

Measurement of Symphysis Pubis Distance in Computed Tomography

Khanal Umesh Prasad, Chataut Dinesh, Shrestha Prajana

Department of Radiology and Imaging (TUTH), Maharajgunj, Kathmandu, Nepal

ABSTRACT

Objective: The aim of this study was to create a reference about normal symphysis pubis (SP) width by using normal computed tomography scans of abdomen and pelvis and to correlate them with the age and gender of the individuals. **Materials and Methodology:** This retrospective study was performed in the Department of Radiology and Imaging, Tribhuvan University Teaching Hospital. Data were collected over the period of 4 months from July 2019 to October 2019 with the total of 120 patients (60 males and 60 females) who underwent non-contrast and contrast enhanced CT scan of abdomen and pelvis and diagnosed to be normal. The age and gender of the patients were noted. The distance between the two pelvic bones was measured in three points of the SP joint: anterior, middle and posterior parts of the joint. The relation between the obtained values and age and gender of the patients was determined. **Results:** The mean width of symphysis pubis measured anteriorly was found to be $0.72\text{cm} \pm 0.21\text{cm}$ with the range from $0.22\text{cm} - 1.08\text{cm}$. The mean middle width of symphysis pubis was found to be $0.34\text{cm} \pm 0.08\text{cm}$ with the range from $0.15\text{cm} - 0.61\text{cm}$. The mean width of symphysis pubis measured posteriorly was found to be $0.30\text{cm} \pm 0.09\text{cm}$ with the range from $0.10\text{cm} - 0.55\text{cm}$. The widths measured at anterior and middle of the SP were significantly higher in women ($P = 0.002$ and $P = 0.02$). Symphysis pubis narrows at anterior concurrently with ageing ($r = -0.43$; $P = 0.000$). Narrowing, though less, is also observed at posterior ($r = -0.31$; $P = 0.000$); however, middle part does not change ($r = -0.13$; $P = 0.142$). **Conclusion:** It is concluded that average anterior, middle and posterior distance of the SP joint for adult Nepalese population is $0.72\text{cm} \pm 0.21\text{cm}$, $0.34\text{cm} \pm 0.08\text{cm}$ and $0.30\text{cm} \pm 0.09\text{cm}$ respectively and the anterior and middle part of the SP joint is wider in women.

Key words: CT, Width, Pubicsymphysis

INTRODUCTION

The symphysis pubis (SP) is a non-synovial amphiarthrosis joint which forms the anterior arch of the skeletal pelvis and connects both pubic bones at midline [1]. It is interposed with a fibrocartilaginous disc, and supported by the superior pubic ligament and inferior pubic ligament [2]. SP forms the anterior arch of the skeletal pelvis and connects lateral pillars of pubic bones as a tie-beam preventing separation. It also supports medial femoral

thrust. Additionally, SP prevents sacrum from pushing down and separating iliac bones from each other. Consequently, the force coming from different directions to SP is buffered and absorbed by stretching disc [3]. Its movements are extremely limited [4]. It seldom produces dramatic symptoms or signs clinically; thus this joint is not studied as much as other symphyseal joints, and is neglected in most radiologic evaluations [5]. There are anatomical variations of SP between men and women. Women SP is shorter and wider. Similarly, interpubic fibrocartilage presents some gender variations.

Address for correspondence:

Dr. Umesh Prasad Khanal, Associate Professor, Department of Radiology and Imaging, TUTH Kathmandu, Nepal.

