***ISSN:* 1812–1217**

The Effect of Digital Image Size on the Accuracy of Linear Cephalometric Measurements

Khudair A Al-Jumaili
BDS, CES, DSCO. (Prof.)
Dept of Pedod, orthod, and Prev Dentistry
College of Dentistry, University of Mosul

Ruba J Mohammad
BDS, MSc (Asst. Lect.)
Dept of Pedod, orthod, and Prev Dentistry
College of Dentistry, University of Mosul

Wafa Gh Fathi
BDS, MSc (Asst. Lect.)
Dept of Pedod, orthod, and Prev Dentistry
College of Dentistry, University of Mosul

الخلاصة

الاهدف: تهدف الدراسة الى مقارنة دقة قياسات الرأس الخطية بين الصور الرقمية المضغوطة وغير المضغوطة. **المواد وطرائق العمل** : الدراسة الحالية اجريت على عينة من٦٠ عراقي بالغ، بعمر (١٨–٢٥) سنة و كانت العينات مطابقة للمواصفات التي حددتها هذه الدراسة . ثمانية قياسات خطية جانبية للراس قد سجلت من الصور الشعاعية الجانبية الرقمية و باستعمال برنامج ال (ACDsee) لضغط و اعادة حفظ الصور الاصلية بحجم (٨٠%) و (٦٠%) للحجم الاصلي للصور ، و تم تحليل البيانات باستعمال الإحصاء الوصفي و اختبار (Duncan) & (ANOVA) الاحصائي. **النتائج:** أظهرت النتائج انه لا يوجد اي اختلافات معنوية في دقة القياسات باستعمال النوعين من الصور. **الاستنتاجات:** ان نتائج هذه الدراسة تشير الى انه يمكن كبس الصور الشعاعية الرقمية الى (٦٠%) من حجمها الاصلي دون ان يؤثر ذلك على دقة قياسات الرأس الخطية وتقليل حجم تخزين الصور، كما يسهل نقل الصورة بشكل أسهل وأسرع.

ABSTRACT

Aims: This study compared the accuracy of linear cephalometric measurements between the compressed and non-compressed digital cephalometric images. **Materials and Methods:** The adult sample consisted of (60) Iraqi subjects (30 females and 30 males) with age ranged 18 – 25 years old, the samples satisfied the criteria of this study. Eight linear cephalometric measurements were recorded from lateral digital cephalometric radiographs, the ACDsee photo manger software used to compress and resaved the original images in 80% and 60% from their original size. The data were analyzed using descriptive statistic and ANOVA & Duncan test. **Results:** No significant differences were found between the accuracy of the compressed and non-compressed digital cephalometric measurements. **Conclusions:** The results of this study indicated that image compression up to 60% of their original size will not effect on the accuracy of routine cephalometric analysis and reduce the size of image storage and facilitates the easier and faster image transmission.

Key words: Direct digital lateral cephalometry; JPEG compression; linear cephalometric measurements.

Al-Jumaili kh A, Mohammad RJ, Fathi WGh.The Effect of Digital Image Size on the Accuracy of Linear Cephalometric Measurements. *Al–Rafidain Dent J*. 2014; 14(1):82-89.
Received: 2/10/2012 ***Sent to Referees:*** 7/10/2012 ***Accepted for Publication:*** 2/12/2012

INTRODUCTION

Digital image files are often very large and the number of images obtained in one study has increased dramatically with the advent of digital modalities, some researchers recently estimated that each digital imaging examination generates approximately 2 gigabytes (GB) of data, all of which needs to be stored on a series of hard devices in which all of these are highly coasted, fortunately. The costs of these hard drives dramatically as new technologies have substantially increased the amount of data that can be stored by using the file compression technique. In addition, lifecycle management software has also been introduced that can help facilities transition older files to cheaper storage devices. [1-4]

Image compression is a process of file reduction. The purpose of image compression is to reduce computer storage space and facilitate image retrieval and transmission. Compression becomes a more important issue as the number of patient records and image files to be stored increases over time. [5,6]

