



ISSN: 0975-833X

Available online at <http://www.journalera.com>

International Journal of Current Research
Vol. 12, Issue, 11, pp.14854-14859, November, 2020

DOI: <https://doi.org/10.24941/ijcr.40096.11.2020>

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

RESEARCH ARTICLE

CT BASED MORPHOMETRIC ANALYSIS OF SACRO-ILIAC JOINT IN SOUTH INDIAN DEMOGRAPHY

^{1,*}Dr. Athul Antony Simon, ²Dr. Stelin Agnes Michael, ³Dr. Lizamma Alex, ⁴Dr. Geena Benjami and ⁵Mrs. Nisha Kurien

¹MBBS, MD (Anatomy) Assistant Professor, Anatomy, P.K.Das Institute of Medical Sciences, Palakkad

²MBBS, MD (Anatomy), Associate Professor, Anatomy, Pushpagiri Medical College, Thiruvalla

³Professor and H.O.D., MBBS, MD (Anatomy), Pushpagiri Medical College, Thiruvalla

⁴Professor and H.O.D., MBBS, MD (Radio-diagnosis), Pushpagiri Medical College, Thiruvalla

⁵Assistant Professor, Community Medicine, Pushpagiri Medical College, Thiruvalla

ARTICLE INFO

Article History:

Received 10th August, 2020

Received in revised form

17th September, 2020

Accepted 15th October, 2020

Published online 30th November, 2020

Key Words:

Sacroiliac Joint, Articular Space Width, CT scan, Morphometric Analysis, Anatomical Variation.

ABSTRACT

Background: Various disease processes can affect the sacroiliac joint (SIJ) altering its joint anatomy causing low back ache. The information obtained from physical examination of SIJ is often not adequate and the use of the radiological imaging methods gains importance for the diagnosis of SIJ diseases. **Objective:** The main objective of this study was to measure the articular space width of SIJ, in-order to ascertain its normal size and to probe the anatomic variations of SIJ in relation to age and sex of the patient, within south Indian population using Computed Tomography (CT). **Materials and methods:** A retrospective cross-sectional radiological study was performed utilizing 3mm abdominal & pelvic CT slices acquired from 301 patients (197 males; 104 females) without sacroiliac complaint, who had undergone scanning for other unrelated pathology. **Result:** The overall mean SIJ space width measured was 2.63 ± 0.78 mm. The mean joint space width for males and females were 2.54 ± 0.67 mm and 2.79 ± 0.93 mm respectively. In adults below 40 years, the measured width was 2.71 ± 0.89 mm and in older patients it was 2.66 ± 0.77 mm. 130 (43.2%) individuals had uniform SIJ and remaining 171 (56.8%) showed non-uniformity. Five anatomical variations were observed; accessory SIJ (9 patients, 3%), iliosacral complex (26 patients, 8%), semicircular defect (23 patients, 7%), ossification centers (9 patients, 3%) and crescentic defect (2 patients, 1%). **Conclusion:** This study has helped us determine the normal SIJ space width existing in South Indian population and determine the frequency of observed anatomic variants. The data acquired through this study, along with its inferences can help in various pathological correlations.

Copyright © 2020, Athul Antony Simon et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Dr. Athul Antony Simon, Dr. Stelin Agnes Michael, Dr. Lizamma Alex, Dr. Geena Benjami and Mrs. Nisha Kurien. 2020. "CT Based Morphometric Analysis of Sacro-iliac Joint in South Indian Demography", *International Journal of Current Research*, 12, (11), 14854-14859.

INTRODUCTION

Pelvic girdle connects lower limb to axial skeleton via the sacroiliac joint (SIJ), a synovial joint in which mobility has been sacrificed for stability and strength, to allow for effective weight transmission from the trunk to the lower limb. The SIJ is a synovial articulation between sacral and iliac auricular surfaces (Lee Justin, 2008) The SIJ is the largest axial joint in the body (Steven, 2005), the average surface area of the joint is 1.5 cm^2 at birth, 7 cm^2 at puberty, and 17.5 cm^2 in the adult, slightly less extensive in females (Brooke, 1923) Typically, the SIJ is formed within sacral segments S1, S2 and S3, although inclusion of the complete S3 segment in the SIJ is not common for females (Vleeming, 2012).