DOI: 10.33309/2639-913X.040104

© 2021 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

In women, it is located lower than men, also it is wider in women. Central cavity is more frequent in women and can reach to considerable sizes. The differences between genders also affect the mechanical characteristics of the joint. SP can be more flexible and wider during pregnancy and birth, and after giving birth it returns to its former form. In men, SP is a stable, hard joint, and its movements are limited; forced kicking movements are exceptions [6]. Other than gender differences, SP joint also shows biomechanical, degenerative, and morphological changes during human body's evolution [5]. Joints in symphysis type generally remain without changing. They are hardly ever affected by systemic inflammatory disease such as rheumatoid arthritis as they lack synovium which, has characteristics of rich vascularity [7]. They are not investigated much clinically and radiologically as they rarely cause pain even if degenerative changes develop during ageing. Although the clinical pathologies of the SP are rare, this joint is indeed a dynamic joint during the evolution of life. In 1930, Todd [2] observed the natural evolution of the SP in four roentgenographic phases. Up to now, studies have been done to measure SP width by plain radiographs [8, 9]. The width of SP joint should be <1cm in all ages [2]. In the present study, SP distance in transverse plane was measured with computed tomography (CT) in adult population. Additionally, the relation between SP distance, and age, gender is examined. Pelvic girdle injuries are one of the most devastating injuries in both children and adults. Evaluation of width of the symphysis pubis is considered as a standard radiologic diagnostic tool on either radiograph or computed tomography scan. This study helps to find out the normal distance in between the symphysis pubis joint of adults and hence helps to determine the upper limit of normal symphysis pubis distance and diagnose the cases of pubic diastasis. This study may be of value in forensic physical anthropology to estimate age of uncovered specimens.

The General objective of this study was to measure the symphysis pubis distance in computed tomography scans. In adult Nepalese population.

The Specific objectives were to evaluate anterior, middle and posterior distance in between the symphysis pubis joint and to correlate SP distance with the age and gender.

The Study was Retrospective Cross Sectional

All the CT of abdomen and pelvis fulfilling the selection criteria during the study period were enrolled numbering 120 total patients. Patients with the age of more than 18 years were included in the study. Abnormal Patients with midline fusion defects, skeletal dysplasia, recent pelvic fracture, neuromuscular disorders or metastasis of pelvic bones were excluded in our population as these conditions might influence

the accuracy of pubic symphyseal width. The patients were imaged on the 128 slice MDCT scanner (Siemens Somatom Definition AS+) and examined using a Standardized imaging protocol.

The collimation was 0.6x128 with a pitch 0.85 mm, 120 kV, 200 mAS. The distances between the two pelvic bones were measured in three points of the SP joint: anterior, middle, posterior parts of the joint. Measurement were taken of the mid-section of the joint. To determine the mid-section of the joint, the first cranial cross section that SP joint is visualized was deemed as the top point, and the last cross section caudally as the bottom point in sequential transverse scans. The number of total cross sections between the top and the bottom were determined. The half of the cross sections total number were counted, then cross sections from the top and the bottom in accordance with this half number were investigated to determine the midsection of the SP joint. Measurements were made in this cross section. All the measurement were taken thrice and the average recorded as the actual distance to ensure accuracy. The measurement were carried out with the measuring tools available on the software of the system. All the measurements were carried out with appropriate magnification. Images were viewed on bone window (WW: 2500, WL: 500) and image enhancement for bone edges were used. Age, gender of the cases were also recorded.

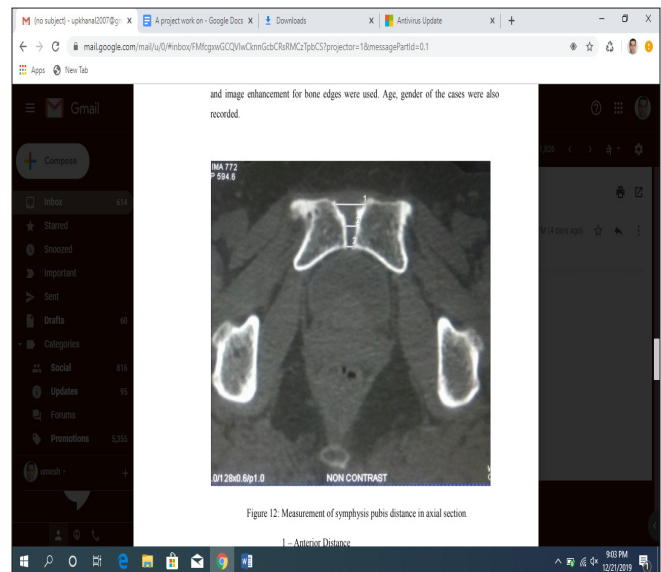


Figure 1. Measurement of Symphysis Pubis Distance in Axial Section.

