Research Article

Association of Subpubic Angle Measurement with Age and Gender in a Group of Adult Sudanese Patients

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Abstract

Background: The measurement of the subpubic angle (SPA) has been used for determining gender with a high degree of accuracy in various ethnic groups. This measurement can also be helpful in forensic and physical anthropology. The aim of this study was to compare the SPA in different adult age groups (males and females) and to use the SPA to estimate the demarking point (DP) for the determination of gender.

Methods: This study included 158 subjects – 59 male and 99 female. The SPA was measured electronically using antero-posterior pelvis X-rays. Measurements were taken retrospectively using the Picture Archiving and Communication System. SPA measurements were compared between the male and female participants in different adult age groups. To determine the gender, the DP was calculated from the means of SPA in male and female participants.

Results: A comparison of the means of SPA between males and females showed that females ($134.94 \pm 15.33°$) had wider SPA than males (105.88 ± 10.33) with a significant difference ($P = 0.012$). While a DP > 126.5 is most likely indicative of a female pelvis, a DP < 104.3 is indicative of a male pelvis. The accuracy levels based on the measured DP of participants in this study were 45.8% and 69.7% for males and females, respectively. Besides, with regards to age, the mean values for different age groups in males and females were statistically insignificant (P-values were 0.21 and 0.75, respectively).

Conclusions: According to the obtained results, the variations in the measurements of the SPA from pelvic X-rays can be used to determine gender. The calculated SPA range and DP were found to predict female gender with higher accuracy. Age was not associated with any notable differences in SPA measurements.

Keywords: subpubic angle, pelvis, Sudanese, sex differences

1. Introduction

The accurate determination of sex and race is an important tool in forensic and physical anthropology as well as obstetrics. A variety of simple pelvimetric measurements, including the subpubic angle (SPA), can be used before delivery to assess the adequacy of the pelvic outlet. These measurements help in the prediction of obstructed labor,

which may be complicated by uterine rupture, postpartum hemorrhage, or maternal infection. These complications represent major causes of maternal mortality in the developing world [1, 2].

The size of the SPA can be used to assess the suitability of the female pelvis for labor. Pelvises with a narrow SPA have closer ischial tuberosities and hence smaller outlets. It is believed the SPA should be ≥90° if problems during delivery are to be avoided [3]. An SPA of <90° significantly increases the chances of damage to the maternal soft tissues and even arrest of the head of the baby [3].

In addition to its importance in obstetrics, measurement of the SPA is important in forensic anthropology for identification of sex from skeletal remains. Many studies confirm the high accuracy, sensitivity, and specificity of the SPA in sex determination [4–6].

Measurement of the SPA in different ethnic groups at both regional and international levels indicated the occurrence of inter-population variations. Studies carried out in Egypt [4], Uganda [7], Nigeria [8], South Africa [9], Iran [10], United States [11], and England [12] unanimously concluded that the SPA was greater in females than males. Further evidence of SPA variability among ethnic groups can be seen in differences between South Africans and Americans of White and African descent [9, 11], as well as certain Nigerian tribes [8].

Table 1 summarizes the measurements of the SPA for males and females in selected ethnic groups.

TABLE 1

	Mean SPA in males (in °)	Mean SPA in females (in °)	Type of study
Egypt [4]	102.3	143.3	Radiographic
Malawi [13]	99.00	129	Radiographic
Nigeria: Ikeweri: Kalabari [8]	100.3 105	119 125	Radiographic
Uganda [7]	93.9	116.1	Radiographic
Iran [5]	101.5	135.5	Radiographic
Anatolian Caucasians [6]	65.9	82.6	Computed tomography
West Australian [14]	69	88	Computed tomography
America: Black White [11]	65.8 63.7	85.2 88.4	Skeletal remains
England [15]	75.8	93.5	Radiographic

The measurement of the SPA and determining its normal range can be used to predict the occurrence of obstructed labor, hence decreasing maternal mortality. The SPA can also be utilized to calculate the demarking point (DP). Both of these measurements are

valuable tools in physical anthropology and specifically the determination of gender from bony remains.

2. Materials and Methods

This descriptive cross–sectional study was conducted retrospectively in a hospital-based setting. Antalya Medical Center, being one of the main radiological centers in Khartoum State, was chosen as the study area. The investigation was carried out on Sudanese patients attending the center for pelvic X-ray between January 2017 and January 2018. Patients with pubic bone fractures, children, and non-Sudanese citizens were excluded.

Data was collected using the center's Picture Archiving and Communication System (PACS) which enabled the use of patient's information without breaking confidentiality. Demographic data including age and gender of the patients were recorded.