The sacrum is wedged between the iliac bones so that the cartilage on the uneven auricular surfaces of both bones is firmly coapted and held in position by powerful interosseous and dorsal sacro-iliac ligaments (Sacroiliac joint, 1987). Movement at this joint is restricted to only a slight rotation and translation by very strong ventral interosseous and dorsal sacroiliac ligaments. Due to its restricted mobility, the SIJ is called an amphiarthrosis (Kampen, 1998). Various disease processes can affect the sacroiliac joint (SIJ) altering its joint anatomy causing low back ache. The nearest part of SIJ to the surface is approximately 2 cm deep and there is no appreciable joint movement. Thus, the information obtained from the physical examination is not adequate and the use of the radiological imaging methods gains importance for the diagnosis of SIJ diseases (Van Der Linden) It is valuable to know the normal structure of SIJ to determine any kind of pathology. SIJs have a lot of structural variations and show some anatomical changes due to age (Prassopoulos, 1999).

*Corresponding author: Dr. Athul Antony Simon, MBBS, MD (Anatomy) Assistant Professor, Anatomy, P.K. Das Institute of Medical Sciences, Palakkad.

It has been documented that ageing can result in increased fibrous adhesions within the SIJ and consequent decrease in the size of its synovial cavity (Lee Justin, 2008). Radiological studies are indispensable in distinguishing the normal and the pathologic appearance of the joint that would act as a useful tool for the diagnosis of SIJ diseases. Through this study we aim to measure the articular space width of SIJ, in-order to ascertain its normal size and to probe the anatomic variations of SIJ in relation to age and sex of the patient, within south Indian population using Computed Tomography (CT). We have opted to utilize CT imaging for visualizing the SIJ as it provides superior spatial resolution when compared to Magnetic Resonance Imaging (MRI) (Pomeranz, 2008).

MATERIALS AND METHODS

A retrospective cross-sectional radiological study was conducted in the Department of Anatomy, Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, from July 2015 – July 2016. 301 patients (197 males; 104 females) without sacroiliac complaint, who had undergone abdominal & pelvic CT scanning for other unrelated pathology, were included in the study.

Study sample included patients aged 18-82 years who were categorized into two groups; < 40 years and > 40 years. CT images of patients < 18 years and patients with diseases of the SIJ and metallic implants were excluded from study. 3mm Abdomen and pelvis CT slices were acquired from a GE single slice spiral CT scanner, using the spine protocol. Patients were positioned supine and scanned in the axial plane with no gantry tilt. The CT sections were analyzed on bone window settings. Width of bilateral sacroiliac joint space was measured using CT workstation tool. The SIJ was studied at two different levels.

Level 1: At the level of the 1st sacral body, the joint space width was measured at the center of the joint, bilaterally.

Level 2: At the level of the 2nd sacral body, the joint was divided into 3 segments. Width was measured individually for the anterior 1/3, middle 1/3, and the posterior 1/3 bilaterally.

For all comparisons made; mean \pm one standard deviation (SD) was taken as normal range, any value falling below mean - 1 SD was considered narrow joint space, and any value greater than mean + 1 SD was considered wide joint space. In our study, the joint space was considered uniform when no SIJ space width difference of more than 0.3 mm was observed between measurements of both sides at level 1. The anatomical variations were observed and documented based on the classification done by Prassopoulos et al. (1999) of Greece (1999) and statistically checked for uniformity.

STATISTICAL ANALYSIS

The data thus obtained was statistically analyzed using SPSS software version 17. Mann Whitney U test was performed to determine the influence of age and gender on SIJ space width and Pearson Chi square test was used to establish whether a change in the SIJ space width at level 1 of the joint would cause any narrowing or widening at level 2 of the joint.