1. Anterior Distance
2. Middle Distance
3. Posterior Distance

Statistical analysis was carried out with the help of IBM SPSS version 26 and Microsoft Excel version 2016. The mean, standard deviation of anterior, middle and posterior pubic width and correlation between anterior, middle and posterior interpubic distance with the age and gender were expressed in tables and figures. Spearman correlation analysis was used to assess the relationships between anterior, posterior and middle interpubic distances and age and gender. Student's t test were used to determine differences between males and females. The effect of age on the anterior, posterior and middle interpubic distances was investigated via linear regression analysis. A P-value of <0.05 was considered statistically significant.

RESULTS

The data was collected from 120 subjects found to be normal in 60 males and 60 females with the age from 19 to 88 years old.

Age and Demographic Distribution

Out of 120 patients, 60 were male and 60 were female. The mean age of the study group was 45.88±17.66 (minimum 19, maximum 88 years, median 45.00). 60 women and 60 men between 19 and 88 years of age were reviewed.

Table 1. Distribution of sample size according to gender.

Gender	Frequency	Percent
Male	60	50%
Female	60	50%
Total	100	100%

Table 2. Descriptive Statistics of Population.

Number Of Patients	Minimum	Maximum	Mean	Standard Deviation
120	19	88	45.88	17.66

The patients were divided into seven groups on the basis of age with a class width of 8 starting from 19 years to 88 as GP1(19-28), GP2(29-38), GP3(39-48), GP4 (49-58), GP5(59-68), GP6(69-78), GP7(79-88). The frequency distribution of the groups were as follows (Figure 2).

Table 3. Age group and frequency of population.

Age Groups	Frequency
19-28	23
29-38	28
39-48	17
49-58	21

59-68	17
69-78	9
79-88	5
Total	120

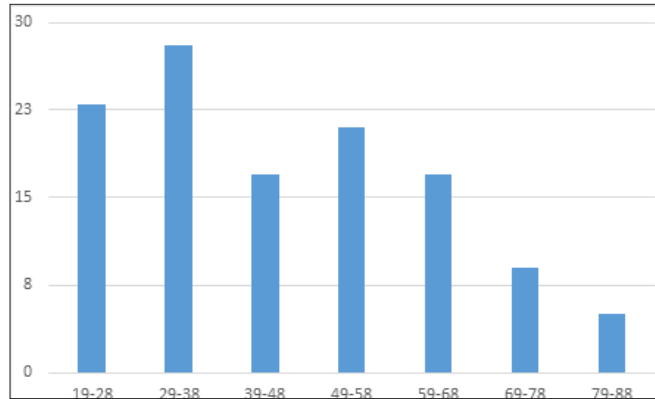


Figure 2. Frequency Distribution Of Population

Mean, SD, Range and P-Value of Total Sample

Table 4. Distribution of mean, SD, Range and p-value of total sample.

	Anterior Distance	Middle Distance	Posterior Distance
Mean	0.72	0.34	0.30
SD	0.21	0.08	0.09
Range	0.22-1.08	0.15-0.61	0.10-0.55
P-value	<0.05	<0.05	<0.05

The mean value of anterior interpubic width of total sample was found to be 0.72 ±0.21 cm with maximum 1.08 cm and minimum 0.22 cm. The mean value of middle interpubic width of total sample was found to be 0.34 ±0.08 cm with maximum 0.61 cm and minimum 0.15 cm. The mean value of posterior interpubic width of total sample was found to be 0.30±0.09 cm with maximum 0.55 cm and minimum 0.10 cm [Table 4].

Symphysis Pubis width According to the Gender

Table 5. Mean, S.D, Minimum and Maximum value of interpubic width of male pelvis.

