

ROLE OF SUBPUBIC ANGLE IN SEXUAL DIMORPHISM & ITS CLINICAL IMPORTANCE: A MORPHOMETRIC STUDY IN ADULT HUMAN BONY PELVIS

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ABSTRACT

Background: Identification of sexing human skeletal remains is an important component and frequently the starting point of many forensic anthropological investigations. Skeletal biologists had recognized that each population group requires its own specific standards for accurate determination of sex. The pelvis is probably the most accurate bone from which sex can be determined. The subpubic angles show more definitive sex difference indicating the presence of interpopulation variations.

Materials and Methods: The material for the present study comprised 50 adult human pelvis [M: F= 40:10], obtained from Department of Anatomy, Government Medical College, Amritsar, Punjab, India. Subpubic angle was measured for each pelvis using standard technique.

Results: The results obtained were tabulated, statistically analysed & compared to the earlier literature. It was seen that in line with earlier studies the subpubic angle was significantly more in females as compared to males.

Conclusions: It is widely recognized that skeletal characteristics vary among populations, thus each population should have specific standards to optimize the accuracy of identification. Hence this study has provided a baseline data of the values of subpubic angle in the North Indian population.

KEY WORDS: Sexual Dimorphism, Pelvis, Subpubic Angle, Forensic.

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INTRODUCTION

Due to a great hike in the crime rate the forensic anthropologists are increasingly approached to aid in the identification of skeletonized remains, to whom they have to assign the sex, age & the population affinity. For over a century the pelvis has been known to be one of the most sexually dimorphic bones of the human body and the subpubic angle is one of the most accurate,

albeit scarcely quantified, features thereof.

In humans, the true pelvis is on an average larger in females than males, whereas for other measurements of the skeleton, males have greater values than females [1]. In both sexes, the pelvis functions in locomotion, posture, visceral support and in adaptation to climate. The pelvis in both sexes is under selection due to locomotion, which would favour a narrow

pelvis. Additionally, the female pelvis is under selection favouring a wide birth canal and hence maintains enough space to allow for delivery of a viable full term foetus [2].

The pelvis is probably the most accurate bone from which sex is determined. According to Krogman & Iscan [3], 95% sexing accuracy can be expected if it is complete. The subpubic angle, ventral arc and composite arc showed correct sexing in over 98% of cases [4].

Subpubic Angle is the angle that exists between the inferior rami and below the pubic symphysis in an articulated bony pelvis. It is also referred to as pubic arch [5, 6]. It is observed that size of the subpubic angles determines the size of birth canal which is an important criterion in vaginal delivery [6].

This angle can be measured from skeletal specimens or by radiological pelvimetry and studies have shown that there are no significant differences between the two methods of measurement [7].

Aim of the study was to quantify the size of the subpubic angle and compare it between the males & females of North India and also to document regional & racial variability of the same.

MATERIALS AND METHODS

The material for the present study comprised 50 adult human pelvis [M: F= 40:10], obtained from Department of Anatomy, Government Medical College, Amritsar, Punjab, India. The bones were undamaged and showed no pathological variation. Subpubic angle was measured for each of the pelvis. It is the angle formed by the two ischio-pubic ramii along their medial borders ($\angle M$ in Fig. 1) [8]. For measuring this angle, two steel bars were fixed along medial borders of ischiopubic rami and then the angle between the two was measured with the help of protractor. (See Fig 2)

Fig. 1: Showing Subpubic Angle($\angle M$).

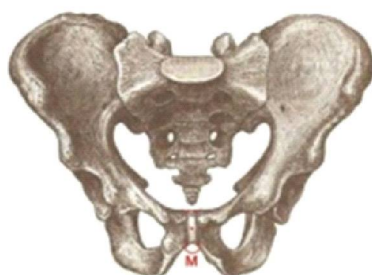


Fig. 2: Showing how to measure Subpubic Angle.



RESULTS

The results obtained were tabulated, statistically analysed & compared to the earlier literature. In the present series, subpubic angle was found to be $59.05^\circ \pm 7.11^\circ$ (Range $47.0^\circ - 75.0^\circ$) in males & $75.60^\circ \pm 9.81^\circ$ (Range $57.0^\circ - 85.0^\circ$) in females. Thus the angle was significantly wider (p-value = 0.000) in females as compared with males.

Table 1: Comparison of Subpubic Angle Between The Two Sexes In Different Populations.