There are two types of image compression methods; lossless and lossy. Lossless compression retains all of the information in each pixel of the original image and essentially is identical to the image that first acquired by the digital imaging system. Lossless compression algorithms provide a very limited degree of file reduction in the range approximately one-half to one- third reduction. Lossless compressed images require more memory to manipulate the image and longer transmission time to send an image to remote site. [7]

Lossy compression affords higher compressibility, but results in some loss of data. Lossy compression is accomplished through the division of the image into smaller blocks and selective discarding of data. Lossy compressed images require less memory to manipulate the image and transmission time is reduced [8]. Joint photographic Experts Group (JPEG), is a common compression protocol that can support both lossless and lossy compression. A number of research studies have investigated the extent that images files can be compressed and still be diagnostic. [9]

The aim of this study were to evaluate the influence of image compression to 80% and 60% of original size on the reproducibility of identification of some cephalometric points on the digital lateral cephalograms and the accuracy of the linear cephalometric measurements.

MATERIALS AND METHODS

Sixty lateral digital cephalometric images were obtained from the students of the college of Dentistry in Mosul University at the age of 18-25 years old (30 females and 30 males).The selection of these samples were based on certain criteria (the dental and skeletal subjects with normal class I, normal over bite (0-4mm) and overjet (0-4mm), full set of permanent teeth with no history of orthodontic treatment or orthognathic surgery).

The digital radiographic images were acquired with a (Planmeca Dimaxis Pro X-ray machine with Dimaxis classic imaging software. Helsinki, Finland 2003); these radiographic images were taken at 80 kVp, 12mA and 23.000 sec. as scanning time and exported in uncompressed tagged image file format (TIFF). Those digital radiographs were selected on the following inclusion criteria: sharpness of the image, ultimate brightness and contrast, minimal noise, and full visualization of all normal anatomic structures. The resolution of these images was (254) pixel / inch which is equivalent to 100 pixels / centimeter (1 pixel = 0.1mm). The image matrix dimension was 2052 x1904 pixels at 8- bit depth. This resulted in an image size of 3.72MB. These digital images were not enhanced by any ways of image enhancements. The digital cephalometric images then were converted into the most common file format that offers lossless compression is the joint photographic experts group (JPEG) format in order to identify the seven landmarks that previously used in researches which were the following points: N (Nasion), S (Sella Tursca), GO (Gonion), ME (Menton), ANS (anterior nasal spine), Ricketts Ls and Ricketts Li. The cephalometric measurements were done and they were the following (Figure 2);

S-N (mm): distance between the points S and N, this represents the ant-posterior extent of the anterior cranial base [10, 11].

S- Go (mm): a vertical distance between points S and GO and this represent the total posterior facial height [12].

N-Me (mm): A vertical distance between points N and Me and this represents the total anterior facial height [13, 14].

ANS-Me (mm): distance between points ANS and Me; this represents the lower anterior facial height [12, 15].

Jarabak (%): the ratio between posterior and anterior facial height (S-Go/N-Me) x100 [16].

ANS-Me/N-Me x100: ratio of the lower anterior facial height to the total anterior facial height x100. [16]

Ricketts Ls and Ricketts Li: according to Esthetic Plane : the upper lip to esthetic plane was measured as the perpendicular distance between Labrale Superius and esthetic plane, whereas the lower lip to esthetic plane was measured as the distance between Labrale Inferius and esthetic plane, and the position of the lips was recorded (+ve) when it was in front of the line and (-ve) when located behind the line, and in this study the Esthetic line or (E) line drew as a line tangent from the tip of the nose to the soft tissues pogonion. This line was employed by Ricketts who stated that the upper and lower lips lie behind this line a mean distance of 2mm and 4mm, respectively. [17]

