A MORPHOMETRIC STUDY OF MIDLINE SECTIONED SYMPHYSIS PUBIS IN HUMAN FETUSES

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ABSTRACT:

INTRODUCTION: Symphysis pubis a midline secondary cartilaginous joint has been studied mostly for age estimation in forensic anthropology. Symphysis pubis forms at about the beginning of the third month of gestation. Centre of chondrification starts to develop in the primitive scleroblastema, grow together at the midline forming the precursor of the symphysis.

AIMS AND OBJECTIVES: To study the developmental of symphyseal surface of pubis morphometrically in human fetuses and to analyze whether it is sex dependent.

MATERIALS AND METHODS: A total of 41 foetuses divided into five groups according to the gestational age with each group having male and female fetuses. The interpubic joint along with the pubis were dissected and a midline incision was given to expose the symphyseal surface. Measurements were taken with the help of Vernier calipers and the data was analyzed using students 't' test.

OBSERVATION AND RESULT: Vertical height of midline sectioned pubic symphysis grew at different rates during different periods of intrauterine life. Growth rate was maximum in group II. Anteroposterior growth of midline sectioned pubic symphysis at the upper end showed significant growth in early stage of gestation, while in the middle part significant increase in measurements was noticed in groups II and III and in the lower portion in groups II and V.

CONCLUSION: Maximal growth of the symphyseal surface of the pubes occurs vertically as well as antero-posteriorly between 19–22 weeks of gestation. Sexual dimorphism was observed in the vertical growth of the pubic symphysis in group II foetuses.

KEYWORDS: Morphometry, Symphyseal surface of pubis, Fetuses.

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INTRODUCTION: Symphysis pubis (interpubic joint), which means "growing together" is formed at the confluence of the pubic bones. Each pubic bone consists of a body and two rami; the superior ramus is joined with the ilium and the inferior ramus with the ischium. The two bones meet in the midline at the pubic symphysis, a secondary cartilaginous joint. Pubic symphysis has been studied by several scientists for the last many decades, mostly for age estimation in forensic anthropology. Bardeen.(1) found that symphysis pubis forms at about the beginning of the third month of gestation. Adair.(2) studied the development of the human pelvis and symphysis, and showed that the centre of chondrification starts to develop in the primitive scleroblastema, grow together at the midline forming the precursor of the symphysis. Todd.(3) observed morphological changes occurring at the pubic symphyseal face and laid down the criteria for postcranial age determination. He put forward the concept that there exists three different types of pubic symphysis in the mammals.

1. Those in which innominate bones were fused at the ischiopubic, or pubic symphysis, as the case may be, forming a synostosis.
2. Those in which the innominate bones were separated by cartilage at the symphysis, forming a synchondrosis.
3. Those in which the innominate bones had no connecting medium at the symphysis; or are connected by a ligamentous band, forming a syndesmosis.

Ruth.(4) highlighted metamorphosis of pubic symphysis in white rat (Mus norvegicus albinus) during postnatal life starting from birth till old age. Castrated rats were also included in his study, which led to the conclusion that castration had no effect upon the development of this joint. Ortega et al.(5) considered rats, guinea pigs and mice in different physiological situation and came to the conclusion that the classification of pubic joint depends upon the species, age, sex and physiological reproductive age studied. Their data suggested that interspecies differences are likely to be found in different parameters and should be considered when choosing an appropriate animal model for research or teaching purposes.

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Pubic symphyseal region has often been considered as marker of sexual dimorphism. Patriquin et al.[6] chose pubic length as best for discriminating between races. Duric et al.[7] combined cranial criteria with pelvic criteria to reliably differentiate between two sexes. According to Nicolene et al.[8] overall dimensions of the symphyseal surface increases with age with males exhibiting greater surface dimensions than females.

