IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 1 Ver. V (Jan. 2016), PP 33-38
www.iosrjournals.org

The Relation among Different Methods for Assessing the Vertical Jaws Relation

[1]Mohammed Nahidh, B.D.S., M.Sc., [2]Hiba M. Al-Chalabi, B.D.S., M.Sc., [3]Ammar Salim, B.D.S., M.Sc., [4]Shahba'a A. Mohammed, B.D.S., M.Sc., [5]Haider M. A. Ahmed, B.D.S., M.Sc., [6]Abeer B. Mahmoud, B.D.S., M.Sc., [7]Samhar A. Al-Shaham, B.D.S., M.Sc.

[1]*Assistant Professor. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[2]*Assistant Lecturer. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[3]*Lecturer. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[4]*Assistant Professor. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[5]*Assistant Lecturer. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[6]*Assistant Professor. Department of Orthodontics. College of Dentistry, University of Baghdad.*
[7]*Lecturer. Department of Orthodontics. College of Dentistry, University of Baghdad.*

Abstract:
Background: *Assessment of vertical jaws relation is so important in diagnosing orthodontic cases like the sagittal and horizontal relations. This study aimed to find the relation among different methods used to evaluate the vertical jaws relation.*
Materials and methods: *Fifty students (25 males and 25 females) from the College of Dentistry, University of Baghdad were selected having normal sagittal and horizontal jaws relations and class I dental relation. Digital true lateral cephalometric radiographs were taken for each individual and analyzed using AutoCAD program 2007. Seventeen angular and linear parameters determined the vertical jaws relation were measured for both genders. The relation among these parameters was obtained using Pearson's correlation coefficient test.*
Results: *The mean values of the measured parameters were near to the norms in the original studies. The linear measurements were larger significantly in males than females. SN-PP, SN-MP, SN-OP and the sum of the posterior angles were significantly higher in females than males. There is clear relation among the measured parameters.*
Conclusions: *Jarabak ratio and sum of posterior angles correlated significantly with each other and with most other parameters. SN plane inclination may give false indication about the vertical relation due to different positions of point Nasion. Like the sagittal jaws relation, only one measurement is not enough for diagnosis the vertical jaws relation.*
Key words: *Vertical jaws relation, orthodontics, diagnosis.*

I. Introduction

In orthodontic diagnosis, the jaws relation must be assessed in three planes of space namely; the sagittal, vertical and horizontal planes. Many methods were used to evaluate these relations and most authors introduced different methods to assess the sagittal relation. On the other hand, few methods, in comparison with sagittal relation, were introduced to evaluate the vertical relation.

A variety of methods have been developed to judge the vertical relation since 1946 when Tweed (1) introduced the Frankfort-mandibular plane angle. In the next year, Björk (2) related the maxillary and mandibular planes to the S-N plane and to each other. Furthermore, Riedel (3), in 1948, measured the inclination of the mandibular plane to cranium and Downs (4) measured the Y-axis and mandibular plane angles.

Wylie and Johnson (5) pointed out the importance of the vertical relation and measured the total facial height, upper facial height, condylar angle, ramal height … etc.

Steiner (6) measured the inclination of the occlusal plane to the cranium, while Ricketts (7) determined the vertical relation using the mandibular arc, facial axis angle, mandibular plane angle and lower facial height. McNamara (8) measured the last three parameters from Ricketts.

In his famous analysis, Jarabak (9) measured the facial heights and determined the Jarabak ratio in addition to relating Y-axis and the mandibular plane to S-N plane.

The aim of this study was to detect the relation among various measurements determining the vertical jaws relationship.

II. Materials And Methods

Sample

The sample of this study comprised of fifty digital true lateral cephalometric radiographs (25 for either sex) for under and postgraduate students in the College of Dentistry, University of Baghdad. The age ranged between 18-33 years. Those students had normal sagittal and horizontal jaw relations, normal occlusion, full permanent dentition regardless the third molars, with no history of orthodontic/ oro-facial surgery, facial trauma or deformity.

Method

The students were examined clinically to fulfill the inclusive criteria and radiographs were taken in the Orthodontic department in the College of Dentistry, University of Baghdad using Planmeca ProMax Dimax3. Each lateral cephalometric radiograph was analyzed by AutoCAD program 2007 to calculate the linear and angular measurements. The angles were measured directly, while the linear measurements were corrected using the scale in the nasal rod.