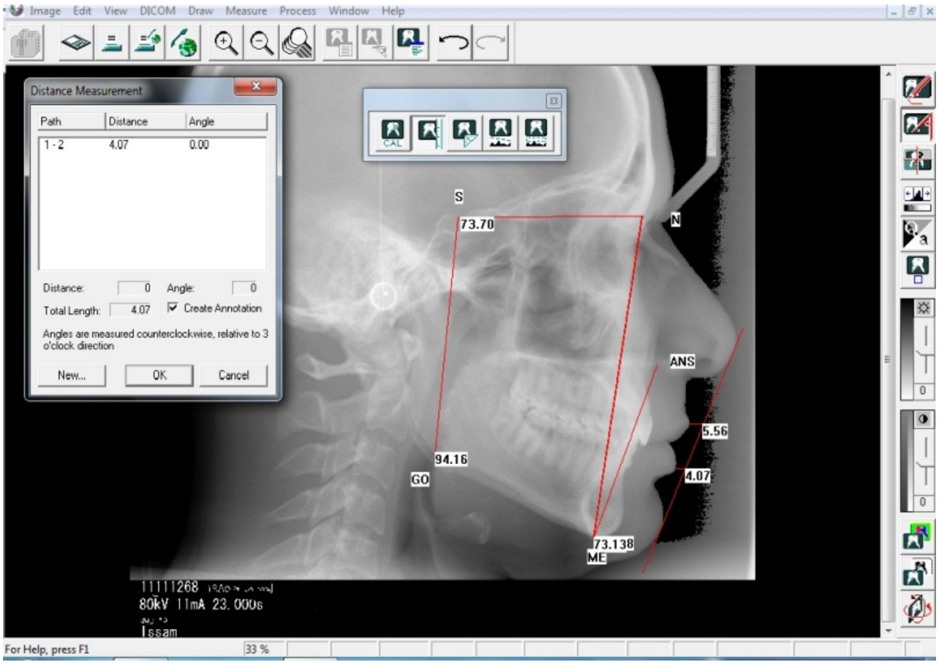

Figure (1): Linear cephalometric analysis of original size radiographic digital image (100%).

These measurements were compared with the results of previous study Al-Hamadany [18] study that have been done on conventional cephalometric radiographs in order to make the standardization to the measurements of present study. Then by using the ACDsee photo manger software version 4.0 (2001 ACDsee system) that installed manually to make the compression of the images, the digital radiographic images were compressed and resaved in 80% and 60% from their original size, the compression ratio expresses the difference between the file size of the original image and the same images after compression as shown in the (Figure 2, 3).

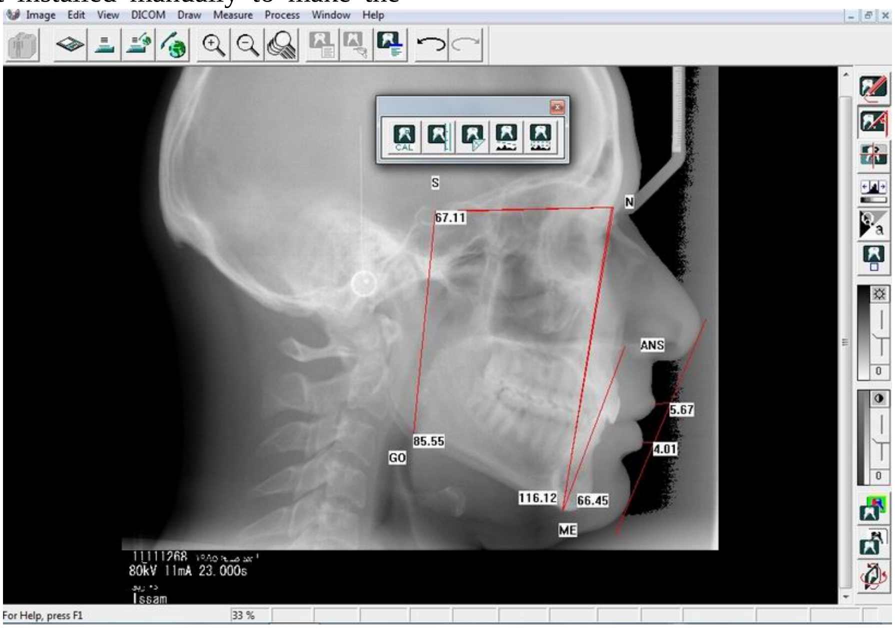

Figure (2): Linear cephalometric analysis of compressed radiographic digital image to the 80% of the original size.