Although exhaustive studies on symphysis pubis in adults have been done, there is a void regarding morphometric analysis of symphysis pubis in fetuses. Therefore, it was found appropriate to investigate the developmental details of symphyseal surface of pubis in human fetuses pertaining to sequential morphometrical changes taking place throughout foetal life and to establish whether these changes are sex dependent.

MATERIALS AND METHODS: A total of 41 foetuses immersion fixed in 10% formalin were obtained from the Museum Department of Anatomy J. N. Medical College. A.M.U. Aligarh. Foetuses of all age groups without congenital craniovertebral anomalies were selected for the study. Gestational age of the foetuses were determined using foetal foot length, Streeter.[9] For the purpose of study foetuses were divided into five groups according to the gestational age with each group having male and female foetuses (Table1).

Groups	Gestational Age (wks)	No. of Males	No. of Females	Total
I	14 - 18	5	5	10
II	19 – 22	5	5	10
III	23 – 26	3	4	7
IV	27 – 30	4	3	7
V	>30	3	4	7

Table 1: Foetal Groups

Fig. 1 (a) lines of incision (b) identification of obturator foramen to excise superior and inferior pubic rami (c) isolation of pubic symphysis region

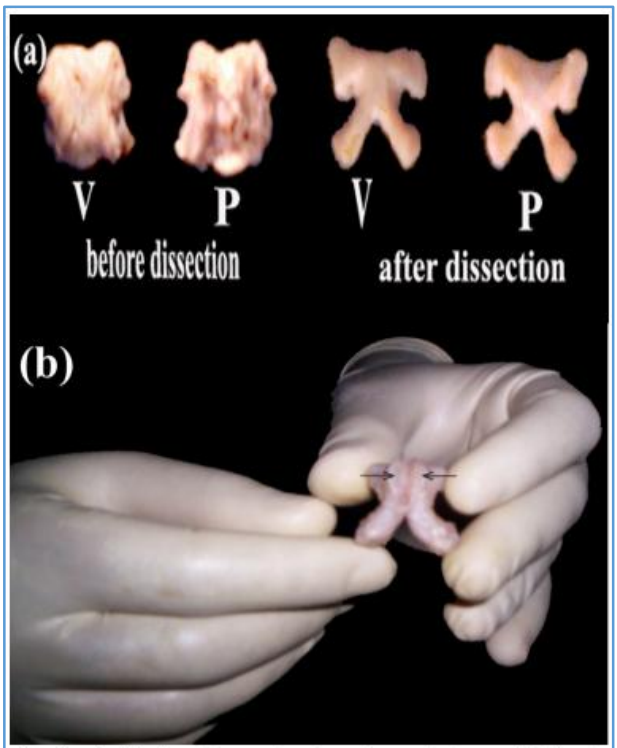

Fig. 2a: Isolated pubic symphysis region ventral aspect (V) and Dorsal aspect (P). 2b: Symphyseal surface after midline incision

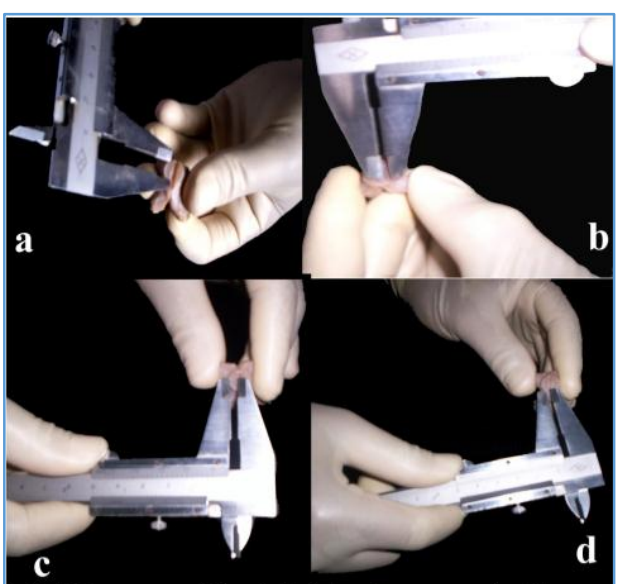

Fig. 3: Measurement (a) vertical height and anteroposterior thickness (b) at the upper end (c) in the middle (d) at the lower end

