



GLOBAL JOURNAL OF MEDICAL RESEARCH
RADIOLOGY, DIAGNOSTIC, IMAGING AND INSTRUMENTATION
Volume 13 Issue 3 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4618 & Print ISSN : 0975-5888

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The study was done to determine the distance between right and left hemi diaphragm in normal Sudanese adults using digital radiography.

The study sample was 100 subjects, 50(50%) were males and 50(50%) were females, with different ages ranged from 18 – 82 years old; all subjects were with normal abdominal ultrasound and normal chest radiographs. The study was done in Fedail hospital in the period from January up to March 2013. The measurements were done on ideal postero anterior (PA) chest radiograph by measuring the difference between the distance from the highest point of right hemi diaphragm and highest point of the left hemi diaphragm. The result showed that the right hemi diaphragm was higher than the left in 98% of total sample and the left was higher in 1% and they were in the same height in 1%.

Keywords: chest x-ray, hemi diaphragm, thoracic, digital radiography.

GJMR-D Classification : NLMC Code: WN 180, WF 800



HEIGHT DIFFERENCE BETWEEN RIGHT AND LEFT HEMI DIAPHRAGM IN NORMAL SUDANESE ADULTS USING POSTERO-ANTERIOR COMPUTED CHEST RADIOGRAPHY

Strictly as per the compliance and regulations of:



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The right was higher in range of 1cm to 2.5cm in 79% and the Male diaphragm height difference ranged between 0.6-2.8 and Female ranged from 0.5-2.9cm. The study found that there are linear relation between distance difference of right and left hemi diaphragm with subjects' age, body mass index (BMI), height and weight.

Computed radiography was useful in measurements of diaphragm height difference for Sudanese as it is accurate and easy.

Keywords: chest x-ray, hemi diaphragm, thoracic, digital radiography.

I. INTRODUCTION

The diaphragm is a curved muscle fibrous sheet that separates the thoracic from abdominal cavity, the position of the domes or cupola of the diaphragm are extremely variable as they differ on body built. [1-3]

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Although the use of computerized Tomography has greatly increased over the past decades, chest radiography remains the most frequently performed imaging examination [4]. A good understanding of normal anatomy and variations is essential for the interpretation of postero anterior (PA) chest radiographs include fissure lines [5, 6, 7, 8, 9], and vascular structures [10], aortic nipple [11, 12, 13] is important.

When interpreting chest radiographs, the position and shape of the diaphragm are routinely used to evaluate whether the lungs are underinflated, as with inadequate inspiration effort or restrictive lung disease, or overinflated, as in emphysema or other obstructive lung diseases. Conventional teaching that the normal position of the right hemi diaphragm projects at about the anterior sixth rib [14, 15] appears to originate from a single study.[16]

A more precise characterization of the normal variation in diaphragm position and shape, based on easily recognized anatomic landmarks, and analysis of factors that might contribute to this variation, such as age and weight, may provide a more consistent origin for this review.[17]

There have been few reports describing the normal radiographic anatomy and variations of the thoracic structures in different population [13]. Most of the data regarding these normal structures have been provided from the Europe and USA. [5–12]

Therefore we reviewed normal PA chest radiographs and analyzed the radiographic anatomy among Sudanese. To our knowledge no information is available in the open literature about Sudanese population. Therefore, we conducted this study in order to measure the height difference between right and left hemi diaphragm on PA chest Digital radiographs obtained from Sudanese subjects with normal chest and abdomen, and to identify the relationship of diaphragm position to Sudanese demographic data including age gender, weight, height and BMI.

II. MATERIALS AND METHODS

a) Patients

The sample was 100 Sudanese Subjects (50 males and 50 female) with age range from 18-82 years.

The chest radiographs were obtained as a part of routine work-up or follow-up study for non-chest diseases, all patients were diagnosed as normal chest x-ray and the abdominal ultrasound was diagnosed as normal; Subjects with plural effusion, lung diseases, scoliosis, sarcoidosis, collagen vascular disease, pulmonary hypertension, large cardio thoracic ratio or, large volume of the abdominal contents, ascites, liver cirrhosis, liver or spleen enlargement disease were excluded.