Cephalometric Landmarks, Planes, and Measurements

The following cephalometric landmarks, planes, and measurements were determined according to Rakosi [10], Jacobson [11] and Athanasiou [12].

Landmarks

1. Point S (Sella): The midpoint of the hypophysial fossa.
2. Point N (Nasion): The most anterior point on the nasofrontal suture in the median plane.
3. Point ANS (Anterior Nasal Spine): It is the tip of the bony anterior nasal spine in the median plane.
4. Point PNS (Posterior Nasal Spine): This is a constructed radiological point, the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose. It marks the dorsal limit of the maxilla.
5. Point Me (Menton): The lowest point on the symphyseal shadow of the mandible seen on a lateral cephalogram.
6. Point Go (Gonion): A point on the curvature of the angle of the mandible located by bisecting the angle formed by the lines tangent to the posterior ramus and inferior border of the mandible.
7. Point Po (Porion): The most superiorly positioned point of the external auditory meatus located by using the ear rods of the cephalostat (mechanical Porion).
8. Point Or (Orbitale): The lowest point on the inferior rim of the orbit.
9. Frontal point of occlusal plane: The midpoint of a line connecting the incisal tip of the mandibular central incisor to the incisal tip of the maxillary central incisor.
10. Dorsal point of occlusal plane: The midpoint of a line connecting the anterior cusp tip of the mandibular first molar to the anterior cusp tip of the maxillary first molar.
11. Point Gn (Gnathion): A point located by taking the midpoint between Pogonion and Menton points of the bony chin.
12. Point Ba (Basion): The lowest point on the anterior margin of the foramen magnum in the median plane.
13. Posterosuperior aspect of the pterygomaxillary fissure (PTM).
14. Point Ar (Articulare): The point of intersection of the external dorsal contour of the mandibular condyle and the temporal bone.

Planes

1. Sella-Nasion (SN) plane: It is the anteroposterior extent of anterior cranial base.
2. N-A line: Line between points N and A.
3. N-B line: Line between points N and B.
4. Palatal plane (PP): A line joining between anterior nasal spine and posterior nasal spine.
5. Mandibular plane (MP): Formed by a line joining Gonion and Menton.
6. Frankfort plane: Formed by points machine Porion and Orbitale.
7. Occlusal plane (OP): A line bisecting the occlusion of the first molars and the central incisors. The plane extends from the frontal point of occlusal plane to the dorsal point of occlusal plane.
8. A line from posterosuperior aspect of the pterygomaxillary fissure (PTM) to Gnathion.
9. S-Ar line: A line from Sella turcica to Articulare.
10. Ar-Go line: A line from Articulare to Gonion.
11. Y axis: A line from Sella turcica to Gnathion.
12. Nasion- Basion (N-Ba) plane: A line from Nasion to Basion.

Measurements
1. ANB angle: The angle between N-A and N-B lines.
2. Palatal plane – SN plane angle (PP-SN): The angle between the S-N plane and the palatal plane.
3. Mandibular plane – SN plane angle (MP-SN): The angle between the S-N plane and the mandibular plane.
4. Basal plane angle (PP-MP): This defines the angle of inclination of the mandible to the maxillary base.
5. Frankfort - mandibular plane angle (FMA): That angle formed between the mandibular and Frankfort planes.
6. Occlusal plane – SN plane angle (OP-SN): The angle between the S-N plane and the occlusal plane.
7. Facial axis angle (FAA): The angle formed by line constructed from the posterosuperior aspect of the pterygomaxillary fissure (PTM) to Gnathion relative to the cranial base, which is represented by a line joining Basion to Nasion.
8. Y-axis angle: It is the angle between Frankfort plane and Y axis plane anteriorly.
9. N-S-Ar: It is the angle between SN and S-Ar planes.
10. S-Ar-Go: It is the angle between S-Ar and Ar-Go planes.
11. Ar-Go-Me: It is the angle between points Ar-Go and Go-Me planes.
12. Sum of posterior angles: The sum of the above three angle.
13. UAFH (upper anterior facial height): The distance between points N and ANS.
14. LAFH (lower anterior facial height): The distance between points ANS and Me.
15. AFH (total anterior facial height): The distance between points N and Me.
16. UPFH: (upper posterior facial height): The distance between points S and Ar.
17. LPFH: (lower posterior facial height): The distance between points Ar and Go
18. PFH (total posterior facial height): The distance between points S and Go.
19. Jarabak ratio: PFH/APH x 100
20. Lower facial height ratio: LAFH/ AFH x 100

