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Original Article

Gender Determination by Greater Sciatic notch and Sacral bone Measurements using three Dimensional Computed tomography in Tripoli for Libyan Population

Alauldin Othman Salim Mohammed Abseekri, Nadra Kandeel Ali Kandeel, Azza Sobhy Mohamed Mohamed Gaber, Dena Mohamed Naguib Abdel Moawed
Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Zagazig University,Eygpt.

***Corresponding author**:
Alauldin Othman Salim Mohammed Abseekri

Email:
alauddinothman2018@gmail.com

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ABSTRACT

Background: In forensic medicine, sexually dimorphic bones such as pelvic bones like the os sacrum, greater sciatic notch parameter, and sacral dimensions are typically used to determine a person's sex. Before complex autopsy preparations are made, a postmortem CT scan offers a quick and simple way to illustrate and measure bone structures .

Aim: To emphasize the role of pelvic bone measurements in sex determination, to estimate sex using based on morphometric data from computed tomography images of sacrum and greater sciatic notch.

Methods: This cross-sectional study was carried out in Tripoli Medical Center, Center for Judicial Expertise and research, Libya and Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Zagazig University, Egypt. Subjects were divided into group I: included 65 male and group II: included 65 female. All participiants were subjected to Pelvic CT scan examinations.

Results: All the CT measurements of the sacral vertebra (m.t.d, a.p.d, area and perimeter except m.s.d) were significantly higher in males compared to females, while all CT measurements of the greater sciatic notch were significantly higher in females compared to males. The area of the sacral vertebra and the the width of the greater sciatic notch were the only significant variable in sex determination.

Conclusion: CT scan was a valuable method in measuring the selected pelvic sacral dimensions. The estimated values of pelvic measurements by using 3D CT images could develop a pelvic model with a regression formula with high accuracy value.

Keywords: Gender Determination, Greater Sciatic notch, Sacral bone, Computed tomography.

INTRODUCTION

In forensic science, identifying a suspect's gender is a crucial undertaking that reduces the number of people who could be searched for. Numerous physical characteristics of the human body have been utilized to determine a person's sex. These characteristics include the patella, teeth, radial and ulnar bones, metatarsals, long bones of the arm, foot form, femoral head, and shoe proportions [1].

There are two ways to determine a person's sex: morphologic and metric. The metric approach was chosen since it was simple to repeat, very accurate, and didn't require any specialized knowledge [2].

Numerous writers propose hip bone-based gender determination formulae derived from discriminant functional analysis. The calculations are more accurate, according to the scientists, if sex is determined by comparing the hip bones of members of the same group [3].

Different physical traits found in different areas of the human skeleton can be used to accurately detect a person's gender. Because it contains so many characteristics that potentially indicate sexual differences, the pelvis is the section of the human skeleton that best serves these functions. Numerous recent studies have demonstrated that the pelvis can serve these goals because it is one of the largest and slowest-decomposing components of the skeleton [4].

It is feasible to determine a person's sex 80% of the time using their pelvic bone. Age was not significantly correlated with sciatic notch variation, but it was higher in females than in males [5].

It has been discovered that the male pelvis has a deeper sciatic notch than the female pelvis, with the former having a larger sciatic notch. The female has bigger anterior breadth and sacral alar, while the male has larger sacral height and S1 vertebra. Males are typically shorter than females in the distance between the posterior inferior iliac spine and the ischial spine, and males have a deeper greater sciatic notch than females do [6].

The anatomical changes in the pelvis between the sexes to account for childbearing make the sacrum useful for sex identification. Situated between the two hip bones, the human sacrum is a massive, triangular bone fusion made up of five vertebrae that forms the postero-superior wall of the pelvic cavity [7].

The sacrum's initial segment has the largest body, while the size of the subsequent segments decreases from above to below. Its shape is similar to a lumbar vertebra. The L5 and S1 vertebrae can both be used to determine a person's sex [8].

One significant imaging technique that offers distinct data sources for quantitatively and non-invasively analyzing human variability is computed tomography (CT). Its rapidity and capacity to record fine bone details make it the perfect instrument for time-saving and safeguarding skeletal remains from manual handling [9].

PATIENTS AND METHODS

This cross-sectional study was carried out in Tripoli Medical Center, Center for Judicial Expertise and research, Libya and Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Zagazig University, Egypt. Subjects were divided into two groups: group I: included 65 male and group II: included 65 female. A written informed consent was taken from the subjects with explanation of the procedure, possible hazards& IRB approval was attained (Number 10214)

Inclusion criteria included Libyan males and females, age between 30 and 40 years with lack of arthrosis, disorders affecting the bone tissue, or bone injury.