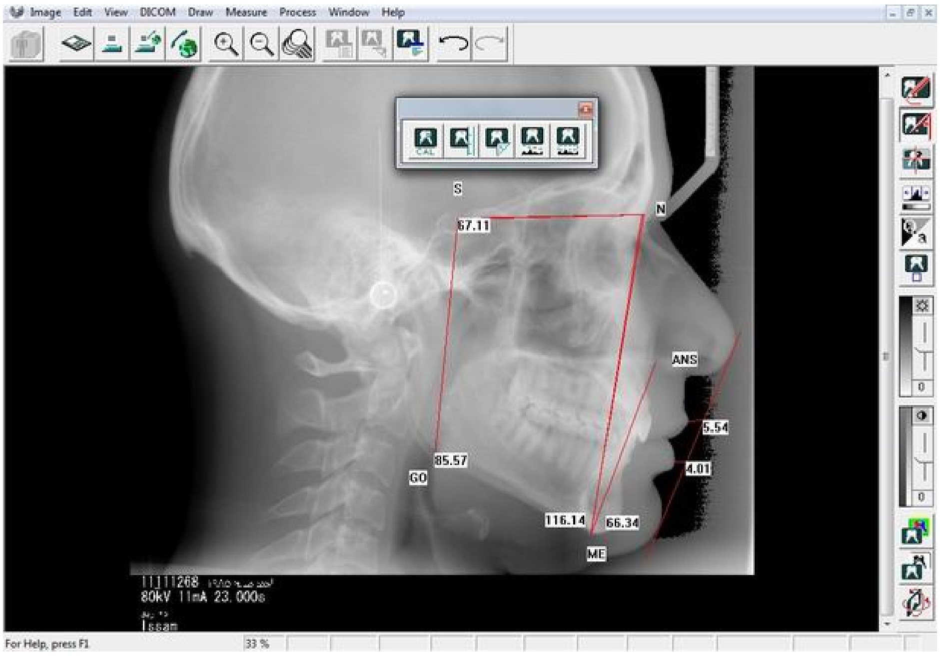

Figure (3): Linear cephalometric analysis of compressed radiographic digital image to the 60% of the original size.

All this work was done on a monitor (Best view, HD TV. With resolution 1024 ×768 pixel) with windows 7, where the dimension of the image at 80% and 60% was (1642 x 1523) and the size (143 kB) and (1231 x 1142) and size was (85 kB) respectively. All the previous cephalometric measurements were done again on the compressed images by the same way as done in the original image. The data were analyzed using Statistical Package for Social Sciences (SPSS) software package (version 15). The minimum, maximum, mean and standard deviation was measured. ANOVA & Duncan test were performed to compare the measurements between the readings. The differences were considered significant at $p \leq 0.05$.

RESULTS

The descriptive statistics that included Mean, Standard Deviations, and Minimum and Maximum values for the measurements using the three types of digital image size: 100%, 80%, and 60% are listed in Table (1).

Table (1): Descriptive statistics and comparison between the measurements using the three types of digital image size: 100%, 80%, and 60%.

variables	Image size	N	Mean (mm)	SD	Minimum	Maximum
	100%	60	75.3235	1.68842	72.82	78.86
S-N	80%	60	75.3235	1.83932	70.53	78.58
	60%	60	75.0580	2.53928	71.09	80.46
	100%	60	90.1830	1.68842	85.87	94.43
S-Go	80%	60	90.1990	1.83932	85.42	94.16
	60%	60	89.7113	2.53928	85.08	95.69
	100%	60	129.0905	1.19696	126.03	133.27
N-Me	80%	60	129.1178	2.70646	125.00	135.24
	60%	60	129.0995	1.69536	124.41	132.83
	100%	60	70.7255	2.29524	67.47	75.19
ANS-Me	80%	60	70.3733	3.64439	60.34	77.69
	60%	60	70.7638	1.68666	66.71	74.89
Jarabak %	100%	60	69.8593	1.79196	64.90	73.58
	80%	60	69.8668	1.84586	65.95	73.94