Statistical Analyses

The data subjected to computerized statistical analyses using SPSS version 21 computer program. The statistical analyses included:
1. Descriptive Statistics; means, standard deviation (SD) and statistical tables.
2. Inferential Statistics; Independent samples t-test for the comparison between both genders and Pearson's correlation coefficient test to detect the relation among the measurements.

In the statistical evaluation, the following levels of significance are used:

Non-significant (NS)	$P > 0.05$
Significant (S)	$0.05 \geq P > 0.01$
Highly significant (HS)	$P \leq 0.01$

III. Results

Table 1 showed the descriptive statistics and genders difference of all variables measured. Generally, males had higher mean values than females in all of the angular measurements except SN-PP, SN-MP, SN-OP and the sum of posterior angles where the females significantly had higher mean values. All of the linear measurements were significantly higher in males than females.

Tables 2, 3 and 4 demonstrated the relation among parameters in males, females and the total sample respectively. Generally, many significant correlations were noted and the most important one between the Jarabak ratio with the sum of posterior angles.

IV. Discussion

Generally, the vertical jaw relation is affected by the rotation of the maxillary and mandibular bases. Rakosi [10] stated that "both jaws may rotate in the same direction (horizontally or vertically) or in opposite directions (maxilla vertically, mandible horizontally or vice versa): rotation in opposite directions meaning horizontal rotation of the maxilla with vertical rotation of the mandible will cause the bite to open. On the other hand, vertical rotation of the maxilla with horizontal rotation of the mandible will cause the bite to close".

The following combinations are probable with rotation in the similar direction: horizontal rotation of maxilla and mandible leading to the mandible shows greater rotation than the maxilla resulting in closure of the bite and the maxilla shows greater rotation than the mandible resulting in bite opening. Vertical rotation of maxilla and mandible leading to the mandible shows greater rotation than the maxilla resulting in bite opening and maxilla shows greater rotation than the mandible, resulting in closure of the bite [10].

Like the maxillary and mandibular planes, the inclination of the anterior cranial base (S-N plane) played an important role in assessing the vertical relation [13]. The anteroposterior and vertical position of point N affected the inclination of this plane especially in adults as the growth of the Sella turcica stopped and become stable.

Table 1: Descriptive statistics and gender difference for the variables measuring the vertical jaws relation

Variables	Descriptive statistics						Gender difference (d.f.=48)		
	Total (N=50)		Males (N=25)		Females (N=25)				
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean difference	t-test	p-value
ANB°	3.020	0.795	3.120	0.881	2.920	0.702	0.200	0.887	0.379 (NS)
SN-PP°	8.580	3.024	7.360	2.942	9.800	2.630	-2.440	-3.091	0.003 (HS)
SN-MP°	31.280	4.026	29.440	3.720	33.120	3.492	-3.680	-3.606	0.001 (HS)
PP-MP°	22.640	3.927	22.160	3.997	23.120	3.876	-0.960	-0.862	0.393 (NS)
FMA°	25.500	4.171	25.240	4.216	25.760	4.196	-0.520	-0.437	0.664 (NS)
SN-OP°	15.260	3.630	13.320	2.883	17.200	3.279	-3.880	-4.444	0.000 (HS)
FAA°	88.220	3.151	88.160	3.579	88.280	2.731	-0.120	-0.133	0.895 (NS)
Y-axis°	61.140	3.731	61.480	3.820	60.800	3.686	0.680	0.641	0.525 (NS)
N-S-Ar°	124.840	5.748	122.200	5.050	127.480	5.237	-5.280	-3.629	0.001 (HS)
S-Ar-Go°	142.720	6.386	143.640	6.297	141.800	6.468	1.840	1.019	0.313 (NS)
Ar-Go-Me°	123.600	4.305	123.720	4.098	123.480	4.584	0.240	0.195	0.846 (NS)
Sum post. angles °	391.160	4.157	389.560	3.852	392.760	3.887	-3.200	-2.924	0.005 (HS)
UAFH (mm.)	51.888	2.881	52.829	2.914	50.946	2.572	1.883	2.422	0.019 (S)
LAFH (mm.)	65.376	5.446	69.020	4.639	61.731	3.371	7.290	6.356	0.000 (HS)
AFH (mm.)	115.511	6.578	120.059	5.513	110.964	3.855	9.095	6.760	0.000 (HS)
UPFH (mm.)	34.136	3.377	36.380	2.185	31.892	2.833	4.487	6.271	0.000 (HS)
LPFH (mm.)	48.051	4.788	51.120	3.428	44.983	3.930	6.136	5.884	0.000 (HS)
PFH (mm.)	77.761	6.818	83.029	3.935	72.493	4.649	10.536	8.648	0.000 (HS)
Jarabak Ratio %	67.277	3.884	69.220	3.128	65.335	3.627	3.884	4.055	0.000 (HS)
LFH Ratio %	56.534	2.167	57.451	1.999	55.617	1.959	1.834	3.276	0.002 (HS)