OBSERVATIONS AND RESULTS

The study sample consisted of 197 (65.4%) males and 104 (34.6%) females; inclusive of two age groups aged 18-40 years and > 40 years. The mean SIJ space width of all males on right and left sides were 2.55 ± 0.68 mm and 2.54 ± 0.66 mm respectively and overall 2.54 ± 0.67 mm. The mean SIJ space width of all females on right and left sides were 2.80 ± 0.95 mm and 2.78 ± 0.90 mm respectively and overall 2.79 ± 0.93 mm. The mean SIJ space width of males < 40 years on right and left sides were 2.64 ± 0.74 mm and 2.45 ± 0.62 mm respectively and in males > 40 years on right and left sides were 2.52 ± 0.66 mm and 2.57 ± 0.68 mm respectively. The mean SIJ space width for females < 40 years on right and left sides were 2.99 ± 1.15 mm and 2.73 ± 1.04 mm respectively and in females > 40 years on right and left sides were 2.72 ± 0.86 mm and 2.80 ± 0.85 mm respectively (Table 1). The mean SIJ space width for the entire sample irrespective of age and gender on right and left side was 2.63 ± 0.79 mm and 2.62 ± 0.76 mm respectively. Thus, the overall mean SIJ space width of the south Indian population included in the study is 2.63 ± 0.78 mm. There was no significant difference in the SIJ space width between the different age groups and gender. Table 1: SIJ space width for males and females (All measurements at Level 1). There were 215 (71%) normal, 44 (15%) narrow and 42 (14%) wide SIJ on the right side. Also, there were 209 (69%) normal, 51 (17%) narrow and 41 (14%) wide SIJs on the left side (Table 2). There was no significant difference observed on comparing the number of normal, narrow and wide joints for both sides and gender for both age groups. Among the 301 study subjects, 130 (43.2%) individuals were found to have a uniform SIJ irrespective of age and gender. Remaining 171 (56.8%) showed non-uniformity. It was observed that as age progressed, there was no notable change in uniformity of the SIJ among males and females of both age groups (Table 3; Chart 1).

Totally five anatomic variants were observed: accessory SIJ in 9 patients (3%), iliosacral complex in 26 patients (8%), semicircular defect in 23 patients (7%), ossification centers in 9 patients (3%) and crescentic defect in 2 patients (1%). 232 (77.1%) subjects did not present any anatomic variation. The distribution of the variants among males and females of both age groups can be inferred from charts 2 & 3. It was also observed that there was no significant change in uniformity with regards to any specific anatomic variation of the SIJ for males and females of both age groups. Pearson Chi square test was used to establish whether a change in the SIJ space width at level 1 of the joint would cause any narrowing or widening at level 2 of the joint. There was a significant correlation on the right side alone. Changes in dimension at level 1 caused proportionate difference at the anterior 1/3, middle 1/3, and posterior 1/3 of SIJ at level 2 ($p=0.000$). Left side SIJ level 1 changes did not alter the level 2 dimensions significantly. (Table 4)

DISCUSSION

Due to the deep-seated nature of the articular surfaces, information obtained from physical examination of SIJ is insufficient and the use of the radiological imaging techniques gain importance for the diagnosis of SIJ diseases. Our study utilized a CT based morphometric analysis of the SIJ to accurately determine the normal joint space width and the anatomic variants encountered.