Sex (Male)	Mean (cm)	S.D (cm)	Max. (cm)	Min. (cm)	Lower-upper bound (95% confidence)(cm)
Anterior Distance	0.66	0.19	1.08	0.33	0.61-0.71
Middle Distance	0.32	0.07	0.54	0.21	0.30-0.34
Posterior Distance	0.31	0.09	0.52	0.10	0.29-0.34

The mean value of anterior interpubic width of male was found to be 0.66 ± 0.19 cm with maximum 1.08 cm and minimum 0.33 cm. The mean value of middle interpubic width of male was found to be 0.32 ± 0.07 cm with maximum 0.54 cm and minimum 0.21 cm. The mean value of posterior interpubic width of male was found to be 0.31 ± 0.09 cm with maximum 0.52 cm and minimum 0.10 cm [Table 5].

Table 6. Mean, S.D, Minimum and Maximum value of interpubic width of female pelvis.

Sex (Female)	Mean (cm)	S.D (cm)	Max. (cm)	Min. (cm)	Lower-upper bound (95%confidence) (cm)
Anterior Distance	0.78	0.21	1.07	0.22	0.72-0.83
Middle Distance	0.36	0.08	0.61	0.15	0.33-0.38
Posterior Distance	0.29	0.08	0.55	0.10	0.27-0.31

The mean value of anterior interpubic width of female was found to be 0.78 ± 0.21 cm with maximum 1.07 cm and minimum 0.22 cm. The mean value of middle interpubic

width of female was found to be 0.36 ± 0.08 cm with maximum 0.61 cm and minimum 0.15 cm. The mean value of posterior interpubic width of female was found to be 0.29 ± 0.08 cm with maximum 0.55 cm and minimum 0.10 cm [Table 6].

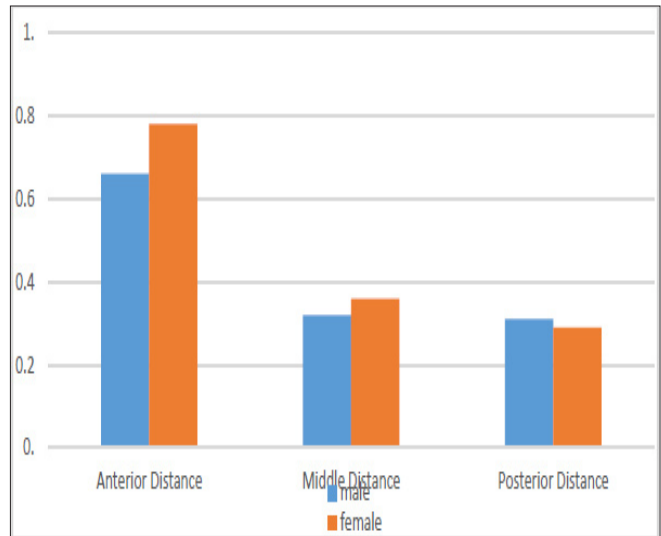


Figure 3. Bar-chart of different parameters according to gender.

Table 7. Test of significance difference between males and females pubic width.

Parameter	Mean difference	T	df	P	Standard Error Difference	Lower-upper bound(95% confidence)
Anterior Distance	-0.11	-3.18	117.53	0.002	0.37	-0.19 - -0.04
Middle Distance	-0.034	-2.30	115.79	0.02	0.14	-0.06 - -0.004
Posterior Distance	0.022	1.32	118	0.18	0.16	-0.01 - 0.05

Independent T test statistics were applied which showed the influence of gender on SP width. The anterior and middle interpubic distances were significantly different in women (P

= 0.002 and P = 0.02) i.e P<0.05. There was not significant difference between genders for the posterior pubic widths (P = 0.18) [Table 7].

Symphysis Pubis width According to the Age

Table 8. Relation between the SP width and age.

SP Distance	Age
Anterior Distance	r = -0.43** P = 0.00
Middle Distance	r = -0.13 P = 0.142
Posterior Distance	r = - 0.31** P = 0.00

** P < 0.01 is significant

There was a negative correlation between the anterior pubic width and age (r = - 0.43; P = 0.00). A negative correlation was also found between age and the posterior pubic width (r = - 0.31, P < 0.00). No correlation was found between the mid-pubic width and age (r = - 0.13, P = 0.14) [Table 8].