On the other hand, Solow [14] in 1980 defined dento-alveolar compensatory mechanism as a system which tried to preserve normal inter-arch relations under varying jaw relationships. Accordingly, the maxillary and mandibular dental and alveolar arches can be regarded as a sort of flexible ribbon, adapted to the varying jaw relationships and thus keeping the normal relationship between the dental arches, so in case of increased lower facial height, the anterior teeth may still erupt to get a normal relation but to a certain limit.

To the best of our knowledge, only one study conducted by Asad and Naeem [15] correlating among eight measurements determining the vertical jaws relation, so the present study was indented to include other measurements and to find their role in assessing the vertical relation.

In this study, the sample was chosen at age between eighteen and thirty three years old to lessen the effect of any residual skeletal growth [16] as most of facial growth will be completed at 16-17 years of age [17]. Class I sagittal jaw relation was one of the criteria for sample selection to exclude the variable position of the maxilla and mandible in relation to the cranial base. This was done clinically using the palpation method and confirmed by ANB angle.

Generally, the mean values of the angular measurements were within the normal values of original studies. In females SN-PP, SN-MP and SN-OP angles are significantly increased than males. This is due to anti-clock wise rotation of SN plane that confirmed by increasing S-N-Ar angle (table 1). On the other hand, PP-MP angle is nearly similar in both genders confirming the problem of the inclination of SN plane. Brown [13] declared that the cant of SN plane is affected by the sagittal and vertical movement of "N" point, varying the cant of SN plane.

The vertical relation in both genders was similar as PP-MP, FMA, FAA, gonial and Y-axis angles are nearly similar with non-significant gender difference.

In the literatures, the most common angles that assess the vertical relation are SN-MP and FMA angles. Both of them depended on two reference lines that subjected to variations due to growth for S-N plane and different selection of point Porion (i.e. anatomical or machine) for the Frankfort plane. Assessing the vertical relation must not concern on these two angles because sometimes the problem may arise in the maxilla itself either there is maxillary excess and deficiency. The inclination of S-N and palatal planes and upper anterior and posterior facial heights may give an indication of a vertical problem.

The cant of occlusal plane itself and with the cant of S-N plane may result in abnormal relation. The canting of the occlusal plane may be resulted from the dento-alveolar compensatory mechanism to disguise the skeletal problem [14].

PP-MP angle related the maxillary or palatal plane to the mandibular plane regardless the facial heights. Again the dento-alveolar compensation and the effect of lower lip or tongue played a role by canting the both planes as in case of class II division 2 or openbite cases.

Y-axis angle depended on the cant of Frankfort plane and the rotation of the mandible. When Frankfort plane is not perfectly horizontal, the vertical relation will be affected. Sometimes prominent or deficient chin may affect the position of point Gnathion. Facial axis angle is also influenced by the position of point Gnathion.

Regarding the facial heights, Jarabak and lower facial height ratios, males had higher mean values than females due to the fact that males had larger skeletal, cranial, facial, and dental arch dimensions than females. Jarabak ratio gives an indication about the growth pattern. Increased posterior facial height explained its higher value leading to appearance of short face and vice versa. Lower facial height ratio relies on the anterior facial heights (upper and lower) and neglects the posterior facial height, so Jarabak ratio is more indicative as the posterior and anterior facial height will be included.