The x-ray machine: major x-ray machines, Shimadzu were used.-Manufacturer: Shimadzu, Japan. Manufacturing date: Jan 2011. Focal spot: Small (0.6) mm / Large (1.2) mm. Maximum kV: 150 kVp. Maximum mA: 500mA. Year of Installation: 2011.

Processing machine: Images processed by using computed radiography, Fuji film (FCR CAPSULLA) model XL II.

Imaging technique: Firstly the procedure was explained to the patients (pts). Then the pts were asked to change his/her clothes with the hospital gown. The patients were centered in the erect position in the stand bucky as for ideal postero-anterior chest radiograph and asked to take a deep breath and hold it.

Postero-anterior chest radiograph technique: A 35.43cm or 35.35cm cassette is selected, depending on the size of the patient. The patient is positioned facing the cassette, with chin extended and centered to the middle of the top of the cassette. The feet are placed slightly apart so that the patient is able to remain steady. The median sagittal plane is adjusted at right angles to the middle of the cassette. The shoulders are rotated forward and pressed downward in contact with cassette.

This is achieved by placing the dorsal aspect of the hands behind and below the hips, with the elbows brought forward, or by allowing the arms to encircle the cassette. The horizontal central beam is directed at right angles to the cassette at the level of thoracic vertebra which is consigned with lung midpoint. The surface marking of T7 spinous process can be assessed by using the inferior angle of the scapula. Exposure is made in full normal arrested inspiration.[18]

The exposure made at inspiration. Images were processed using Fuji computed radiography system (FCR). Images were manipulated, adjusted, and then stored in the computer.

b) Method of measurement

The subjects were asked for their ages and the weight had been registered using weights measuring device, the heights were measured by a meter. After ideal chest radiograph acquisition and processing then measurements were done. A straight line was drawn at the maximum height of each hemi diaphragm. The lines are parallel to each other. Then the distance between the both lines was measured.

III. RESULTS

The following figures and tables presented the data obtained from 100 normal subjects after measuring the distance between the right and left hemi diaphragm, the variables taken were age, height (m), weight (Kg), Body Mass Index (BMI). Correlations were taken by presenting trend line and resultant equations in the graphs, this was done for males who act 50% of the sample and the females who act 50% of the sample as well as the Total sample (100%).

Table 1 : mean and standard deviation of the variables (age, Hemi diaphragm distance, weight, height, BMI for male, Female and total sample

Variables	Male (mean± STDV)	Female (mean± STDV)	Total Sample (mean± STDV)
Ages (years)	39.98 ±16.8	44.04±16.6	42.01±16.7
Hemi Diaphragms			
Distance	1.6±0.6	1.42±0.7	1.5±0.6

Weight (Kg)	74.5±13.2	69.92±13.2	72.2±13.3
Height (M)	1.7±0.1	1.64±0.1	1.7±0.1
(BMI)	24.3±4.0	25.65±4.8	24.9±4.5

Table 2 : Hemi Diaphragms distance Classes for the Total Sample, Male and Female, Frequency and Percentages

Hemi Diaphragms distance (Total sample)	Frequency And Percentage%	Diaphragm distance (Males)	Frequency And Percentage%	Diaphragm distance (Females)	Frequency And Percentage%
-0.5—0.5	5(5%)	0.6-1.0	11(22%)	-0.5-0.5	5(10%)
0.6-1.1	23(23%)	1.4-1.8	21(42%)	0.6-1.1	10(20%)
1.2-1.7	38(38%)	1.9-2.3	11(22%)	1.2-1.7	22(44%)
1.8-2.2	22(22%)	2.4-2.8	6(12%)	1.8-2.3	9(18%)
2.3-2.8	11(11%)	>2.8	1(2%)	2.4-2.9	4(8%)
>2.8	1(1%)	-	-	-	-

Table 3 : Height Classes in Meters (M) For the Total Sample, Male and Female, Frequency and Percentages