DISSECTION: Upper surface of the interpubic joint was palpated and suprapubic transverse incision was given in the skin extending bilaterally upto middle of inguinal fold. Another incision was given on both the sides extending from the lateral ends of above incision to the level of middle of ischiopubic rami. Aforementioned incisions were made deeper and the pubis was exposed on both the sides by cutting the adductors of thigh, and rectus abdominis (Fig. 1a).

Skin along with the external genitalia was reflected downwards. Obturator foramen was identified and cleaned. Superior pubic and ischiopubic rami were cut by making an incision across the obturator foramen on both the sides

(Fig. 1b). The interpubic joint along with the pubis of both the sides were isolated and dissected out (Fig. 1c).

The dissected symphysis along with pubis were cleaned of all the adhering soft tissues under a dissecting microscope (Fig. 2a). A midline incision was given in the interpubic symphyseal region of the isolated specimen from the posterior aspect, anterior part remaining intact to expose the symphyseal area (Fig. 2b).

Vertical height (Fig. 3a) and anteroposterior thickness of the midline sectioned pubic symphysis were measured at the upper end (Fig. 3b), in the middle (Fig. 3c) and at the lower end (Fig. 3d) with the help of Vernier calipers.

All the readings were recorded and subjected to statistical analysis using students 't' test. P value ranging from <0.05 to <0.001 were considered significant, the latter being highly significant.

OBSERVATIONS AND RESULT:

Groups	No. of Cases (n)	Min - max Mean±SD (mm)	% Difference	P value
I	10	2.58 – 4.98 3.80±0.66	-	-
II	10	4.15 – 6.18 5.24±0.61	+ 38	< 0.001
III	7	5.18 – 6.75 6.06±0.49	+ 16	< 0.2
IV	7	5.75 – 7.50 6.73±0.57	+ 11	< 0.001
V	7	5.45 – 9.83 7.88±1.44	+ 17	< 0.02

Table 2: Vertical height of midline sectioned pubic symphysis

Groups	No. of Cases (n)	Min - max Mean±SD (mm)	% Difference	P value
I	10	0.80 – 1.75 1.16±0.28	-	-
II	10	1.43 – 2.05 1.68±0.20	+ 45	< 0.001
III	7	1.73 – 2.16 1.88±0.14	+ 12	< 0.50
IV	7	1.80 – 2. 30 2.06±0.14	+ 10	< 0.50
V	7	2.13 – 3.00 2.46±0.28	+ 19	< 0.001

Table 3: Anteroposterior thickness of midline sectioned pubic symphysis at the upper end

Groups	No. of cases (n)	Min - max Mean±SD (mm)	% Difference	P value
I	10	1.13 – 2.20 1.63±0.39	-	-
II	10	1.83 – 2.60 2.28±0.27	+ 40	< 0.001
III	7	2.13 – 3.20 2.62±0.31	+ 15	< 0.001
IV	7	2.36 – 3.13 2.73±0.27	+ 4	< 0.10
V	7	2.45 – 3.80 3.21±0.50	+ 18	< 0.01

Table 4: Anteroposterior thickness of midline sectioned pubic symphysis in the middle

Groups	No. of Cases (n)	Min - max Mean±SD (mm)	Percent difference	P value
I	10	0.70 – 1.55 0.98±0.25	-	-
II	10	1.23 – 1.48 1.34±0.10	+ 37	< 0.001
III	7	1.08 – 1.48 1.36±0.12	+ 1	< 0.50
IV	7	1.45 – 1.95 1.65±0.17	+ 21	< 0.10
V	7	1.43 – 2.45 1.86±0.29	+ 13	< 0.01

Table 5: Anteroposterior thickness midline sectioned pubic symphysis at the lower end