Wylie and Johnson (5) stressed on using the linear measurements in assessing the sagittal and vertical jaws relations as angle can only assess the relative position of the three (or four) points which establish the lines that structure the angle. The angle cannot in itself provide an absolute measure, although it is plausible that by measuring numerous angles a decision could be attained as to an absolute departure from an accepted standard.

The vertical relation is better measured by the sum of posterior angles and the Jarabak ratio because they showed strong indirect high significant relation. They showed a moderate to strong direct high significant relation with SN-MP, FMA and PP-MP angles. The latter angles depended upon SN, MP, PP and FH planes that subjected to different inclination due to growth or dento-alveolar compensatory mechanism. This finding comes in the line of Asad and Naeem (15) who concluded that PP-SN angle, Jarabak ratio and lower facial height ratio should be appraised due to their significant task in differential diagnosis.

V. Conclusions

According to the results of the present study, there is no single accurate method for assessing the vertical jaws relation, but the sum of posterior angle and Jarabak ratio showed a strong highly significant indirect relation. Depending on SN-MP, SN-PP and FMA angles may give false indication unless PP-MP angle measured to exclude the canting of SN and Frankfort planes.

References

[1]. Tweed CH. The Frankfort mandibular plane angle in orthodontic diagnosis, classification and treatment planning and prognosis. Am J Orthod Oral Surg 1946; 32(4):175-230.

[2]. Björk A. The face in profile. An anthropological X-ray investigation on Swedish children and conscripts. Svensk tandläkare-Tidskrift 1947; 40(5B) Suppl.: 1-180.

[3]. Riedel RA. A cephalometric roentgenographic study of the relation of the maxilla and associated parts to the cranial base in normal and malocclusion of the teeth. Thesis, Northwestern University Dental School, 1948.

[4]. Downs WB. Variations in facial relationship: their significance in treatment and prognosis. Am J Orthod 1948; 34(10): 812-40.

[5]. Wylie WL, Johnson EL. Rapid evaluation of facial dysplasia in the vertical plane. Angle Orthod 1952; 22(3): 165–82.

[6]. Steiner CC. Cephalometrics for you and me. Am J Orthod 1953; 39(10): 729-55.

[7]. Ricketts RM. A foundation for cephalometric communication. Am J Orthod 1960; 46(5): 330-57.

[8]. McNamara JA Jr. A method of cephalometric evaluation. Am J Orthod 1984; 86(6): 449-69.

[9]. Jarabak JR, Fizzel JA. Technique and treatment with light wire edgewise appliance. 2nd ed. St. Louis: Mosby; 1972.

[10]. Rakosi T. An atlas and manual of cephalometric radiography. 2nd ed. London: Wolfe medical publications Ltd.; 1982.

[11]. Jacobson A. Radiographic cephalometry from basics to videoimaging. 1st ed. Chicago: Quintessence publishing Co.; 1995.

[12]. Athanasiou AE. Orthodontic cephalometry. 1st ed. London: Mosby Wolfe; 1995.

[13]. Brown M. Eight methods of analysing a cephalogram to establish anteroposterior skeletal discrepancy. Br J Orthod 1981; 8(3): 139-46.

[14]. Solow B. The dentoalveolar compensatory mechanism: background and clinical implications. Br J Orthod 1980; 7(3): 145–61.

[15]. Asad S, Naeem S. Correlation between various vertical dysplasia assessment parameters. Pakistan Orthod J 2009; 1(1): 28-33.

[16]. Sinclair PM, Little RM. Dentofacial maturation of untreated normals. Am J Orthod 1985; 88(2): 146–56.

[17]. Jones ML, Oliver RG. W&H Orthodontic Notes. 6th ed. Oxford: Wright; 2000.