Exclusion criteria included skeletal immaturity, bone fractures, pathogenic abnormalities like developmental dysplasia that is present from birth, bone implant, chronic disease and metabolic bone diseases, CT scans with abnormalities like scoliosis, hip prostheses and poor quality studies, surgery, tumors, osteoporosis and osteoarthritis and pregnancy.

All subjects were subjected to history taking; Digital data from pelvic CT scan tests was used as research material. Moreover, a Siemens SOMATOM CT scanner with 16 slices was employed as part of the radiological assessment instrument. Two radiologists measured the CT pictures without knowing the sex of any of the patients. Two radiologists measured every single data set separately. The radiologists took three measurements of each variable, for a total of six measurements per variable.

Radiological CT technique :

These radiographs were routinely taken at a distance of 100 cm. Every radiograph was taken from the anteroposterior position. Every radiograph, which belonged to adults between the ages of 30 and 40, was devoid of pathological abnormalities. Following a fresh recon with a 1.5 mm slice width, the first sacral segment measures were ascertained using three-dimensional image processing on a separate workstation; bone window and sharpness B70 for optimal viewing using the software program analyze (Syngo VB 42). There was no need for contrast because the person was lying down in a supine position. Eight measurements were evaluated in this work: three for the larger sciatic notch and five for the first sacral vertebra. According to Hussein et al. [8] and Bakici et al. [10] all measurements were in mm except the area in cm².

A- First Sacral vertebra (S1)

1 .Maximum transverse diameter (m.t.d): the greatest separation between the two lateral points.

2 .Antero-posterior diameter (a.p.d): the greatest separation between the two projecting points that are most anterior and posterior.

3.Area: determined by the program analyzer: In square terms, Area of Circle = $\pi r2$ or $\pi d2/4$, where (Pi) π = 22/7 or 3.14. The circumference to diameter ratio of any circle is represented by Pi (π). This mathematical constant is unique. where r is the circle's radius.

4.Maximum transverse diameter between the sacral ala: the greatest separation between the sacral ala's two furthest points.

5. Perimeter: Calculated from the equation = Where π: is Pi; approximately 3.14, r1 is the m.t.d and r2 is the a.p.d. [8].

B- Greater sciatic notch:

1.Width of greater sciatic notch: The measured distance was the straight line segment connecting the posterior edge of the ilium's pyramidal process to the tip of the ischial spine .

2. Depth of notch: This is the shortest path between the larger sciatic notch's breadth line and its deepest point of concavity.

3 .Posterior segment width of the notch: This indicates the length of the larger sciatic notch's posterior segment breadth where the width line and depth line cross .

Statistical Analysis:

SPSS v28 (IBM Inc., Armonk, NY, USA) was used for the statistical analysis. The unpaired Student's t-test, logistic regression, chi-square test, or Fisher's exact test were employed.

RESULTS

Our study consisted of 65 (50.0%) males with mean age of 34.9 ± 2.9 years and 65 (50.0%) females with mean age of 34.8 ± 2.78 years. [Table 1]

According to the 1st observer, all the CT measurements of the sacral vertebra (m.t.d, a.p.d, area and perimeter) were considerably greater in the group of men than in the group of women (P<0.05). But m.s.d was insignificantly different between both groups. According to the 2nd observer, all the CT measurements of the sacral vertebra (m.t.d, a.p.d, area and perimeter) were considerably greater in the group of men than in the group of women (P<0.05). But m.s.d was insignificantly different between both groups. [Table 2].

According to the 1st observer, all CT measurements of the greater sciatic notch (Width, depth and posterior segment) were significantly higher in female group compared to male group (P<0.001). [Table 3]

In this study according to 1st observer, m.t.d can significantly identify sex of the studied patients with AUC of 0.639, P value=0.005, and at cutoff value >50.5 with 66.15% sensitivity, 46.15 % specificity, 55.1% PPV and 57.7% NPV. a.p.d can significantly identify sex of the studied patients with AUC of 0.604, P value=0.038, and at cutoff value >34.9 with 78.46% sensitivity, 40.0 % specificity, 56.7% PPV and 65.0% NPV. The area can significantly identify sex of the studied patients with AUC of 0.620, P value=0.017, and at cutoff value >13.7 with 67.69% sensitivity, 47.69 % specificity, 56. 4% PPV and 59.6% NPV. Perimeter can significantly identify sex of the studied patients with AUC of 0.614, P value=0.024, and at cutoff value >14.14 with 76.92% sensitivity, 38.46 % specificity, 55.6% PPV and 62.5% NPV. But m.s.d can insignificantly identify sex of the studied patients. [Table 4]