Sr. No.	Author	Race	Mean Angle ($^\circ$) \pm S.D. (n)	
			Males	Females
1	Turner (1886) [11]	Negroes	-	71
	"	Hawain	-	102
	"	Laplander	-	104
2	Nicholson (1938) [12]	Rural english	-	75.8
3	Young & Ince (1940) [13]	London	75.80*	93.5
4	Smout (1948) [14]	British	-	80
5	Tague (1989) [7]	Indian Knoll	73.8 \pm 8.2 (74)	98.2 \pm 8.4 (58)
	"	Pecos Pueblo	61.6 \pm 8.2 (104)	86.0 \pm 10.0 (114)
	"	Libben	68.8 \pm 7.8 (46)	95.2 \pm 10.8 (21)
	"	Haida	65.4 \pm 8.2 (29)	93.0 \pm 12.3 (19)
	"	White Americans	63.7 \pm 7.8 (50)	88.4 \pm 8.5 (50)
6	Caldwell & Moley 1993 [15]	Negroes	60	80
		Europeans	<60	>90
7	Igbigbi PS & Nanono-Igbigbi AM (2003) [16]	Ugandans	93.86	116.11
8	Msamati et al (2005) [17]	Black Malawian	99.2 \pm 15.7 (73)	129.1 \pm 14.6 (46)
9	Oladijo (2006) [18]	Nigerians	91.87 \pm 10.66 (99)	115.49 \pm 11.58 (101)
10	Oladijo et al (2009) [19]	Malawians	99.16 \pm 15.73 (75)	129 \pm 14.19 (48)
		Ugandans	93.86 \pm 21.12 (110)	116.11 \pm 17.79 (95)
		Ijaw	109.38 \pm 10.0 (38)	119.48 \pm 12.06 (62)
		Igbo	95.29 \pm 10.58 (62)	111.44 \pm 12.85 (55)
11	Present Study	North Indians	59.05 \pm 7.11 (40)	75.60 \pm 9.81 (10)

DISCUSSION

The accurate identification of sex and race from human skeletal remains is pivotal of forensic & physical anthropology, especially because of the

escalating crime rates which have become a worldwide phenomenon [9]. Sex determination from skeletal remains is one of the most important aspects of the osteologic analysis of a given population. Several bones show a marked sexual dimorphism, so they are suitable for sexing skeletons with a high accuracy. Among these, differences in the pelvic bones are pronounced especially at the ischiatic notch, subpubic angle, and the general configuration [10].

Extensive work has been done on subpubic angle by the previous authors. A comparison of the values given by various studies in different racial populations is given in Table I. When compared with other races our female values were found to be in consonance only with Negroes [11] & Rural English [12] but less than the others.

As far as subpubic angle in males is concerned, it is more in all the other races except Negroes and the Europeans where it is $\leq 60^\circ$ [15] and hence comparable to our male values of 59.05° .

Bryce [20] has reasoned this sex variation to be due to more growth in females at symphysis during puberty leading to separation of obturator foramina with increase in this angle in them. Heyns [21], on one hand, regarded the subpubic angle more than 90° to be normal and favourable for labour & the one less than 90° to be contracted. On the other hand, he commented that the angles exceeding 90° must be rare. In consonance with his second comment, in the present study, in none of the male or female pelvis, a subpubic angle of more than 90° could be traced. Ontogeny: Sexual Dimorphism is evident in human foetuses particularly in the pelvis with the sciatic notch being wider in female foetuses & deeper in males and the subpubic angle wider in females. This was substantiated by Boucher [22] who found that there was a greater difference between the sexes of foetal subpubic angle than in adults [22]. This is because in male infants the secretion of androgens beginning in prenatal life produces sexual dimorphism with a larger muscle mass, a higher birth weight and skeletal changes which are apparent in pelvic morphology [23]. These changes in pelvis are further accentuated by acceleration in growth which occurs at puberty. This transformation is a com-

plex & dynamic process affected by sex differences related to variation in rates & direction of growth in specific areas of pelvis as well as individual variation [24].

Expansion occurs at the growth centres in the iliac crests, ischial tuberosities, acetabulum and margins of sacroiliac joint but the enlargement is also due to selective resorption & deposition of bone within individual bones of the pelvis. Examples of these are greater length of pubic bone in females contributing to their wider pelvic inlet & the directional difference in growth of inferior sections of the ischio-pubic ramus & ischial tuberosity with both growing in a more lateral direction in females resulting in a wider subpubic angle [24]. Clinical Implications:

A narrow subpubic arch is strongly associated with prolonged labour and postpartum anal incontinence in nulliparous women. However, perineal & anal sphincter trauma, assessed by ultrasound, does not account for the higher rate of postpartum anal incontinence in women with a narrow subpubic arch angle [25].

The bony pelvis has historically been assessed by obstetricians because of its effect on birth mechanics. It has previously been demonstrated that there are differences in bony pelvis dimensions when comparing women with and without pelvic floor dysfunction. It is therefore plausible that variations in bony pelvic dimensions may pose as risk factors for delivery induced levator ani trauma and hence, pelvic floor dysfunction [26].

Berger et al [27] suggested that a wider subpubic angle may be a risk factor for trauma during childbirth that leads to postpartum stress urinary incontinence. They further added that the anterior location of the fetal head afforded by a wider pelvis might directly damage the urethra or urethral supports, similar to the vaginal delivery induced urethral changes. Alternatively, trauma from the delivery may unmask pre existing poor urethral function that, prior to delivery was compensated for by urethral supports, and/or pelvic floor functioning.

CONCLUSION

These results illustrate the advantage of using the subpubic angle to assist in the estimation of sex and population affinity and also reinforce

the need for population specific parameters to be applied. This study is thus important and is therefore recommended to obstetricians, physical and forensic anthropologists.

Conflicts of Interests: None

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