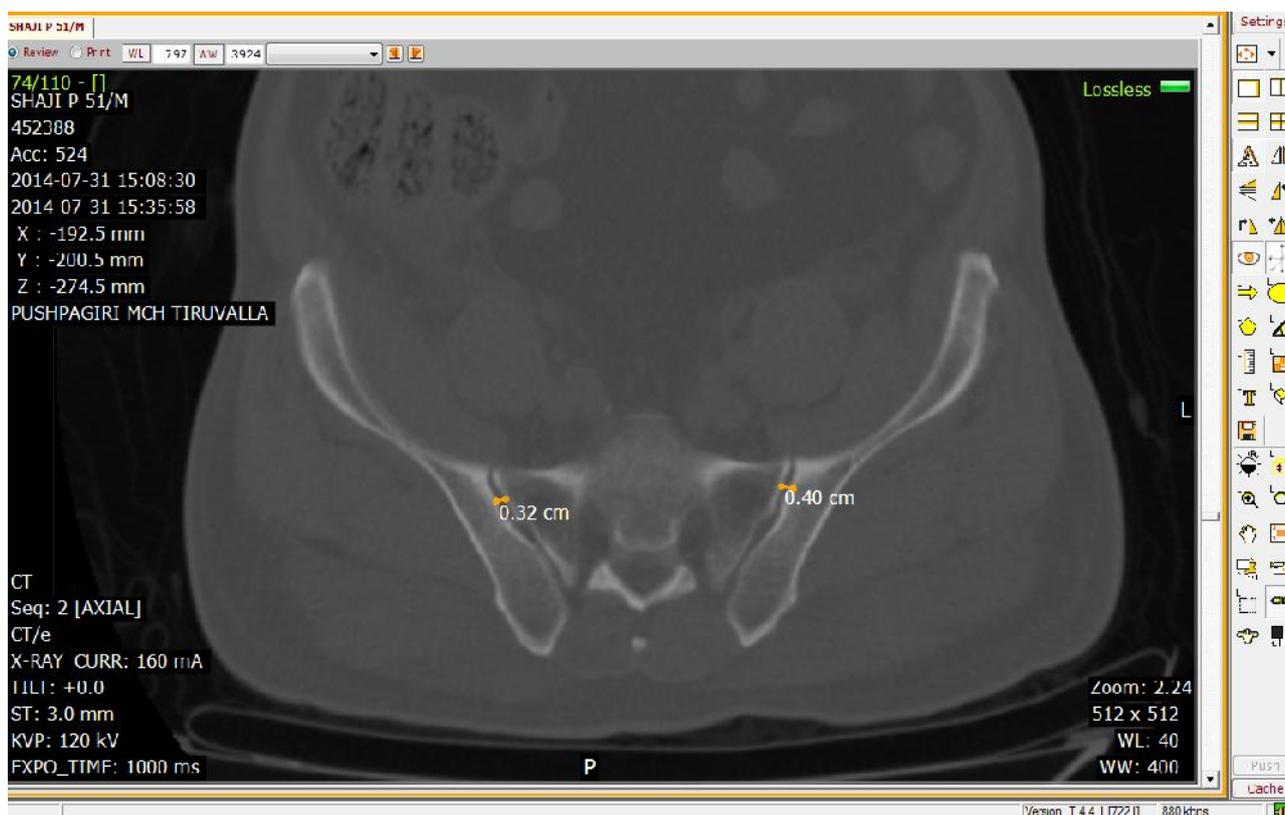


Figure 1. SIJ space width at Level 1 being measured using bone window settings in the image viewer at CT workstation

SIJ space width	<40years			>40years			Overall		
	Right (in mm)	Left (in mm)	P value	Right (in mm)	Left (in mm)	P value	Right (in mm)	Left (in mm)	P value
Male	2.64±0.74	2.45±0.62	0.307	2.52±0.66	2.57±0.68	0.216	2.55±0.68	2.54±0.66	0.084
Female	2.99±1.15	2.73±1.04	0.328	2.72±0.86	2.80±0.85	0.394	2.80±0.95	2.78±0.90	0.058

Table 2. Number and Percentage of narrow, normal and wide SIJs of both gender

Sacroiliac Joint		Narrow		Normal				Wide					
		<40 years		>40years		<40years		>40years		<40 years		>40years	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Males	Right	13	6.6	20	10.2	30	15.2	105	53.3	9	4.6	20	10.2
	Left	10	5.1	24	12.2	35	17.8	99	50.3	7	3.6	22	11.2
Females	Right	2	1.9	9	8.7	24	23	56	53.8	4	3.8	9	8.7
	Left	4	3.8	13	12.5	23	22.1	52	50	3	2.9	9	8.7

Table 3: Number and percentage of males and females showing uniformity and non-uniformity

SIJ	Uniform				Non-uniform				P value
	<40 years		>40 years		<40 years		>40 years		
	No.	%	No.	%	No.	%	No.	%	
Males	24	12.2	69	35	28	14.2	76	38.6	0.873
Females	9	8.7	28	26.9	21	20.2	46	44.2	0.504

Table 4. Level 2 SIJ space width comparison with level 1

Level 2	Narrow		Normal		Wide		P value
	No.	%	No.	%	No.	%	
Right Anterior 1/3	55	18.3	202	67.1	44	14.6	0.000
Right Middle 1/3	58	19.3	204	67.8	39	13	0.000
Right Posterior 1/3	35	11.6	232	77.1	34	11.3	0.000
Left Anterior 1/3	45	15.0	206	68.4	50	16.6	0.066
Left Middle 1/3	71	23.6	190	63.1	40	13.3	0.109
Left Posterior 1/3	34	11.3	225	74.8	42	14.0	0.032