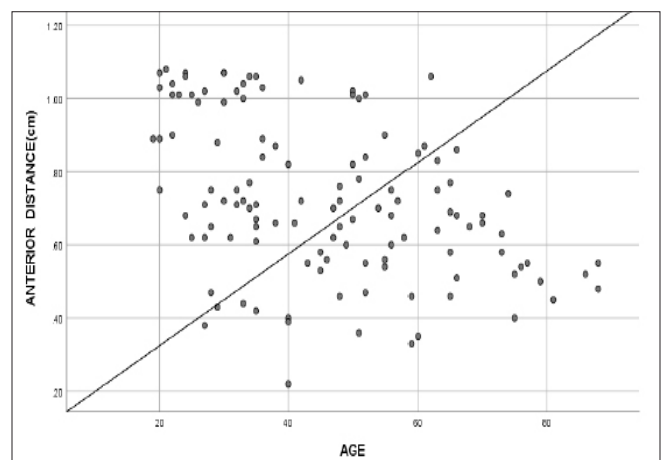


Figure 4. Scatter Diagram of Anterior Distance by Age.

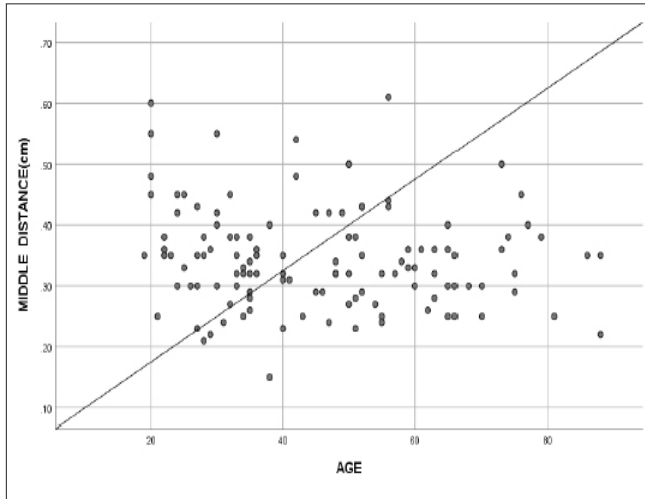


Figure 5. Scatter Diagram of Middle Distance by Age.

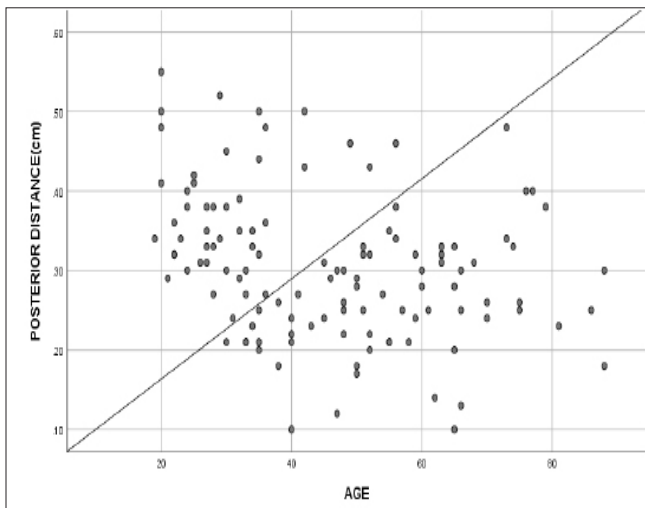


Figure 6. Scatter Diagram of Posterior Distance by Age.