The pelvic X-rays used in this study were taken in an antero-posterior view. The patients were placed in the standard supine position with their legs extended and feet approximated while the X-ray tube was angulated vertically. Measurements of the angle were obtained electronically from images by computed radiography (Allengers-525) (see appendices 1 and 2).

Data were analyzed using the Statistical Package for the Social Sciences (SPSS. IBM®). Statistical tests used were descriptive analyses, and t-test was conducted for comparison of means. The DPs for males and females were obtained from the calculated ranges (calculated range = Mean $\pm$ 2 SD) according to Singh and Potturi [16]. The DP for males was any angle greater than the minimum calculated range for females and the DP for females was any angle greater than the male calculated maximum range.

3. Results

In total, 158 subjects were enrolled in this study, 99 of which were females (63%) and the remaining 59 were males (37%). The mean of the SPA in females (134.94° $\pm$ 15.33) was found to be greater than the mean in males (105.88° $\pm$ 10.33). This difference was statistically significant (P-value: 0.012), as shown in Table 1.

There was no statistical association between gender, age groups, and means of SPA (the P-values in males and females were 0.21 and 0.75, respectively), Table 2.

The DPs obtained showed that any SPA <104.3° indicated a male gender, while any angle >126.5° was indicative of a female gender. Using these DPs, the accuracy level of gender determination was reported as 69.7% and 45.8 % for females and males, respectively (Table 3).

TABLE 2: Descriptive statistics for the SPA in males and females.

Gender	Number	Mean ± SD	Median	Mode	Minimum	Maximum	P-value
Male	59	105.88° ± 10.33	107	109	90	132	0.012*
Female	99	134.94° ±15.33	135	143	94	167	

*P-value is significant ($p \leq 0.05$ was considered as significant).

TABLE 3: Association between gender, age group, and means of SPA.

Gender	Age Group	N	Mean ± SD	P-value
Male	18–34	19	103.14 ± 9.23	
	35–50	22	104.6 ± 8.89	0.21*
	>50	18	109.6 ± 11.21	
Female	18–34	28	135.94 ± 14.74	
	35–50	33	137.53 ± 16.54	0.75*
	>50	38	133.77 ± 16.68	

*P-value is insignificant ($p \leq 0.05$ was considered as significant).

TABLE 4: Calculated range for SPA in males and females and the demarking points according to Singh and Potturi.

Gender	Minimum SPA (mean − 2SD)	Maximum SPA (Mean + 2 SD)	Demarking point	Accuracy level (%)
Male	85.2	126.5	<104.3	45.8
Female	104.3	165.6	>126.5	69.7

4. Discussion

Pelvic X-ray measurements, including the SPA and DP, are significant in the fields of physical anthropology and obstetrics. Using the pelvic X-rays from the present study that investigated a select sample of Sudanese individuals, it was determined that the SPA is generally higher in females than males. Furthermore, measurements taken from these images can predict female gender with a higher degree of accuracy.

The SPA has been measured at regional and international levels in different ethnic groups. In the regional context, a study conducted in Egypt by Abd-El-hameed *et al.* using 400 antero-posterior radiographs reported a slightly higher SPA in females than those in the present study. The mean value of the SPA was found to be approximately

similar in Egyptian males and their Sudanese counterparts investigated in the current study [4].

Overall, the SPA is lower in other African countries when compared with the figures found in this investigation. This is evident in data reported from Malawi [13], Nigeria (conducted among native ethnic groups Ikwerre and Kalabari) [8], Uganda [7], and South Africa [9]. Despite the different methodologies used in the aforementioned studies (bony remains, radiographs, and computed tomography), the SPA values were consistently lower than those in the current study. This difference may be explained by the varying cultural, environmental, and genetic factors that are known to determine the shape of the pelvis [17].

At the international level, results of the present investigation are consistent with those obtained from 200 Iranians (males and females) [5]. Other investigations were done among Anatolian Caucasians [6], Western Australian [14], Black and White Americans [11], and British [12]. These studies showed even greater differences in the SPA measurements where the mean values reported were far lower than the ones reported in this study. This discrepancy may be caused by the ethnic variations as well as the differences in the methods used to measure the SPA. Findings among the Sudanese population, while different from other African nations, are generally similar to Egyptians and Iranians.

The DP method has been used in several surveys to determine the accuracy of the measurements in assigning sex as male and females [4, 16]. In the present study, the DP is more accurate in assigning female gender. When comparing these results to previous studies, they are more accurate than those in Ugandan and Malawian populations despite the use of the same measurement technique. In contrast, this study's results are less accurate than in Egyptians [4, 7].