	60%	60	69.4390	1.46974	67.00	73.59
ANS-Me/ N-Me%	100%	60	54.9195	1.81536	52.30	59.58
	80%	60	54.5007	2.60509	47.02	58.70
	60%	60	54.8240	1.49922	51.92	57.90
ULE	100%	60	-5.5493	2.89277	-15.19	0.00
	80%	60	-5.6842	2.43737	-10.86	0.00
	60%	60	-5.7868	2.62327	-13.65	0.00
LLE	100%	60	-4.1020	1.76359	-7.78	-1.72
	80%	60	-4.2150	2.09128	-7.71	3.44
	60%	60	-4.2805	1.80498	-7.85	1.37

The results of One Way ANOVA statistical test showed that there was no significant difference between all groups at P > 0.05 as listed in Table (2).

A more specific Duncan's multiple range tests for the eight variables using the three types of digital image size; 100%, 80%, and 60% are listed in Table (3), figure (1) which are showed that there were no significant differences between all the groups.

Table (2): ANOVA for Comparing the Values of all variables Measured from the three image sizes.

variables		SS	df	MS	f-value	p-value
S-N	**Between Groups**	6.855	2	3.428		
	Within Groups	748.226	177	4.227	0.811	0.446
	Total	755.081	179			
S-Go	**Between Groups**	9.211	2	4.605		
	Within Groups	778.350	177	4.397	1.047	0.353
	Total	787.561	179			
N-Me	**Between Groups**	0.023	2	0.012		
	Within Groups	686.281	177	3.877	0.003	0.997
	Total	686.304	179			
ANS-Me	**Between Groups**	5.560	2	2.780		
	Within Groups	1262.277	177	7.132	0.390	0.678
	Total	1267.837	179			
Jarabak %	**between Groups**	7.196	2	3.598		
	Within Groups	517.929	177	2.926	1.230	0.295
	Total	525.125	179			
ANS-Me/N-Me%	**Between Groups**	5.782	2	2.891		
	Within Groups	727.451	177	4.110	0.703	0.496
	Total	733.233	179			
ULE	**BetweenGroups**	1.703	2	0.851		
	Within Groups	1250.234	177	7.063	0.121	0.887
	Total	1251.937	179			
LLE	**between Groups**	0.978	2	0.489		
	Within Groups	633.758	177	3.581	0.137	0.872
	Total	634.737	179			

Table (3): Duncan's multiple range test for comparing values of all variables measured from the three image sizes.

variables	Image size	N	Mean (mm)	Duncan's Grouping*
	100%	60	75.3235	
S-N	80%	60	75.3235	A
	60%	60	75.0580	
	100%	60	90.1830	
S-Go	80%	60	90.1990	A
	60%	60	89.7113	
	100%	60	129.0905	
N-Me	80%	60	129.1178	A
	60%	60	129.0995	
	100%	60	70.7255	
ANS-Me	80%	60	70.3733	A
	60%	60	70.7638	
	100%	60	69.8593	
Jarabak %	80%	60	69.8668	A
	60%	60	69.4390	
	100%	60	54.9195	
ANS-Me/ N-Me %	80%	60	54.5007	A
	60%	60	54.8240	
	100%	60	-5.5493	
ULE	80%	60	-5.6842	A
	60%	60	-5.7868	
	100%	60	-4.1020	
LLE	80%	60	-4.2150	A
	60%	60	-4.2805	

* Means with same letter were statistically not significant (P > 0.05).