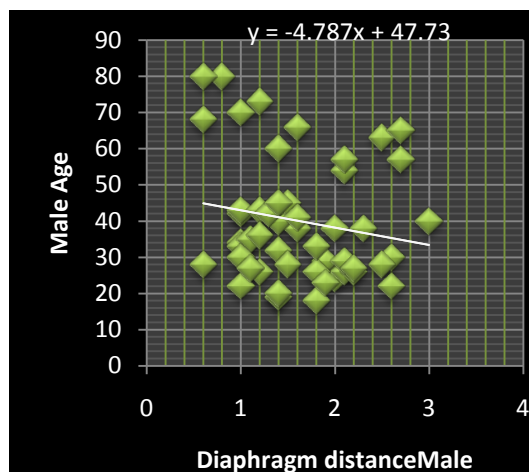
Total sample Height(M)	Frequency And Percentage%	Males Height (M)	Frequency And Percentage%	Females Height (M)	Frequency And Percentage%
1.37-1.47	1(1%)	1.37-1.47	1(2%)	1.55-1.59	11(22%)
1.48-1.58	8(8%)	1.48-1.58	1(2%)	1.60-1.64	15(30%)
1.59-1.69	38(38%)	1.59-1.69	7(14%)	1.65-1.69	12(24%)
1.70-1.80	42(42%)	1.70-1.80	30(60%)	1.70-1.74	11(22%)
1.81-1.91	10(10%)	1.81-1.90	10(20%)	1.75-1.79	1(2%)
>1.91	1(1%)	>1.90	1(2%)	-	-

Table 4 : Weight Classes in kilograms (kg) For the Total Sample, Male and Female, Frequency and Percentages

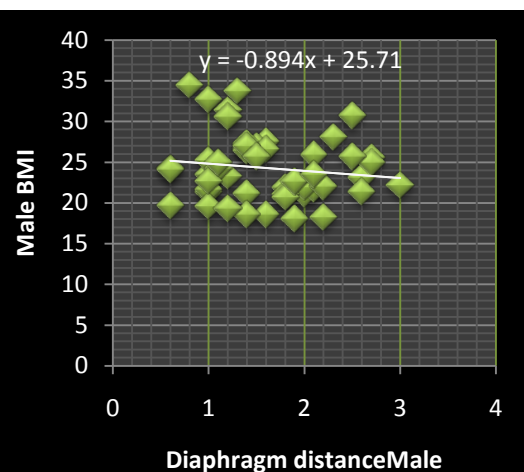
Total sample Weight(Kg)	Frequency and Percentage%	Males Weight (Kg)	Frequency and Percentage%	Females Weight (Kg)	Frequency and Percentage%
44-54	6(6%)	44-54	2(4%)	48-58	9(18%)
55-65	26(26%)	55-65	12(24%)	59-69	18(36%)
66-76	36(36%)	66-76	15(30%)	70-80	16(32%)
77-87	19(19%)	77-87	12(24%)	81-91	3(6%)
88-98	10(10%)	88-98	8(16%)	92-102	2(4%)
>98	3(3%)	99-109	1(2%)	>102	2(4%)

Table 5 : Body /Mass Index (BMI) Classes for the Total Sample, Male and Female, Frequency and Percentages

Total sample (BMI)	Frequency and Percentage%	Male (BMI)	Frequency and Percentage%	Female (BMI)	Frequency and Percentage%
18.1-19.6	9(9%)	18.1-21.1	9(18%)	18.5--23.1	19(38%)
20.6-22.2	24(24%)	22.1-25.1	22(44%)	24.1-28.8	22(44%)
23.2-24.8	22(22%)	26.1-29.1	13(26%)	29.8-34.5	7(14%)
25.8-26.3	12(12%)	30.1-33.1	5(10%)	35.5-40.2	1(2%)
27.3-28.8	18(18%)	34.1-37.1	1(2%)	>40	1(2%)
>28.8	15(15%)	-	-	-	-



[A]



[B]

Figure 1 : [A] Scatter Plot Diagramme shows linear relationship between the diaphragm heights in males with age; the relation shows that the height decreased by 4.8 as the age increased starting from 47.7. [B]shows linear relationship between the diaphragm heights in males with BMI; the relation shows that the BMI decreased by 0.9