Table 2: The relation among different measurements in male group

Variables		SN-MP	PP-MP	FMA	SN-OP	FAA	Y-axis	N-S-Ar	S-Ar-Go	Ar-Go-Me	Sum	UAFH	LAFH	AFH	UPFH	LPFH	PFH	JR%	LFH %
SN-PP	r	0.369	-0.384	-0.001	0.516	0.255	-0.064	0.228	0.073	-0.071	0.342	0.751	0.077	0.344	0.078	-0.064	0.014	-0.336	-0.292
	p	0.069	0.058	0.998	0.008	0.218	0.760	0.274	0.731	0.737	0.095	0.000	0.716	0.092	0.709	0.760	0.948	0.100	0.156
SN-MP	r		0.704	0.532	0.697	0.583	0.116	-0.136	0.439	0.424	0.991	0.349	0.564	0.557	-0.061	-0.542	-0.330	-0.927	0.381
	p		0.000	0.006	0.000	0.002	0.579	0.518	0.028	0.035	0.000	0.087	0.003	0.004	0.773	0.005	0.107	0.000	0.060
PP-MP	r			0.559	0.314	0.400	0.197	-0.322	0.405	0.456	0.725	-0.180	0.553	0.353	-0.067	-0.459	-0.277	-0.662	0.619
	p			0.004	0.127	0.047	0.346	0.117	0.045	0.022	0.000	0.390	0.004	0.084	0.750	0.021	0.180	0.000	0.001
FMA	r				0.408	0.555	0.766	-0.468	0.515	0.289	0.535	0.191	0.643	0.595	0.081	-0.056	0.159	-0.443	0.480
	p				0.043	0.004	0.000	0.018	0.008	0.162	0.006	0.362	0.001	0.002	0.702	0.791	0.447	0.027	0.015
SN-OP	r					0.399	0.262	0.116	0.337	-0.024	0.677	0.485	0.431	0.541	-0.060	-0.229	-0.112	-0.667	0.129
	p					0.048	0.206	0.582	0.099	0.910	0.000	0.014	0.031	0.005	0.774	0.272	0.594	0.000	0.538
FAA	r						0.549	-0.255	0.641	-0.116	0.589	0.411	0.679	0.671	0.203	-0.048	0.289	-0.400	0.452
	p						0.004	0.218	0.001	0.580	0.002	0.041	0.000	0.000	0.330	0.818	0.161	0.048	0.023
Y-axis	r							-0.107	0.298	-0.228	0.106	0.208	0.552	0.565	0.407	0.325	0.553	0.004	0.326
	p							0.612	0.147	0.273	0.616	0.319	0.004	0.003	0.043	0.113	0.004	0.984	0.112
N-S-Ar	r								-0.742	-0.257	-0.175	0.156	-0.323	-0.135	0.341	0.047	-0.071	0.065	-0.469
	p								0.000	0.215	0.402	0.457	0.115	0.520	0.096	0.824	0.735	0.759	0.018
S-Ar-Go	r									-0.180	0.471	0.249	0.559	0.492	-0.120	-0.178	0.152	-0.345	0.447
	p									0.389	0.018	0.230	0.004	0.012	0.567	0.394	0.469	0.091	0.025
Ar-Go-Me	r										0.433	-0.251	0.087	-0.057	-0.301	-0.290	-0.443	-0.419	0.270
	p										0.031	0.227	0.679	0.787	0.144	0.160	0.026	0.037	0.191
Sum	r											0.345	0.582	0.567	-0.070	-0.539	-0.317	-0.925	0.404
	p											0.092	0.002	0.003	0.741	0.005	0.123	0.000	0.045
UAFH	r												0.279	0.658	0.479	-0.036	0.282	-0.372	-0.324
	p												0.177	0.000	0.015	0.864	0.171	0.067	0.114
LAFH	r													0.889	0.300	0.204	0.500	-0.393	0.789
	p													0.000	0.145	0.329	0.011	0.052	0.000
AFH	r														0.502	0.170	0.540	-0.458	0.422
	p														0.011	0.418	0.005	0.021	0.036
UPFH	r															0.141	0.562	0.076	-0.085
	p															0.501	0.003	0.717	0.686
LPFH	r																0.815	0.687	0.172
	p																0.000	0.000	0.412
PFH	r																	0.499	0.262
	p																	0.011	0.206
JR%	r																		-0.170
	p																		0.416