Also, according to 2nd observer, m.t.d can significantly identify sex of the studied patients with AUC of 0.609, P value=0.032, and at cutoff value >49.21 with 70.77% sensitivity, 38.46 % specificity, 53.5% PPV and 56.8% NPV. a.p.d can significantly identify sex of the studied patients with AUC of 0.599, P value=0.049 and at cutoff value >34.63 with 75.38% sensitivity, 26.15 % specificity, 50.5% PPV and 51.5% NPV. The area can significantly identify sex of the studied patients with AUC of 0.638, P value=0.006, and at cutoff value >12.6 with 80.0% sensitivity, 29.23 % specificity, 53.1% PPV and 59.4% NPV. Perimeter can significantly identify sex of the studied patients with AUC of 0.646, P value=0.003, and at cutoff value >14.14 with 80.0% sensitivity, 36.92 % specificity, 55.9% PPV and 64.9% NPV. But m.s.d can insignificantly identify sex of the studied patients. [Table 4]

According to 1st observer, the width of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.990, P value<0.001, and at cutoff value ≤45.6 with 100.0% sensitivity, 98.46 % specificity, 98.5% PPV and 100.0% NPV. The depth of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.779, P value<0.001, and at cutoff value ≤33.49 with 92.31% sensitivity, 44.62 % specificity, 62.4% PPV and 85.3% NPV. The posterior segment of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.718, P value<0.001, and at cutoff value ≤14.40 with 100.0% sensitivity, 50.77 % specificity, 67.0% PPV and 100.0% NPV. [Table 5]

According to 2nd observer, the width of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.991, P value <0.001, and at cutoff value ≤45.7 with 100.0% sensitivity, 98.46 % specificity, 98.5% PPV and 100.0% NPV. The depth of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.780, P value<0.001, and at cutoff value ≤33.41 with 92.31% sensitivity, 44.62 % specificity, 62.5% PPV and 85.3% NPV. The posterior segment of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.718, P value<0.001, and at cutoff value ≤14.0 with 72.31% sensitivity, 50.77 % specificity, 59.5% PPV and 64.7% NPV. [Table 5]

On multivariate logistic regression analysis, we found that the m.t.d, a.p.d and the area of the sacral vertebra according to the 1st observer were the only significant variable in sex determination (P<0.05). The area of the sacral vertebra according to the 2nd observer was the only significant variable in sex determination (P=0.026). [Table 6]

On multivariate logistic regression analysis, we discovered that the sole relevant variable in determining sex was the breadth of the larger sciatic notch as reported by the first observer (P=0.001). Using multivariate logistic regression analysis, we discovered that the sole relevant variable in determining sex was the breadth of the larger sciatic notch as reported by the second observer (P=0.007). [Table 7]

Table 1: Demographics of the studied groups

		Total (n=130)	Male group (n=65)	Female group (n=65)	P value
Age (years)	Mean ± SD	34.8 ± 2.83	34.9 ± 2.9	34.8 ± 2.78	0.951
	Range	30 - 40	30 – 40	30 - 40	

Table 2: CT measurements of the sacral vertebra of the studied groups according to the 1st and 2nd observer