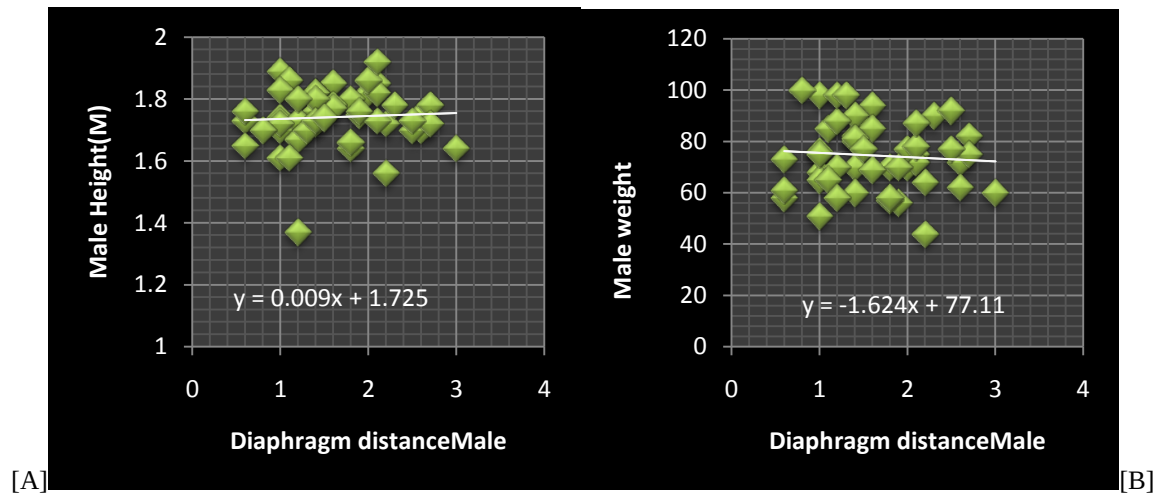


Figure 2 : [A] Scatter Plot Diagramme shows linear relationship between the diaphragm heights in males with Height; the relation shows that the height increased by 0.009 as the diaphragm distance increased starting from 1.72.[B]shows linear relationship between the diaphragm heights in males with Weight; the relation shows that the diaphragm height decreased as the weight increased.

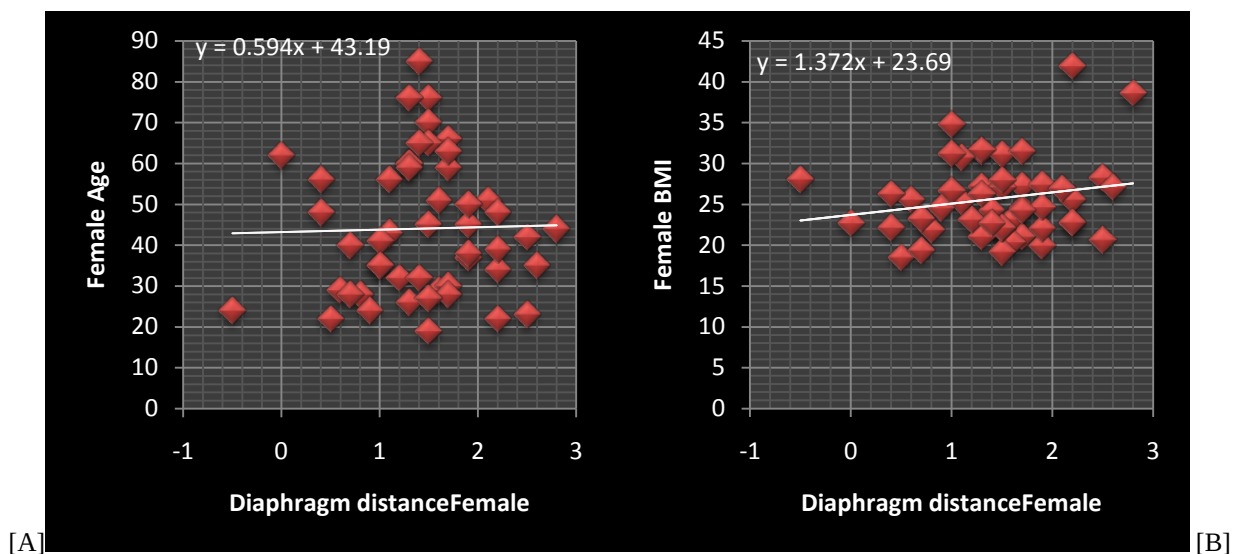


Figure 3 : [A] Scatter Plot Diagramme shows linear relationship between the diaphragm heights in Females with age; the relation shows that the height increased by 0.6 as the age increased starting from 43.2.[B] shows linear relationship between the diaphragm heights in Females with BMI; the relation shows that the height increased by 1.4 as the BMI increased starting from 23.7