Table 3: The relation among different measurements in female group

Variables		SN-MP	PP-MP	FMA	SN-OP	FAA	Y-axis	N-S-Ar	S-Ar-Go	Ar-Go-Me	Sum	UAFH	LAFH	AFH	UPFH	LPFH	PFH	JR%	LFH %
SN-PP	r	0.180	-0.488	-0.035	0.271	-0.056	-0.116	0.388	-0.071	-0.171	0.203	0.500	-0.352	-0.006	-0.157	-0.222	-0.274	-0.301	-0.545
	p	0.390	0.013	0.869	0.191	0.791	0.581	0.055	0.736	0.413	0.330	0.011	0.085	0.978	0.454	0.286	0.186	0.144	0.005
SN-MP	r		0.762	0.722	0.373	0.416	0.271	0.115	0.027	0.546	0.843	-0.013	0.320	0.295	-0.059	-0.730	-0.611	-0.901	0.220
	p		0.000	0.000	0.067	0.039	0.191	0.583	0.898	0.005	0.000	0.952	0.119	0.152	0.779	0.000	0.001	0.000	0.291
PP-MP	r			0.645	0.175	0.398	0.311	-0.126	0.056	0.583	0.610	-0.360	0.527	0.260	0.050	-0.501	-0.366	-0.601	0.575
	p			0.001	0.403	0.049	0.130	0.548	0.791	0.002	0.001	0.077	0.007	0.209	0.812	0.011	0.072	0.001	0.003
FMA	r				0.164	0.326	0.695	-0.040	-0.076	0.673	0.615	0.121	0.280	0.311	0.277	-0.581	-0.343	-0.602	0.141
	p				0.433	0.112	0.000	0.849	0.720	0.000	0.001	0.564	0.175	0.131	0.180	0.002	0.093	0.001	0.502
SN-OP	r					0.208	0.276	0.543	-0.342	0.021	0.187	-0.116	0.327	0.220	0.170	-0.195	-0.164	-0.327	0.290
	p					0.320	0.182	0.005	0.094	0.920	0.371	0.582	0.110	0.291	0.417	0.351	0.434	0.111	0.160
FAA	r						0.556	-0.042	0.272	-0.081	0.301	0.438	0.466	0.680	0.411	-0.056	0.284	-0.102	0.056
	p						0.004	0.843	0.188	0.700	0.144	0.029	0.019	0.000	0.041	0.790	0.168	0.628	0.790
Y-axis	r							0.143	-0.177	0.238	0.180	0.253	0.401	0.473	0.674	-0.049	0.279	0.018	0.158
	p							0.494	0.399	0.252	0.390	0.221	0.047	0.017	0.000	0.816	0.178	0.933	0.452
N-S-Ar	r								-0.760	0.148	0.258	-0.085	-0.073	-0.119	0.367	-0.173	-0.165	-0.112	0.008
	p								0.000	0.480	0.214	0.686	0.729	0.571	0.071	0.409	0.432	0.594	0.970
S-Ar-Go	r									-0.519	0.028	0.190	0.036	0.155	-0.533	0.111	0.078	-0.009	-0.099
	p									0.008	0.895	0.362	0.866	0.458	0.006	0.597	0.713	0.966	0.639
Ar-Go-Me	r										0.514	-0.179	0.098	-0.016	0.297	-0.609	-0.466	-0.536	0.179
	p										0.009	0.393	0.642	0.940	0.149	0.001	0.019	0.006	0.392
Sum	r											-0.008	0.076	0.079	-0.042	-0.767	-0.642	-0.797	0.058
	p											0.968	0.717	0.706	0.843	0.000	0.001	0.000	0.784
UAFH	r												-0.133	0.508	0.256	0.111	0.332	0.075	-0.705
	p												0.527	0.010	0.217	0.597	0.105	0.720	0.000
LAFH	r													0.778	0.285	0.260	0.370	-0.069	0.789
	p													0.000	0.168	0.209	0.069	0.742	0.000
AFH	r														0.397	0.271	0.508	-0.041	0.228
	p														0.049	0.189	0.009	0.847	0.274
UPFH	r															0.072	0.471	0.301	0.051
	p															0.734	0.017	0.143	0.808
LPFH	r																0.871	0.834	0.127
	p																0.000	0.000	0.546
PFH	r																	0.839	0.065
	p																	0.000	0.758
JR%	r																		-0.081
	p																		0.701