Groups	Sex	No. of Cases (n)	Mean±SD (mm)	Percent difference	P value
I	Male	5	3.93±0.48	25	<0.2
	Female	5	3.68±0.78		
II	Male	5	5.48±0.54	10	<0.001
	Female	5	5.00±0.59		
III	Male	3	6.26±0.38	6	<0.05
	Female	4	5.91±0.52		
IV	Male	4	6.54±0.62	6	<0.10
	Female	3	6.98±0.36		
V	Male	3	7.78±0.29	2	<0.8
	Female	4	7.96±1.88		

Table 6: Vertical height midline sectioned pubic symphysis– sexual dimorphism

Groups	Sex	No. of Cases(n)	Mean±SD (mm)	Percent Difference	P value
I	Male	5	1.21±0.17	9	< 0.2
	Female	5	1.11±0.35		
II	Male	5	1.75±0.23	9	< 0.10
	Female	5	1.60±0.11		
III	Male	3	1.87±0.05	1	< 0.8
	Female	4	1.89±0.17		
IV	Male	4	2.06±0.18	0	< 0.8
	Female	3	2.07±0.02		
V	Male	3	2.62±0.33	11	< 0.10
	Female	4	2.35±0.16	11	<0.10

Table 7: Anteroposterior thickness of midline sectioned pubic symphysis at the upper end – sexual dimorphism

Groups	Sex	No. of Cases (n)	Mean±SD (mm)	Per cent Difference	P value
I	Male	5	1.74±0.25	14	< 0.10
	Female	5	1.52±0.39		
II	Male	5	2.36±0.24	7	< 0.05
	Female	5	2.21±0.28		
III	Male	3	2.70±0.07	5	< 0.50
	Female	4	2.56±0.40		
IV	Male	4	2.82±0.28	8	< 0.002
	Female	3	2.61±0.22		
V	Male	3	3.58±0.24	22	< 0.02
	Female	4	2.94±0.47		

Table 8: Anteroposterior thickness of midline sectioned pubic Symphysis in the middle-sexual dimorphism

Groups	Sex	No. of Cases (n)	Mean±SD (mm)	Percent difference	P value
I	Male	5	1.03±0.11	5	< 0.50
	Female	5	0.98±0.30		
II	Male	5	1.38±0.12	6	< 0.05
	Female	5	1.30±0.06		
III	Male	3	1.43±0.04	8	< 0.10
	Female	4	1.32±0.14		
IV	Male	4	1.73±0.19	12	< 0.05
	Female	3	1.54±0.07		
V	Male	3	2.02±0.31	13	< 0.10
	Female	4	1.78±0.19		

Table 9: Anteroposterior thickness of midline sectioned pubic symphysis at the lower end – sexual dimorphism

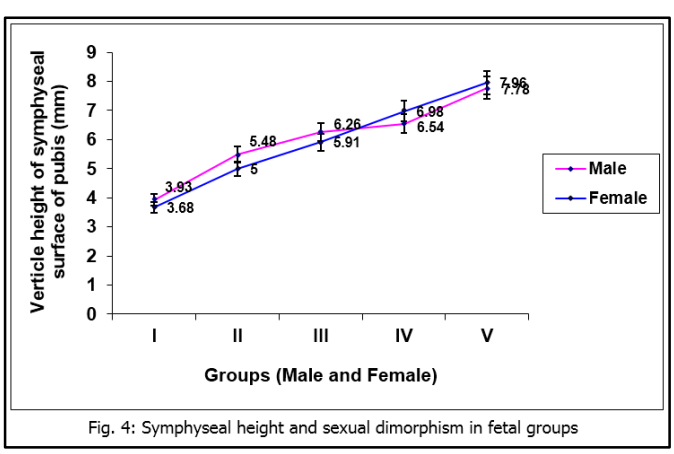

Fig. 4: Symphyseal height and sexual dimorphism in fetal groups

Vertical height of midline sectioned pubic symphysis grew at different rates during different periods of intrauterine life. Growth rate was maximum in group II (+38 per cent), nil in group III and very slow in groups IV and V (Table 2).

