
.000	18.439	7210.093	2	14420.187	**Between Groups**	**co-angle**
		391.022	72	28153.600	**Within Groups**	
			74	42573.787	**Total**	
.000	19.751	187.989	2	375.978	**Between Groups**	**co-length**
		9.518	72	685.287	**Within Groups**	
			74	1061.265	**Total**	
.000	13.341	91.363	2	182.726	**Between Groups**	**co-width**
		6.848	72	493.090	**Within Groups**	
			74	675.816	**Total**	
.000	51.196	22278.013	2	44556.027	**Between Groups**	**co-depth**
		435.154	72	31331.120	**Within Groups**	
			74	75887.147	**Total**	
.000	25.142	224.882	2	449.764	**Between Groups**	**co-curvtr**
		8.945	72	644.006	**Within Groups**	
			74	1093.769	**Total**	

Table 4: Levene Test of Homogeneity of Variances

Sig.	df2	df1	Levene Statistic	
.000	72	2	54.378	**co-angle**
.000	72	2	13.035	**co-length**
.000	72	2	25.258	**co-width**
.000	72	2	56.274	**co-depth**
.000	72	2	34.525	**co-curvtr**

Table 5: Tamhane test for coronoid process measurements between three skeletal groups

95% Confidence Interval		Sig.	Std. Error	Mean Difference (I-J)	(J) factor	(I) factor	Dependent Variable
Upper Bound	Lower Bound						
6.90	-1.46	.301	1.678	2.720	1	0	co-angle
-10.80	-45.12	.001	6.704	-27.960*	2		
1.46	-6.90	.301	1.678	-2.720	0	1	
-13.36	-48.00	.000	6.789	-30.680*	2		
45.12	10.80	.001	6.704	27.960*	0	2	
48.00	13.36	.000	6.789	30.680*	1		
.014003	-2.997843	.053	.6084719	-1.4919200	1	0	co-length
-2.884640	-7.748240	.000	.9681713	-5.3164400*	2		
2.997843	-.014003	.053	.6084719	1.4919200	0	1	
-1.349568	-6.299472	.001	.9882801	-3.8245200*	2		
7.748240	2.884640	.000	.9681713	5.3164400*	0	2	
6.299472	1.349568	.001	.9882801	3.8245200*	1		
-.786705	-2.940335	.000	.4335391	-1.8635200*	1	0	co-width
-1.706986	-5.938934	.000	.8346476	-3.8229600*	2		
2.940335	.786705	.000	.4335391	1.8635200*	0	1	
.231307	-4.150187	.091	.8712296	-1.9594400	2		
5.938934	1.706986	.000	.8346476	3.8229600*	0	2	
4.150187	-.231307	.091	.8712296	1.9594400	1		
15.61	9.59	.000	1.209	12.600*	1	0	co-depth
75.17	38.51	.000	7.153	56.840*	2		
-9.59	-15.61	.000	1.209	-12.600*	0	1	
62.66	25.82	.000	7.198	44.240*	2		
-38.51	-75.17	.000	7.153	-56.840*	0	2	
-25.82	-62.66	.000	7.198	-44.240*	1		
.448344	-1.748744	.378	.4377532	-.6502000	1	0	co-curvtr
-3.045063	-7.933497	.000	.9577975	-5.4892800*	2		
1.748744	-.448344	.378	.4377532	.6502000	0	1	
-2.273846	-7.404314	.000	1.0186666	-4.8390800*	2		
7.933497	3.045063	.000	.9577975	5.4892800*	0	2	
7.404314	2.273846	.000	1.0186666	4.8390800*	1		

*. The mean difference is significant at the 0.05 level.
*0 = normodivergent group
*1 = hypodivergent group
*2 = hyperdivergent group

Table 6: Correlation between Coronoid process measurements and other variables in three Skeletal groups

Go-Me	Ar-Go	ANS-Me	S-Go	N-Me	ArGoMe	SArGo	NSAr	SN-MP		
-.362	-.245	-.575	-.151	-.016	-.067	.588	-.194	.330	**co-angle**	**Short**
.075	.237	.003	.472	.939	.752	.002	.353	.107		
.563	.581	.360	.260	.363	-.262	-.247	-.007	-.105	**co-length**	
.003	.002	.077	.210	.074	.207	.235	.974	.619		
.235	.161	.047	-.007	.263	.015	.020	-.235	-.121	**co-width**	
.258	.442	.824	.973	.204	.942	.923	.259	.565		
-.224	.092	.000	-.150	.225	.140	.089	-.350	-.317	**co-depth**	
.281	.662	.998	.475	.279	.504	.671	.086	.123		
.589	.628	.525	.590	.232	.001	-.524	.031	-.503	**co-curvtr**	
.002	.001	.007	.002	.264	.998	.007	.882	.010		
-.533	-.167	-.117	.216	-.285	.276	.245	-.025	-.325	**co-angle**	**Normal**
.006	.424	.577	.299	.168	.181	.237	.904	.113		
.350	.190	.282	-.087	.365	.067	-.043	.115	.330	**co-length**	
.087	.363	.172	.679	.073	.751	.839	.583	.107		
.452	.091	-.141	-.024	.384	-.199	.202	.163	.241	**co-width**	
.023	.667	.503	.909	.058	.340	.333	.438	.245		
.046	.062	.157	.171	.223	.036	-.158	-.104	-.291	**co-depth**	
.826	.767	.455	.413	.285	.864	.452	.621	.157		
.299	.090	-.045	-.151	.369	-.285	.121	.278	-.264	**co-curvt**	
.146	.667	.831	.473	.069	.167	.563	.179	.202		
-.998	-.997	-.819	-.843	-.806	-.687	.417	.320	-.338	**co-angle**	**Long**
.000	.000	.000	.000	.000	.000	.038	.119	.098		
-.981	-.977	-.808	-.822	-.777	-.680	.383	.332	-.287	**co-length**	
.000	.000	.000	.000	.000	.000	.059	.105	.164		
-.998	-.999	-.811	-.841	-.810	-.677	.417	.324	-.361	**co-width**	
.000	.000	.000	.000	.000	.000	.038	.114	.076		
.980	.985	.781	.793	.821	.645	-.389	-.323	.306	**co-depth**	
.000	.000	.000	.000	.000	.001	.055	.115	.137		
-.995	-.996	-.804	-.829	-.815	-.672	.412	.325	-.337	**co-curvtr**	
.000	.000	.000	.000	.000	.000	.041	.114	.100		
-.963	-.971	-.600	.027	.002	.195	.479	-.200	.567	**co-angle**	**Total**
.000	.000	.000	.819	.985	.093	.000	.085	.000		
-.814	-.828	-.403	.107	.162	.115	.300	-.128	.460	**co-length**	
.000	.000	.000	.361	.166	.327	.009	.273	.000		
-.819	-.831	-.443	-.026	-.058	.001	.306	-.221	.319	**co-width**	
.000	.000	.000	.824	.620	.993	.008	.057	.005		
.955	.952	.452	-.021	-.172	-.281	-.394	.132	-.600	**co-depth**	
.000	.000	.000	.860	.140	.015	.000	.260	.000		
-.897	-.915	-.425	.093	.198	.219	.289	-.143	.520	**co-curvtr**	
.000	.000	.000	.429	.089	.059	.012	.221	.000		