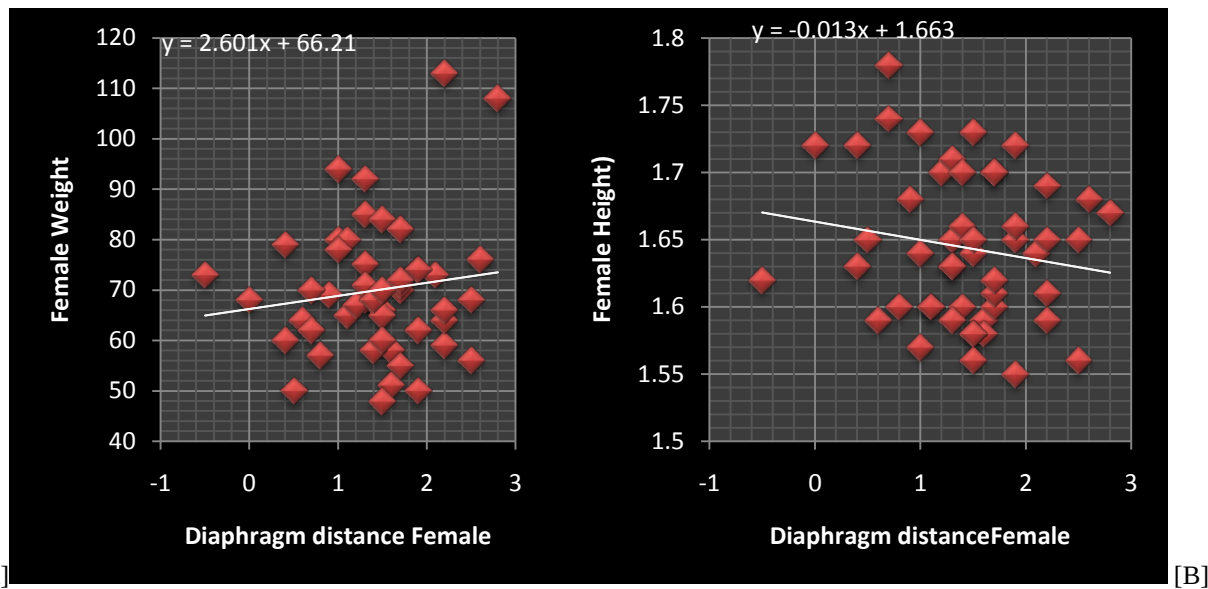


Figure 4 : Scatter Plot Diagramme shows linear relationship between the diaphragm heights in Females with Weight; the relation shows that the height increased by 2.6 as the Weight increased starting from 66.2.[B] shows linear relationship between the diaphragm heights in Females with Height; the relation shows that the Diaphragm height decreased by 0.01 as the Female Height increased starting from 1.7 meter.