Anteroposterior growth of midline sectioned pubic symphysis at the upper end (Table 3) showed significant growth in early stage of pregnancy (group II), i.e., 19-22 weeks of gestation and in the terminal part group V (>30 weeks of intrauterine life), P value being highly significant (<0.001) in both. In groups III and IV there was no significant change in measurements.

The pattern of growth in the middle of midline sectioned pubic symphysis (Table 4), was different compared to the upper end. Here highly significant increase in measurements was noticed in groups II and III. P value being highly significant (<0.001) in both the groups and to some extent in group V (P value<0.01). Growth spurt was observed in group II (+40 per cent).

The lower portion of the midline sectioned pubic symphysis (Table 5) followed the same growth pattern as at the upper end. Marked increase in thickness was observed in groups II and V, P value being <0.001 and <0.01 respectively. Maximum growth of the midline sectioned pubic symphysis occurred in group II, i.e., during 19-22 weeks of intrauterine life (+37 per cent).

Sexual dimorphism was observed in the vertical growth of the midline sectioned pubic symphysis in group II fetus where highly significant P value (<0.001) was observed and relatively less significant value (<0.05) in group III (Table 6). Vertical growth was greater in males up to 26 weeks of gestation thereafter it was more in females (Fig. 4).

Growth of the midline sectioned pubic symphysis at the upper end was independent of the sexes (Table 7). However, sexual dimorphism was observed in groups II, IV and V in the middle (Table 8), and at the lower end in group II and IV fetus (Table 9).

DISCUSSION: Major part of research in pubic symphyseal anatomy is devoted to its forensic value especially for postnatal age determination. Todd.[3] for the first time provided detailed information of postcranial skeletal age determination based on morphological changes of the pubic symphyseal face for forensic purposes. Schiavetti and Merola.[10] reported degenerative changes of the pubic symphysis with aging. Vix and Ryu.[11] in their detailed study of adult human symphysis pubis from postmortem specimens fixed the criteria for normal and abnormal joints. Dokladal.[12] considered age dependent changes of the symphyseal surface of the pubic bone in anthropoid apes. According to Snow morphological changes of the pubic symphysis provided an important means of estimating age at death in the adult skeleton. This view was supported by Buchner.[13] whose human material ranged from birth to adult. Meindl et al.[14] described biological stages of pubic metamorphosis and discussed evolutionary specialization of the hominid symphysis. Telmon et al.[15] had emphasized that age determination was a major field of interest in forensic anthropology and for this purpose they used three directional imaging of the pubic symphysis.

Gamble et al.[16] reported that in males the symphysis was longer in vertical direction in adults. This result was reflected in our findings during intrauterine life in some of the groups as mentioned above. Igbigbi and Msamati.[17] studied the anteroposterior x-ray films of pelvis of 255

adult subjects aged between 18 and 65 years. They demonstrated that the mean length of female pubis was longer than the males statistically, in contrast to our findings in foetuses. This indicated that the growth rate in the pubic region was different in two sexes even after birth. Patriquin et al.[6] had successfully demonstrated the utility of pubic length for discriminating between races and sexes with an average accuracy of 88% for males and 85% for females.

Parallel reports regarding anteroposterior growth of symphyseal surface of the pubis during intrauterine life at the three levels of measurement and between the male and female foetuses were not available.

CONCLUSION: Maximal growth of the symphyseal surface of the pubes occurs vertically as well as antero-posteriorly between 19–22 weeks of gestation.

Different measurements of symphyseal surface of the pubis have variable growth rates at different period of gestation.

Sexual dimorphism was observed in the vertical growth of the midline sectioned pubic symphysis in group II fetus and in the middle and at the lower end in the antero- posterior growth in groups II and IV foetuses.

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