The relation between age, gender, and SPA was also considered in this study. There was no significant difference in the SPA among the different age groups. Similar results were reported in the Anatolian Caucasians by Karakas *et al*. [6].

Limitations

Considering that this study was conducted using data from one center, the population size was limited. Future studies may be extended to include multiple centers both inside and outside Khartoum.

5. Conclusion

The SPA is a reliable index to predict the gender with high accuracy. The DPs obtained showed that any SPA <104.3° indicated male gender while any angle >126.5° was indicative of female gender. DP was more reliable in females than males. SPA is not affected by age in prediction of gender.

Declaration Section

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Ethical Approval

During this study, privacy and confidentiality were maintained. Ethical approval was obtained from the Research Ethical Committee of the Faculty of Medicine, University of Khartoum. Permission was obtained from the administration of the Antalya Medical Center to conduct the study.

Competing Interests

Authors declare that there were no funding or any relationship or activity that interferes with the study.

Authors' Contributions

RAM was involved in the study concept and design; acquisition, analysis, and interpretation of data; drafting the article or revising it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for the accuracy and integrity of all aspects of the work.

KAA was involved in the study concept and design; analysis and interpretation of data; drafting the article and revising it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for the accuracy and integrity of all aspects of the work.
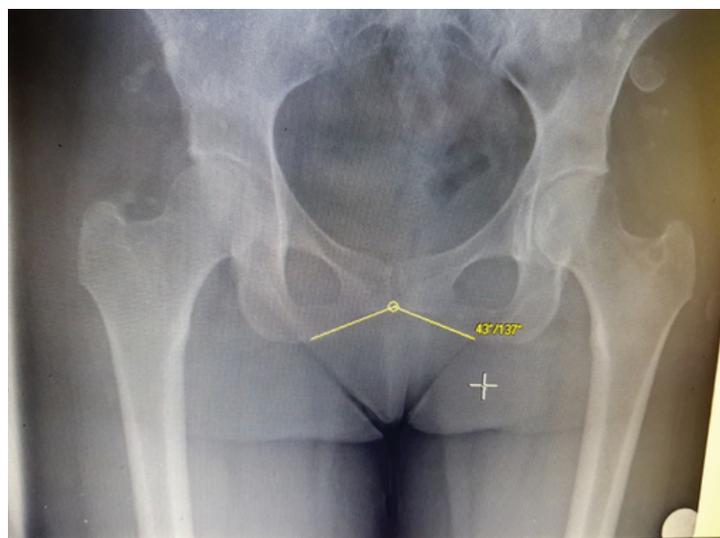
Appendices

Appendix 1

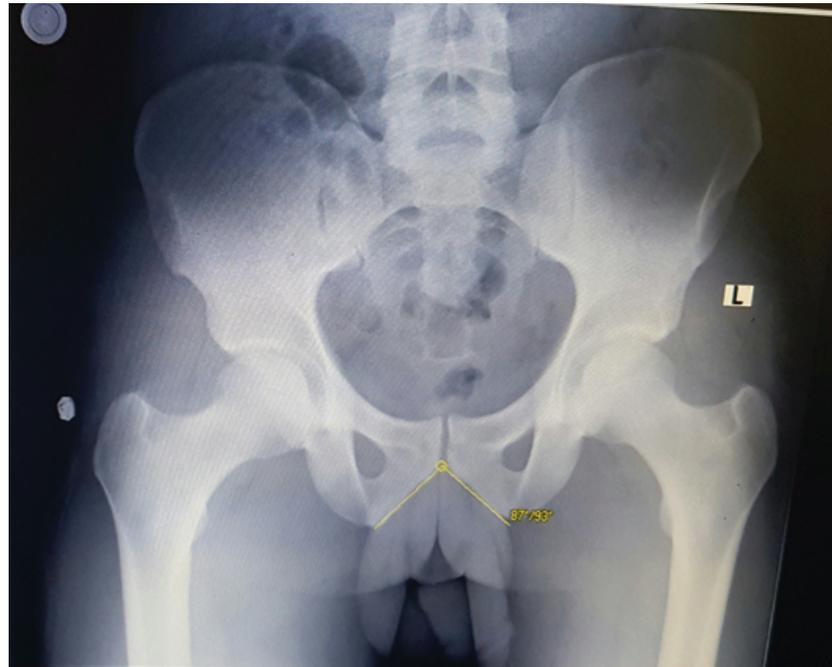Antero-posterior pelvic X-ray showing the measurement of SPA in a female participant.

Appendix 2

Antero-posterior pelvic X-ray showing the measurement of SPA in a male participant.

Appendix 1

Appendix 2

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