		Male group (n=65)	Female group (n=65)	Test of sig	P value
CT measurements of the sacral vertebra of the studied groups according to the 1st observer					
m.t.d	Mean ± SD	54.98 ± 11.8	51.17 ± 6.3	t= 2.290	**0.024***
	Range	36.2 - 74.6	39.5 - 60.9		
a.p.d	Mean ± SD	43.2 ± 8.84	40.01 ± 8.37	t= 2.134	**0.035***
	Range	30.7 - 58.3	30.6 - 59		
m.s.d	Mean ± SD	107.9± 17.3	106.02 ± 8.3	t= 0.821	0.413
	Range	76.3 – 128	90.8 - 118.7		
Area	Mean ± SD	18.97± 7.64	16.5 ± 4.97	t= 2.179	**0.031***
	Range	9.99 - 31.8	10.5 - 26.8		
Perimeter	Mean ± SD	15.8 ± 2.6	14.8 ± 2.19	t= 2.352	**0.020***
	Range	11.04- 20.1	11.4 - 18.51		
CT measurements of the sacral vertebra of the studied groups according to the 2nd observer					
m.t.d	Mean ± SD	55.4 ± 10.58	51.5 ± 7.77	t= 2.416	**0.017***
	Range	38.9 - 74.6	39.37 - 69.16		
a.p.d	Mean ± SD	44.5 ± 9.84	41.05 ± 9.33	t= 2.134	**0.045***
	Range	30.53 - 59.3	30.1 - 59.27		
m.s.d	Mean ± SD	107.01±16.4	105.3 ± 11.68	t=0.668	0.505
	Range	76.3 - 129.8	71.31 - 119.7		
Area	Mean ± SD	19.3 ± 7.78	16.9 ± 5.12	t= 2.062	**0.041***
	Range	9.9 - 32.5	10.53 - 27.8		
Perimeter	Mean ± SD	15.9 ± 2.73	15.01 ± 2.08	t=2.150	**0.033***
	Range	11.05 - 21.5	11.87 - 18.51		

m.t.d: maximum transverse diameter, a.p.d: the anteroposterior diameter, m.s.d: maximum transverse diameter *: statistically significant as P value <0.05

Table 3: CT measurements of the greater sciatic notch of the studied groups according to the 1st and 2nd observer

		Male group (n=65)	Female group (n=65)	Test of sig	P value
CT measurements of the greater sciatic notch of the studied groups according to 1st observer					
Width	**Mean ± SD**	44.1 ± 1.29	54.9 ± 5.08	t= 16.52	**<0.001***
	Range	40.35- 45.67	43.7 - 61.75		
Depth	**Mean ± SD**	27.1 ± 3.94	32.1 ± 4.96	t= 6.466	**<0.001***
	Range	20.07 - 35	25.44 - 39.9		
Posterior segment	**Mean ± SD**	12.6 ± 1.36	14.95 ± 2.99	t= 5.761	**<0.001***
	Range	10.16 - 14.4	10.07 - 19.1		
CT measurements of the greater sciatic notch of the studied groups according to 2nd observer					
Width	**Mean ± SD**	44.1 ± 1.63	54.8 ± 5.08	t= 16.30	**<0.001***
	Range	36.01- 45.71	43.87 - 61.75		
Depth	**Mean ± SD**	27.1 ± 3.91	32.2 ± 4.96	t= 6.49	**<0.001***
	Range	20.2 - 34.89	25.44 - 39.9		
Posterior segment	**Mean ± SD**	12.6 ± 1.34	15 ± 2.99	t= 5.73	**<0.001***
	Range	10.15 - 14.4	10.07 - 19.1		

*: statistically significant as P value <0.05

Table 4: Diagnostic accuracy of CT measurements of the sacral vertebra in sex identification according to the 1st and 2nd observer

	Cut off	Sensitivity	95% CI	Specificity	95% CI	PPV	NPV	AUC	P value
Diagnostic accuracy of CT measurements of the sacral vertebra in sex identification according to the 1st observer									
m.t.d	>50.5	66.15	53.4 - 77.4	46.15	33.7 - 59.0	55.1	57.7	0.639	**0.005***
a.p.d	>34.9	78.46	66.5 - 87.7	40.00	28.0 - 52.9	56.7	65.0	0.604	**0.038***
m.s.d	>117.1	49.23	36.6 - 61.9	95.38	87.1 - 99.0	91.4	65.3	0.606	0.057
Area	>13.7	67.69	54.9 - 78.8	47.69	35.1 - 60.5	56.4	59.6	0.620	**0.017***
Perimeter	>14.14	76.92	64.8 - 86.5	38.46	26.7 - 51.4	55.6	62.5	0.614	**0.024***
Diagnostic accuracy of CT measurements of the sacral vertebra in sex identification according to the 2nd observer									
m.t.d	>49.21	70.77	58.2 - 81.4	38.46	26.7 - 51.4	53.5	56.8	0.609	**0.032***
a.p.d	>34.63	75.38	63.1 - 85.2	26.15	16.0 - 38.5	50.5	51.5	0.599	**0.049***
m.s.d	>113.93	40.0	28.0 - 52.9	76.92	64.8 - 86.5	63.4	56.2	0.571	**0.172**
Area	>12.6	80.00	68.2 - 88.9	29.23	18.6 - 41.8	53.1	59.4	0.638	**0.006***
Perimeter	>14.14	80.00	68.2 - 88.9	36.92	25.3 - 49.8	55.9	64.9	0.646	**0.003**

m.t.d: maximum transverse diameter, a.p.d: the anteroposterior diameter, m.s.d: maximum transverse diameter, CI: confidence interval, PPV: positive predictive value, NPV: negative predictive value, *: statistically significant as P value<0.05.