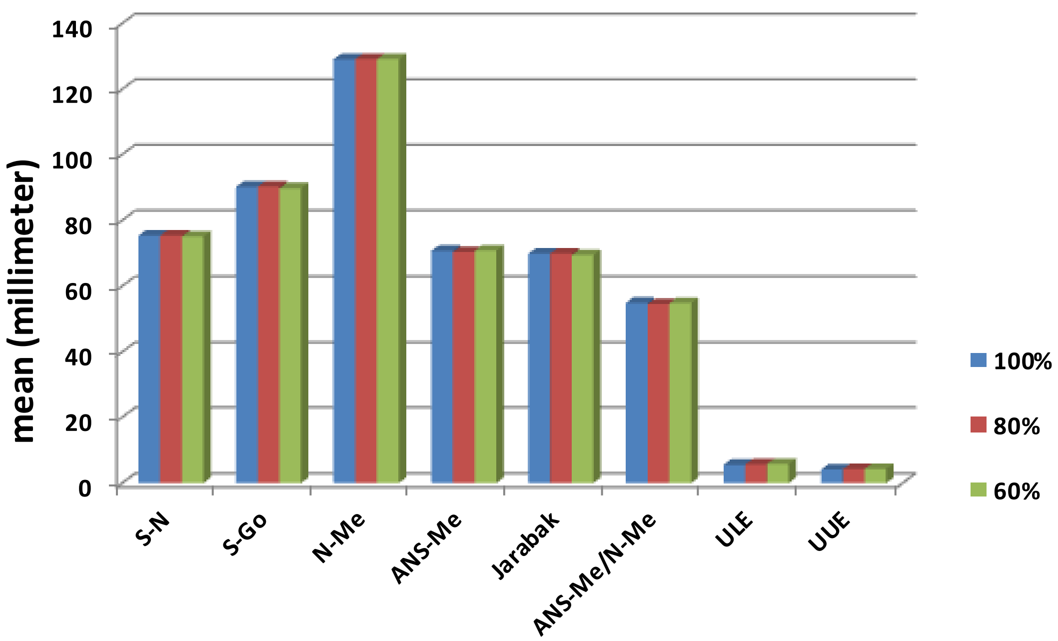

Figure (4): Comparing values of all variables measured from the three image sizes.

DISCUSSION

The JPEG standard has become widely acceptance in nonmedical imaging applications, and has been applied recently to images in certain areas of medicine, and is the format of choice by DICOM (Rigolin, 1996)[19]. A useful property of JPEG is that adjusting compression parameters can vary the degree of looseness. In the study of Gurdal *et.al* [20], the effects of image processing before compression, such as edge enhancement or digital zoom on highly compressed images can add structure artifacts to the images making them virtually unusable and this agreed with the method of this study.

The results in this study showed that there were no statistically significant differences among the three types of the digital image compressions for all the liner cephalometric measurements when the lossless compression was used and this comes in agreement with Cziraki study [21] who stated that the JPEG lossless compression did not affect the reproducibility and accuracy of identification for a few landmarks, also did not impact on the accuracy of cephalometric measurement. Furthermore, it may be acceptable to use this compression level in individual cases to assess dentofacial proportions. In addition to that, this study agreed with Mol study [22] who suggested that the amount of compression must be chosen for each unique diagnostic task and based on the inherent quality of the original radiographic image as well as the usefulness of the image for future reference.

This study also comes in agreement with study of Dived [23] who stated that, a common experience that information technology (IT) changes rapidly with time, with a risk those different generations may become incompatible. Therefore, in order to ensure that data persist transfer from one system to another, the dentist must ensure that not only are the systems DICOM compatible, but also that all digital images are transferred into the new record system without a loss of data. So far there does not appear to be a report to confirm that this can actually be achieved in dentistry' meanwhile the result of this study agreed with Eraso *et al*. [24] who reported that loss of image quality is not a factor unless the file size is reduced to 4% or less.

CONCLUSION

The results of this study indicate that image compression up to 60% of original size can be used to perform routine cephalometric analysis, without loss of clinical orthodontic diagnostic information. In addition to reduce the size of image; storage in the computer hard-memory and facilitates the easier and faster image transmission.