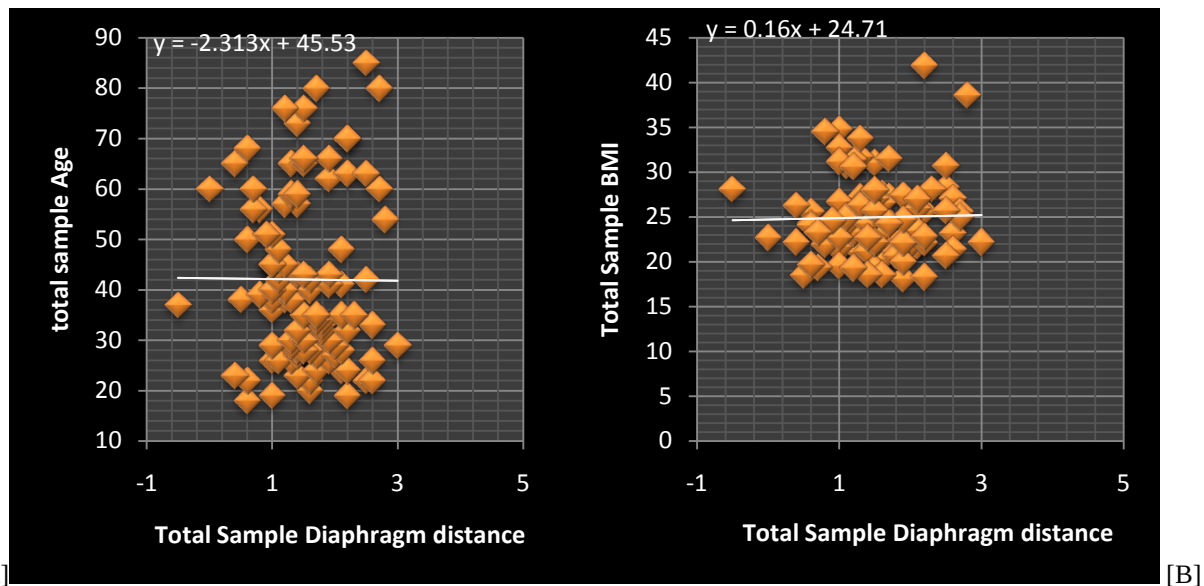


Figure 5 : Scatter Plot Diagram shows linear relationship between the diaphragm heights in Total Sample with age; the relation shows that the height decreased by 2.3 as the age increased starting from 45.5.[B] shows linear relationship between the diaphragm height and BMI, The diaphragm height increase as the BMI increased.

IV. DISCUSSION

Measurements were performed on ideal PA chest radiograph, measurement points was clearly identified. Table 1 shows the total sample means and standard deviations of the variables, the total sample age mean was 42.01 and ± 16.73 , the total sample weight mean was 72.2 ± 13.34 , the total sample height mean was 1.6926 ± 0.09 , the total sample body mass index (BMI) was 24.957 ± 4.45 and the total sample diaphragm distance mean was 1.522 ± 0.64 .

The mean age for male was 39.98 it was lower than mean age for females which was 44.04. The mean of male weight was 74.48 and for female was 69.92, the height of males was greater by 0.1m, the BMI mean for male was 24.26 and for female 25.65, the BMI of female was greater than male because male height was greater. The total sample age range was from 18 to 85, for male the range was from 18 to 82, while for female the range was from 19 to 85. Age classes for total sample, frequency and percentage were studied.

For the total sample the right hemi diaphragm was higher than the left hemi diaphragm in 98 sample which was act 98% of the total sample, the left hemi diaphragm was higher in 1 sample which was 1% of the total sample and they was in the same height in also 1 sample which was 1% of the total sample.

In males samples the right was higher in 50 sample (100%), while in females the right was higher in 48 samples (96%), the left was higher in 1 sample (2%) and they was in the same height In 1 sample (2%).For the total sample 79(79%) of the right hemi diaphragm was higher in range of 1.0 to 2.5 cm, 7(7%) were in range of 2.5 to 3.0 cm, 12 were in range of 0.1 to 0.9, 1 (1%) the right and the left were in the same height and in 1 sample the left was higher. Of 1 person with a high diaphragm was overweight; It is possible that he took an improperly deep inspiration. There were two instances where the diaphragm in addition to being low was also flat, but there were no cardiovascular or lung disease this is similar to what had been mentioned previously. [19]

For the males the distance between right and left hemi diaphragm is decreased as the age, BMI and weight increased subsequently , while it increased as the height increased For the females the distance between right and left hemi diaphragm increased as the age, BMI and weight increased as ,while it decreased as the height increased For the total, the distance between right and left hemi diaphragm decreased as the age increased while the distance increased as the BMI, weight and height increased .

Simile study showed that the averages the diaphragm was slightly higher in females, in heavy persons and after the age of 40 years. [19]

V. CONCLUSION

The study found that the right hemi diaphragm is higher than the left in 98% of sample, the left hemi diaphragm may be higher than the right but it consider significant and can be at the same height.

There is a correlation between hemi diaphragms distance and sample age, BMI, weight and height; the distance decrease with increase of age, the distance increase as increase of BMI, the distance increase as increase of weight and the distance increase as increase of height.

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