Table 5: Diagnostic accuracy of CT measurements of the greater sciatic notch in sex identification according to the 1st and 2nd observer

	Cut off	Sensitivity	95% CI	Specificity	95% CI	PPV	NPV	AUC	P value
Diagnostic accuracy of CT measurements of the greater sciatic notch in sex identification according to 1st observer									
Width	≤45.6	100.0	94.5 - 100.0	98.46	91.7 - 100.0	98.5	100.0	0.990	**<0.001***
Depth	≤33.49	92.31	83.0 - 97.5	44.62	32.3 - 57.5	62.5	85.3	0.779	**<0.001***
Posterior segment	≤14.40	100.0	94.5 - 100.0	50.77	38.1 - 63.4	67.0	100.0	0.718	**<0.001***
Diagnostic accuracy of CT measurements of the greater sciatic notch in sex identification according to 2nd observer									
Width	≤45.70	100.00	94.5 - 100.0	98.46	91.7 - 100.0	98.5	100.0	0.991	**<0.001***
Depth	≤33.41	92.31	83.0 - 97.5	44.62	32.3 - 57.5	62.5	85.3	0.780	**<0.001***
Posterior segment	≤14	72.31	59.8 - 82.7	50.77	38.1 - 63.4	59.5	64.7	0.718	**<0.001***

CI: confidence interval, PPV: positive predictive value, NPV: negative predictive value, *: statistically significant as P value<0.05.

Table 6: Multivariate logistic regression analysis for identification of sex using CT measurements of the sacral vertebra in sex identification according to the 1st and 2nd observer

	Coefficient	SE	P	OR	95% CI
Multivariate logistic regression analysis for identification of sex using CT measurements of the sacral vertebra in sex identification according to the 1st observer					
m.t.d	0.071	0.024	**0.003***	1.073	1.023 to 1.126
a.p.d	0.0540	0.025	**0.038***	1.055	1.003 to 1.110
m.s.d	0.023	0.016	0.160	1.023	0.990 to 1.057
Area	0.184	0.040	**<0.001***	1.202	1.110 to 1.302
Perimeter	-0.018	0.108	0.867	0.982	0.793 to 1.214
Multivariate logistic regression analysis for identification of sex using CT measurements of the sacral vertebra in sex identification according to the 2nd observer					
m.t.d	0.0339	0.022	0.125	1.034	0.990 to 1.080
a.p.d	-0.012	0.031	0.696	0.987	0.929 to 1.050
m.s.d	-0.027	0.018	0.125	0.972	0.938 to 1.007
Area	0.082	0.036	**0.026***	1.086	1.010 to 1.167
Perimeter	0.185	0.116	0.111	1.203	0.958 to 1.511

m.t.d: maximum transverse diameter, a.p.d: the anteroposterior diameter, m.s.d: maximum transverse diameter, SE: standard error, OR: odds ratio, CI: confidence interval, *: statistically significant as P value <0.05.

Table 7: Multivariate logistic regression analysis for identification of sex using CT measurements of the greater sciatic notch in sex identification according to the 1st and 2nd observer

	Coefficient	SE	P	OR	95% CI
Multivariate logistic regression analysis for identification of sex using CT measurements of the greater sciatic notch in sex identification according to the 1st observer					
Width	-1.795	0.557	**0.001***	0.166	0.055 to 0.495
Depth	-0.361	0.372	0.331	0.696	0.335 to 1.444
Posterior segment	1.987	1.300	0.126	7.295	0.570 to 93.288
Multivariate logistic regression analysis for identification of sex using CT measurements of the greater sciatic notch in sex identification according to the 2nd observer					
Width	-1.992	0.740	**0.007***	0.136	0.032 to 0.581
Depth	-0.541	0.496	0.275	0.581	0.220 to 1.537
Posterior segment	2.621	1.906	0.169	13.7574	0.32 to 577.33

SE: standard error, OR: odds ratio, CI: confidence interval

DISCUSSION

We found that according to the 1st and 2nd observers that all the CT measurements of the sacral vertebra (m.t.d, a.p.d, area and perimeter) were considerably greater in the male group than in the female group (P<0.05), but m.s.d was insignificantly different between both groups .