REFERENCES

1. Hatcher M. Data base application of digital medical x- rays and labs: computerization, storage, retrieval, interpretation and distribution. *J med syst*. 2005 29:317-325.
2. Lehrer R. teaching technology to technologists. *Radiol Technol*. 2008.79:405-414.
3. Herrmann T. Computed radiography and digital radiography: A Comparison of technology, functionality, patient dose, and image quality. 2008. Web. Site (https: eradimaging.com.).
4. Elizabeth A .K, Mark B.W, Katherine A, Keith J.S., Kimberly A ,Margaret W, Sandra B, RN,JD, Anthony S . Digital radiography image quality: image processing and display. *Jam Coll Radiol;* 2007.4: 389-400.
5. Gail F Williamson. Digital radiography in dentistry: moving from film-based to digital imaging. Crest. Oral –B at dental- care.com continuing education course. 3.2010.
6. Pabla T, Ludlow JB, Tyndall DA, *et al*. Effect of data compression on proximal caries detection: observer performance with Den Optix photostimulable phosphor images. *Dentomaxillofac radiol.* 2003.32 (1) 45-9.
7. Eraso F E, Analoui M, Watson AB, Rebeschini R. Impact of lossy compression on diagnostic accuracy of radiographs for periapical lesions. *Oral surg oral med oral pathol oral radiol Endod*. 2002.93 (5) 621-5.
8. Koenig L, Parks E, Analoui M, Eckert G. The impact of image compression

on diagnostic quality of digital images for detection of chemically – induced periapical lesions. *Dentomaxillo fac-Radiol.* 2004.33 (1) 37-43.
9. Jacobsen J Hansen B, Wenzel A, Hintze H. Relationship between histological and radiographic caries lesion depth measured in images from four digital radiography systems. *Dentomaxillofac radiol* .2004.38(1) 34-8.
10. Wylie W.L. The relationship between ramus height dental height and overbite. *Am. J. Orthod.* 1946.32: 257 – 267.
11. Bishara SE, Treder JE, Jackobsen JR. Facial and Dental Changes in Adulthood. *Am J Orthod Dentofacial Orthoped*. 1994.106 (2): 175 – 186.
12. Bjork A .Cranial base development. *Am J Orthod* .1955; 41:198-225.
13. Nanda R.S., Meng H .Kaplla S. and Goorhuis J. Growth changes in the soft tissue facial profile. *Angle Orthod*; 1989.60(3): 177 – 190.
14. Coben SE.The integration of facial skeletal variants. *Am J Orthod.* 1955.41(6):407-434.
15. Wylie W L, Johnson E L: rapid evaluation of facial dysplasia in the vertical plane. *Angle Orthod.* 1952.22(3): 165 - 182.
16. Biggerstaff R.H., Allen R.C., Tuncay O.C., Berkowitz J. A vertical analysis of the human craniofacial complex. *Am. J. Orthod*; 1977.72(4): 397 – 405.
17. Ricketts RM. A foundation for cephalometric communication. *Am J Orthod*. (1960a); 46(5): 330 – 357.
18. Al-Hamadany AK (2000) .Three-Dimensional Analysis of Mandible in Class One Normal Occlusion of Iraqi Adults in Mosul City (A Cephalometric Study). M. Sc. Thesis. Mosul, Iraq. Ch.4: 68-73.
19. Rigolin VH, Robiolio PA, Spm LA, Hama wood BP, Moms KG, Fortin DF, Baker WA, Bashore TM, Cusma JT. Compression of digital coronary angiograms does not affect visual or quantitative assessment of coronary artery stenosis severity. *Am J Cardiol;* 1996 .78(2):1- 135**.**
20. Gurdal P, Hildebolt CF and Akdeniz BG. The effects of different image file formats and image-analysis software programs on dental radiometric digital evaluations. *Dentomaxillofac Radiol*. 2001; 30(1): 50-55.
21. Suzanne Cziraki. The Reproducibility and Accuracy of Cephalometric Analysis Using Different Digital Imaging Modalities and Image Compression*. M. Sc. Thesis Toronto.* 2001. *Pp 2-25.*
22. Mol A. Image processing tools for dental applications. *Dent Clin NA.* 2000.44(2):299- 317.
23. David MacDonald. Factors to consider in the transition to digital radiological imaging**.** *Journal of the Irish Dental Association;* 2009.55 (1): 26 –34.
24. Eraso, F.E., Anaioui, M., Watson, A.B., Rebeschini, R**.** Impact of lossy compression on diagnostic accuracy of radiographs for periapical lesions. *Oral Surg*. 2002.93 (5): 621-625.