DISCUSSION

The objective of this study was to measure anterior, middle, posterior width of the SP joint. The sample consisted of 120 subjects with different genders, 60 males (50%) and 60 females (50%) [Table 1]. Descriptive statistics of different measured values were presented in Table 2, 3, 4, 5, 6, 7 and table 8. By comparing the mean value of interpubic distances between males and females, a significant difference was found with P value < 0.05 at 95% CI. In our study, the mean width of symphysis pubis measured anteriorly was found to be 0.72cm±0.21cm. The mean middle width of symphysis pubis was found to be 0.34cm±0.08cm. The mean width of symphysis pubis measured posteriorly was found to be 0.30cm±0.09cm. The mean value of anterior interpubic width of male was found to be 0.66± 0.19 cm. The mean value of middle interpubic width of male was found to be 0.32 ±0.07

cm. The mean value of posterior interpubic width of male was found to be 0.31±0.09 cm. The mean value of anterior interpubic width of female was found to be 0.78±0.21 cm. The mean value of middle interpubic width of female was found to be 0.36 ±0.08 cm. The mean value of posterior interpubic width of female was found to be 0.29±0.08 cm. Our study found the anterior and middle pubic width to be greater in female than in males and narrowing of anterior and posterior SP width was observed with ageing (P=0.000). This result agreed with the result of the study conducted by Banu Alicioglu, Ozcan Kartal, Hulya Gurbuz, Necdet Sut in 2007. [6] The mean value of the different widths of the SP joint (i.e. anterior, middle and posterior) of male in their study were 11.75 cm, 4.95 cm, and 3.67 cm respectively and that of females were 12.58 cm, 4.60cm and 3.66 cm, respectively which has suggested that the anterior and middle width of SP joint is greater in females than in males.

In the study conducted by Onder Kalenderer et.al: [6] in 2009 [19] suggested that one should be suspicious about pelvic injury if the width of pubic symphysis is over 1 cm especially in patients younger than 10 years-old. Our study favors the statement as the normal width of SP joint was found to be 0.45 cm. The study also concluded that the pubic symphysis width narrowed by skeletal maturation which supports our study. Oetgen, Matthew, Andelman, Steven, Martin, Benjamin D. in 2017 [23] measured the width of pubic symphysis and found the average width of the pubic symphysis decreased from 5.55mm to 3.69mm, from age 2 to 16 years. The study demonstrated an age – dependent decrease in width of the pubic symphysis. Our study has the similar results which supports the narrowing of SP width with ageing. Vernon et al. [9] determined that SP width was 5.9 ± 1.3 mm in men, 4.9 ± 1.1 mm in women. These measurements were done on roentgenograms and were asserted to reflect the width of the joint anteriorly, since the width of the symphysis increases from posterior to anterior. Our results were different, anterior and middle pubic widths were significantly high in women (0.78 ± 0.21 cm at anterior, 0.36 ± 0.08 cm at midpoint of the joint in women; 0.66 ± 0.19 cm at anterior and 0.32 ± 0.07 cm at midpoint of the joint in men). Posterior pubic widths were not different in both genders.

CONCLUSION

The symphysis pubis distance were measured in CT scan of abdomen and pelvis. This study showed CT to be a reliable method for the measurement of SP width. The result showed greater mean value for anterior and middle width of SP joint in female than in male. A significant changes were found in the SP width with ageing. Hence, this study concluded that the anterior and middle part of the SP joint is wider in women, because the fibrocartilaginous disc is

thicker to provide the mobility. SP joint narrows at anterior and posterior concurrent with ageing. This narrowing is more in anterior part. In the midpoint part, no change occurs, that is, pubic bone surfaces towards SP joint takes the form of a convex.