In concordance with our study, Hussein et al. showed in comparison to males, all S1 measures were lower in females. Significant differences in sex identification were found in four measurements: m.t.d., a.p.d., area, and perimeter [8]. The findings of earlier research [11] showing that all S1 values were lower in females than in males were supported by these data.

Also, Setiawati et al. discovered that there were significant differences (p < 0.05) in the radiologic components tested between the sexes, with the exception of the sacral segment's transverse diameter (p = 0.180) [12].

Our study showed that according to the 1st and 2nd observers, the female group's bigger sciatic notch CT parameters (Width, depth, and posterior segment) were all substantially higher than the male group's (P<0.001).

In agreement with our study, Intasuwan et al. [13] have demonstrated a level of sexual dimorphism in GSN that is statistically significant. It was discovered that the shape of the larger sciatic notch was narrow and asymmetrical in males, but wide and symmetrical in females.

The size of the pelvic inlet is related to the shape and dimensions of the GSN. As a result, it was shown that, when employed alone, the GSN is very accurate at estimating sex [14].

In line with our findings, Soltani et al. found that the GSN was wider in female than male (p<0.001) [15 .[

Also, according to Davivongs et al., females have a wider and deeper greater sciatic notch than males do [16]

In addition, Knecht et al. [17] discovered that women had a longer posterior portion of the larger sciatic notch than men do. A prior study found that women have a larger posterior angle of the greater sciatic notch than men do [18].Furthermore, Palfrey et al the width and posterior segment of the larger sciatic notch varied significantly across the sexes in a study of bones from West Africa that was higher in female than male [19]. Dibennardo and Taylor et al examined the adult coxae of known-sex American blacks and whites, and discovered that both racial women had deeper greater sciatic notch depths [20]

Also, Antony et al. a total of 40 hip bones revealed that the greater sciatic notch's width is considerably greater in female hip bones than in male hip bones, and the greater sciatic notch's depth is much larger in male hip bones than in female hip bones [21]

Additionally, in study of Devadas et al., the width is greater in female than in male (p=0.0003) [22].

The width was significantly different in both sexes (p<0.001) in both sides. Jain and Choudhary revealed that the width was greater on the female's right side (p>0.05) and the male's left side (p<0.05) [23]

Akshaya K et al. stated that Vernier calipers were used in a study on 60 pelvic bones from India to evaluate the depth of the sciatic notch and the distance between the posterior inferior iliac spine and ischial spine. They discovered that there were differences between the sexes in the characteristics they examined and came to the conclusion that the female pelvis had a deeper sciatic notch than the male pelvis, with the posterior inferior iliac spine and ischial spine being farther apart [24].

However, although the difference was not statistically significant (p=0.533 and p=0.551, respectively), the breadth was greater on the left side for females and on the right side for males in another study by Kalsey et al. Racial disparities could be the cause of this discrepancy in the results [25].

Furthermore, in this study, the midwidth is larger in females than in males (p<0.001). Both in males and females, this metric is marginally larger on the left side (p=0.159). Both the male and female midwidths differ significantly (p<0.001) on both sides [15].

Regarding posterior segment, the result of Soltani et al. [15] a study by Soltani et al. [15] revealed a significant difference (p<0.001) in the posterior angle between males and females on both the right and left sides. They showed that there was a substantial difference (p<0.001) in the posterior segment between the male and female on both sides. The posterior section revealed a significant difference (p=0.017) between the right and left sides with regard to side.

In agreement with our study, Raut et al. study found that the posterior segment was significantly greater in female than male in both sides [18]. The result was also similar in Dnyanesh et al. [26].

Therefore, without taking the side into account, the posterior portion cannot be utilized to determine sex. The post segment in the Shah et al. study showed a significant difference between the sexes, with the female having a longer post segment than the male (p<0.001). [27].