Table 4: The relation among different measurements in total sample

Variables		SN-MP	PP-MP	FMA	SN-OP	FAA	Y-axis	N-S-Ar	S-Ar-Go	Ar-Go-Me	Sum	UAFH	LAFH	AFH	UPFH	LPFH	PFH	JR%	LFH %
SN-PP	r	0.417	-0.341	0.011	0.520	0.126	-0.118	0.435	-0.056	-0.121	0.390	0.418	-0.337	-0.149	-0.305	-0.363	-0.394	-0.455	-0.513
	p	0.003	0.015	0.942	0.000	0.385	0.416	0.002	0.700	0.401	0.005	0.003	0.017	0.303	0.031	0.009	0.005	0.001	0.000
SN-MP	r		0.701	0.581	0.643	0.462	0.125	0.205	0.140	0.416	0.930	0.003	-0.011	-0.038	-0.349	-0.729	-0.624	-0.929	0.046
	p		0.000	0.000	0.000	0.001	0.387	0.154	0.331	0.003	0.000	0.985	0.942	0.794	0.013	0.000	0.000	0.000	0.751
PP-MP	r			0.603	0.267	0.396	0.238	-0.139	0.208	0.513	0.659	-0.287	0.309	0.135	-0.084	-0.443	-0.297	-0.600	0.483
	p			0.000	0.061	0.004	0.097	0.335	0.147	0.000	0.000	0.044	0.029	0.350	0.561	0.001	0.036	0.000	0.000
FMA	r				0.268	0.453	0.721	-0.192	0.205	0.488	0.553	0.128	0.314	0.293	0.098	-0.295	-0.119	-0.485	0.255
	p				0.060	0.001	0.000	0.181	0.154	0.000	0.000	0.376	0.026	0.039	0.498	0.037	0.411	0.000	0.074
SN-OP	r					0.266	0.175	0.509	-0.102	-0.014	0.531	-0.033	-0.133	-0.144	-0.315	-0.484	-0.496	-0.617	-0.069
	p					0.062	0.224	0.000	0.479	0.923	0.000	0.819	0.359	0.319	0.026	0.000	0.000	0.000	0.636
FAA	r						0.544	-0.132	0.466	-0.099	0.430	0.391	0.431	0.469	0.207	-0.051	0.160	-0.229	0.245
	p						0.000	0.360	0.001	0.495	0.002	0.005	0.002	0.001	0.150	0.724	0.267	0.110	0.086
Y-axis	r							-0.027	0.074	0.016	0.095	0.245	0.418	0.436	0.468	0.157	0.324	0.056	0.259
	p							0.855	0.607	0.911	0.514	0.086	0.003	0.002	0.001	0.277	0.022	0.698	0.069
N-S-Ar	r								-0.726	-0.048	0.218	-0.119	-0.452	-0.404	-0.079	-0.349	-0.430	-0.259	-0.381
	p								0.000	0.741	0.128	0.410	0.001	0.004	0.585	0.013	0.002	0.070	0.006
S-Ar-Go	r									-0.353	0.167	0.254	0.339	0.346	-0.161	0.078	0.182	-0.065	0.217
	p									0.012	0.246	0.075	0.016	0.014	0.263	0.591	0.206	0.654	0.129
Ar-Go-Me	r										0.427	-0.192	0.085	-0.007	0.058	-0.339	-0.263	-0.404	0.213
	p										0.002	0.181	0.557	0.959	0.688	0.016	0.065	0.004	0.138
Sum	r											0.026	-0.016	-0.035	-0.297	-0.715	-0.587	-0.875	0.027
	p											0.855	0.911	0.811	0.036	0.000	0.000	0.000	0.853
UAFH	r												0.305	0.634	0.469	0.241	0.437	0.049	-0.286
	p												0.031	0.000	0.001	0.092	0.002	0.735	0.044
LAFH	r													0.921	0.607	0.563	0.725	0.190	0.809
	p													0.000	0.000	0.000	0.000	0.187	0.000
AFH	r														0.698	0.566	0.773	0.190	0.517
	p														0.000	0.000	0.000	0.185	0.000
UPFH	r															0.491	0.758	0.474	0.281
	p															0.000	0.000	0.001	0.048
LPFH	r																0.909	0.834	0.378
	p																0.000	0.000	0.007
PFH	r																	0.770	0.422
	p																	0.000	0.002
JR %	r																		0.121
	p																		0.404