Table 5. Comparison of number and percentage of anatomic variants observed in various studies; n = sample size

Anatomic Variant	Prassopoulos et al Greece (1999); n=534		Mehmet Demir et al Turkey (2007); n=400		Current study India (2016); n=301	
	No.	%	No.	%	No.	%
Accessory SIJ	102	19.1	70	17.5	9	3.0
Iliosacral complex	31	5.8	38	9.5	26	8.0
Semicircular defect	16	3.0	19	4.8	23	7.0
Crescent like iliac bony plate	20	3.7	14	3.5	2	1.0
Ossification centers	3	0.6	4	1.0	9	3.0
Bipartite iliac bony plate	22	4.1	22	5.5	-----	-----
Without variation	340	63.7	233	58.3	232	77.1

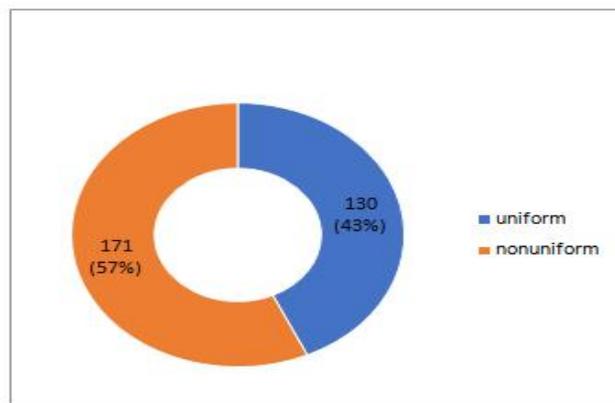


Chart 1. Uniformity comparison

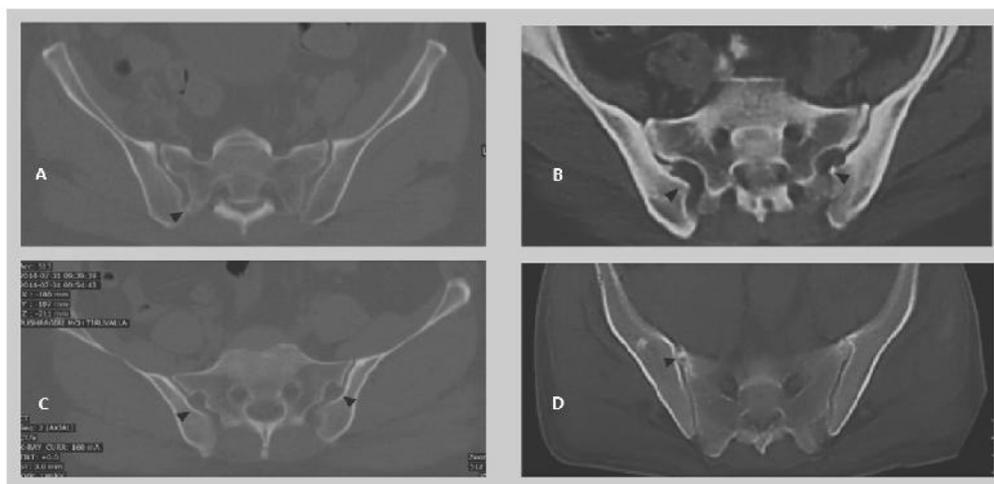


Figure 2. SIJ variations observed – A. Right Accessory SIJ, B. Bilateral Iliosacral complex, C. Bilateral Semicircular defect, D. Right ossification centre. (Arrow heads) (Images B & D incorporated from Mehmet demir et al. study from Gaziantep University, Turkey 2007)