Our study showed that m.t.d can significantly identify sex of the studied patients with AUC of 0.639, P value=0.005, and at cutoff value >50.5 with 66.15% sensitivity, 46.15 % specificity, 55.1% PPV and 57.7% NPV. a.p.d can significantly identify sex of the studied patients with AUC of 0.604, P value=0.038, and at cutoff value >34.9 with 78.46% sensitivity, 40.0 % specificity, 56.7% PPV and 65.0% NPV. The area can significantly identify sex of the studied patients with AUC of 0.620, P value=0.017, and at cutoff value >13.7 with 67.69% sensitivity, 47.69 % specificity, 56. 4% PPV and 59.6% NPV. Perimeter can significantly identify sex of the studied patients with AUC of 0.614, P value=0.024, and at cutoff value >14.14 with 76.92% sensitivity, 38.46 % specificity, 55.6% PPV and 62.5% NPV. But m.s.d can insignificantly identify sex of the studied patients.

In agreement with our study, Hussein et al. observed that a.p.d, m.t.d, area, Perimeter 0.657, can significantly identify sex of the studied patients with AUC 0.609, 0.652, 0.648, 0.657 respectively (P< 0.001) [8].

Also, Benazzi et al. performed their study on 114 Italian and studied the accuracy of m.t.d, area, perimeter and ala breadth and found that the accuracy of was Area (86.9%) [28]

In addition, Zech et al. performed CT scan on m.t.d, a.p.d, area, perimeter and ala breadth and reported that the accuracy of Perimeter& a.p.d were (78.9%) [29]. Franklin et al. evaluated CT on m.t.d, a.p.d, pelvic inlet, reported that the accuracy of outlet Sacral data (69%) and other parameters were (100%) accuracy [11].

We found that the width of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.990, P value<0.001, and at cutoff value ≤45.6 with 100.0% sensitivity, 98.46 % specificity, 98.5% PPV and 100.0% NPV. The depth of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.779, P value<0.001, and at cutoff value ≤33.49 with 92.31% sensitivity, 44.62 % specificity, 62.4% PPV and 85.3% NPV. The posterior segment of the greater sciatic notch can significantly identify sex of the studied patients with AUC of 0.718, P value<0.001, and at cutoff value ≤14.40 with 100.0% sensitivity, 50.77 % specificity, 67.0% PPV and 100.0% NPV.

In Soltani et al. study, the posterior angle and posterior segment breadth (90.3% and 89.5%, respectively) were the most reliable characteristics for determining sex [15].

On multivariate logistic regression analysis, we found that the m.t.d, a.p.d and the area of the sacral vertebra according to the 1st observer were the one factor that significantly influences sex determination (P<0.05). The breadth of the larger sciatic notch as reported by the first observer was the only significant variable in sex determination, according to multivariate logistic regression analysis (P=0.001). The area of the sacral vertebra according to the second observer was the only significant predictor in sex determination, according to multivariate logistic regression analysis (P=0.026). The breadth of the larger sciatic notch, as reported by the second observer, was the only significant variable in sex determination, according to multivariate logistic regression analysis (P=0.007).

The "perimeter" value, which has an accuracy of roughly 69.6%, is the most important parameter in determining sex from S1 data. The results of the forward stepwise regression analysis of all parameters indicated 68.8% prediction probability and 66% accuracy when using the a.p.d.; the area showed 68% prediction probability and 69% accuracy when using the m.t.d. [8].

A multivariate analysis employing logistic regression to identify important characteristics and produce a formula that might accurately estimate a person's sex [30]. Significant values were found for the pelvic components, supporting the earlier debate. These elements, particularly SPA, which often ranked among the high scoring categories, demonstrated variations in sexual dimorphism in both sexes. This method yielded 100% sensitivity for male identification and 81.1% specificity for female identification, resulting in a high total validity (91.05% accuracy). However, these findings must be compared with those of earlier research, wherein higher validity values which could approach 100% were obtained [31].

Setiawati et al. shown how a pelvic model might be created using the estimated values of pelvic measurements obtained with 3D-CT. The particular radiometric parameters derived from this research have a beneficial effect on the analysis and description of the size and shape of the pelvis in both the male and female populations [12].

CONCLUSION

The CT scan was a useful tool for determining the chosen pelvic sacral dimensions. A pelvic model with a regression method with a high accuracy value might be developed utilizing the predicted values of pelvic measurements obtained from 3D CT scans. We concluded that all the CT measurements of the sacral vertebra (m.t.d, a.p.d, area and perimeter except m.s.d) were significantly higher in males compared to females, while all CT measurements of the greater sciatic notch were significantly higher in females compared to males. The area of the sacral vertebra and the width of the greater sciatic notch were the only significant variable in sex determination.

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