REFERENCES

1. Agur AM, Dalley AF. Grant's atlas of anatomy. Lippincott Williams & Wilkins; 2009.
2. Putschar WG. The structure of the human symphysis pubis with special consideration of parturition and its sequelae. American Journal of Physical Anthropology. 1976 Nov;45(3):589-94.
3. Williams A, Newell RL, Davis M, Collins P. Pelvic girdle, gluteal region and hip joint. Gray's anatomy. 39th edn. Elsevier, Churchill Livingstone. 2005:1424-8.
4. Jarlaud T, Railhac JJ, Without N, De Paulis F. Normal and pathological pubic symphysis: contribution of imaging.
5. Li Z, Alonso JE, Kim JE, Davidson JS, Etheridge BS, Eberhardt AW. Three-dimensional finite element models of the human pubic symphysis with viscohyperelastic soft tissues. Annals of biomedical engineering. 2006 Sep 1;34(9):1452-62.
6. Alicioglu B, Kartal O, Gurbuz H, Sut N. Symphysis pubis distance in adults: a retrospective computed tomography study. Surgical and radiologic anatomy. 2008 Mar 1;30(2):153-7.
7. Gamble JG, Simmons SC, Freedman MA. The symphysis pubis. Anatomic and pathologic considerations. Clinical orthopaedics and related research. 1986 Feb(203):261-72.
8. McAlister DM, Webb HR, Wheeler PD, Shinault KA, Teague DC, Fish JR, Beall DP. Pubic symphyseal width in pediatric patients. Journal of Pediatric Orthopaedics. 2005 Nov 1;25(6):725-7.
9. VIX VA, RYU CY. The adult symphysis pubis: normal and abnormal. American Journal of Roentgenology. 1971 Jul;112(3):517-25.
10. Mahesh M. Search for Isotropic Resolution in CT from Conventional through Multiple- Row Detector. Radio Graphics 2002; 22(4):949-962
11. Bushberg JT, Siebert JA, Leidholdt EM, Boone JM. The essential physics of medical imaging. Baltimore, Williams & Wilkins, 1993.
12. Seeram E. Computed tomography: physical principles, clinical applications and quality control. Philadelphia, Pa: Saunders, 2001.
13. Curry TS, Dowdey JE, Murry RC. Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins; 1990.
14. Goldman LW. Principles of CT: multislice CT. Journal of nuclear medicine technology. 2008 Jun 1; 36(2):57-68.
15. Bushberg JT, Seibert JA, Leidholdt EM, Boone JM, Goldschmidt EJ. The essential physics of medical imaging. Medical Physics. 2003 Jul 1;30(7):1936
16. Becker I, Woodley SJ, Stringer MD. The adult human pubic symphysis: a systematic review. Journal of anatomy. 2010 Nov;217(5):475-87.
17. Gonçalves da Rocha RC, Chopard RP. Nutrition pathways to the symphysis pubis. Journal of anatomy. 2004 Mar;204(3):209-15.
18. Garagiola DM, Tarver RD, Gibson L, Rogers RE, Wass JL. Anatomic changes in the pelvis after uncomplicated vaginal delivery: a CT study on 14 women. American Journal of Roentgenology. 1989 Dec 1;153(6):1239-41
19. Kalenderer Ö, Turgut A, Bacaksız T, Bilgin E, Kumbaracı M, Akkan HA. Evaluation of symphysis pubis and sacroiliac joint distances in skeletally immature patients: A computerized tomography study of 1020 individuals. Acta orthopaedica et traumatologica turcica. 2017 Mar 1;51(2):150-4.
20. Nejad AH, Jamali A, Wootton-Gorges SL, Boakes JL, Ferguson TA. Symphysis pubis width in the pediatric population: a computerized tomography study. Journal of Trauma and Acute Care Surgery. 2012 Oct 1;73(4):923-7.
21. Lottering N, Reynolds MS, MacGregor DM, Meredith M, Gregory LS. Morphometric modelling of ageing in the human pubic symphysis: Sexual dimorphism in an Australian population. Forensic science international. 2014 Mar 1;236:195-e1.
22. Bayer J, Neubauer J, Saueressig U, Südkamp NP, Reising K. Age-and gender-related characteristics of the pubic symphysis and triradiate cartilage in pediatric computed tomography. Pediatric radiology. 2016 Nov 1;46(12):1705-12.
23. Oetgen ME, Andelman S, Martin BD. Age-Based Normative Measurements of the Pediatric Pelvis. Journal of orthopaedic trauma. 2017 Jul 1;31(7):e205-9.

How to cite this article: Umesh Prasad K, Dinesh C, Prajana S. Measurement of Symphysis Pubis Distance in Computed Tomography. J Clin Res Radiol 2021;4(1):16-21. DOI: 10.33309/2639-913X.040104