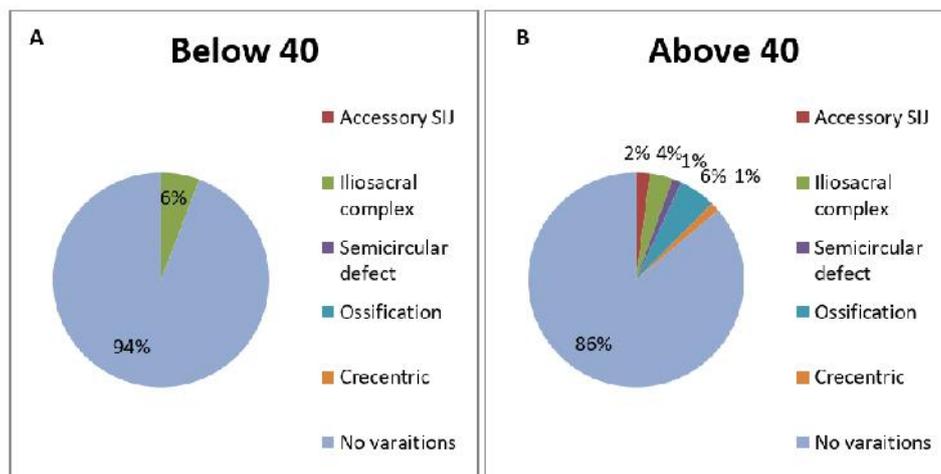


Chart 2. SIJ Variations among males; A - <40yrs, B - > 40yrs

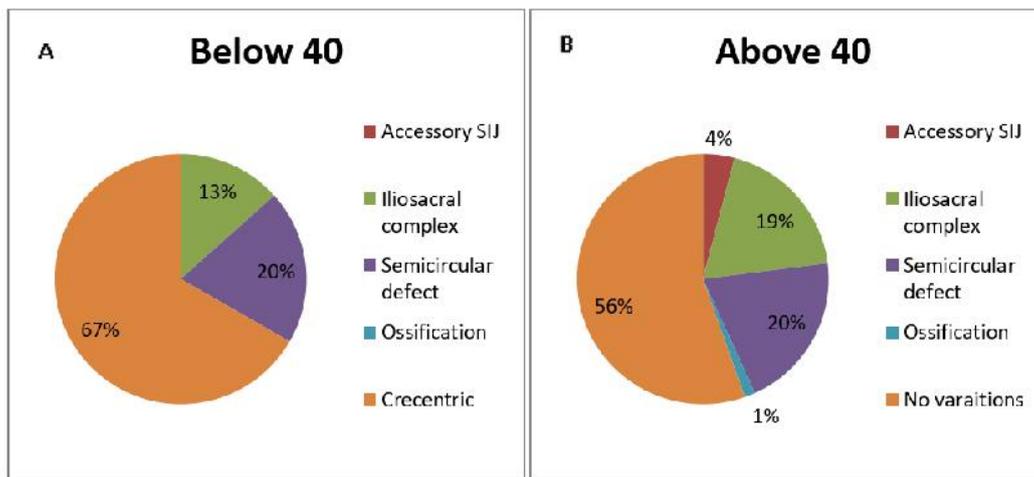


Chart 3. SIJ Variations among females; A - <40yrs, B - >40yrs

The overall mean SIJ space width in our study was 2.63 ± 0.78 mm, which exceeded the values obtained from CT based morphometric analysis of SIJ carried out by Sharma et al (2015) from Manipal University, India. Their study consisted of 149 subjects (75 men; 74 women) aged between of 18 and 80 years. The mean joint space width according to Sharma et.al was 1.74 ± 0.5 mm (ranged from 0 mm to 4.3 mm). Our mean SIJ space width also exceeded the values of Mehmet Demir et al (2007) from Gaziantep University, Turkey who had conducted a similar study. The mean joint space width of the 400 patients included in their study was 1.72 ± 0.57 mm (ranged from 0.77 mm to 4.39 mm). In adults below 40 years of age, the measured width was 2.49 ± 0.66 mm. In older patients the width was 1.47 ± 0.21 mm (Vleeming, 2012) This difference can be explained on grounds of race. The SIJ space width of females included in our study was slightly greater than males. This observation was in line with both Sharma et al and Mehmet demir et al study. During pregnancy, the pelvic joints and ligaments loosen under the influence of the hormone relaxin (Lee Justin, 2008). This alters the SIJ anatomy with subsequent increase in the joint space width.

Our study also showed no statistically significant difference between SIJ space width for a gender or age group which is similar to the report by Sharma et al (2006). In our study, 130 (43.2%) individuals had uniform SIJ irrespective of age and gender and the remaining 171 (56.8%) showed non-uniformity. It was also observed that as age progressed, there was no notable change in uniformity of the SIJ among males and females of both age groups. This contradicted Sharma et al and Mehmet Demir et al who stated that as age progressed, there was increased incidence of non-uniformity of SIJ among females (Frost, 2006; Dolly, 2015). We were able to detect only five variations of SIJ in comparison to the six variants observed by Prassopoulos et al and Mehmet Demir et al. Bipartite iliac bony plate was absent and iliosacral complex was the commonest variant in our study. Both the Greek and Turkish study had found accessory SIJ as the highest occurring variant (Table 5). We also found that age and gender did not affect the uniformity of SIJ with respect to any specific anatomic variation. This finding antagonized the 2007 Turkish study who had found a higher incidence of non-uniformity with increased age among females with certain variants. Our study was the only one to measure the SIJ space width at two different levels.

It was probed whether alterations in the SIJ space width at level 1 would cause any narrowing or widening at level 2. There was found to be a directly proportionate relationship that existed on the right side, possibly due to the preferred weight transmission to the right foot in right dominant subjects utilizing the right SIJ, which later on with ageing resulted in increased fibrous adhesions within the SIJ and consequent decrease in the size of its synovial cavity (Lee Justin, 2008).

Conclusion

This study has helped us determine, the normal SI joint space width that exists in our community for a specific age group and gender and also helped to determine the frequency of anatomical variations observed. The data acquired through this study, along with its inferences can provide normal morphometric values of SI joint that will help us study pathological conditions like sacroilitis and low back ache.

Acknowledgement

We express our heartfelt gratitude to the teaching and non-teaching staff of Department of Anatomy, Department of Community Medicine and Department of Radio-diagnosis, Pushpagiri Institute of Medical Sciences, Thiruvalla for their sincere co-operation that enabled us to carry out the study.

Conflict of interest

All abdominal & pelvic CT of study subjects were obtained from Department of Radio-diagnosis, Pushpagiri Medical College, Thiruvalla. All CT scans were previously taken for patients manifesting unrelated pathology without sacro-iliac diseases or complaints. I Dr. Athul Antony Simon, then anatomy Assistant Professor (2014-2016), Pushpagiri Medical College can confirm that there is no conflict of interest existing on any aspect of this self-funded study for any of the authors.

Funding: All expense incurred for study has been exclusively borne by the principal investigator.

GLOSSARY OF ABBREVIATION

Abbreviation	Word
Dr	Doctor
CT	Computed Tomography
SIJ	Sacroiliac joint

SIJs	Sacroiliac joints
mm	Millimeter
MRI	Magnetic Resonance Imaging
GE	General Electric
SPSS	Statistical Package for Social Sciences
p value	Calculated probability
n	Sample size
cm	Centimeter

REFERENCES

- Brooke R. The sacro-iliac joint. *J Anat* (1923) 58: 299-305.
- Dolly S., Priyanka, Influence of Age and Gender on Sacro Iliac Joint Space Measured on Computed Tomography. *IJSR*. March, (2015) 4(3): 306-308.
- Ehara Shigeru, El-Khoury Y. Georges, Bergman A. Ronald. The Accessory Sacroiliac Joint: A Common Anatomic Variant. *AJR*, April (1988) 150: 857-859.
- Frost L. Stacy et al. The Sacroiliac Joint: Anatomy, Physiology and Clinical Significance. *Pain Physician*. (2006) 9: 61-68.
- Kampen WU, Tillmann B. Age-related changes in the articular cartilage of human sacroiliac joint. *AnatEmbryol (Berl)* (1998) 198: 505-513.
- Lee Justin, Niranjana N.S. Pelvic girdle, gluteal region and thigh, In Standring, Susan. *Gray's Anatomy: The Anatomical Basis of Clinical Practice*. 40th edition, anniversary edition. Churchill Livingstone Elsevier, (2008) 1354-55.
- Mehmet et.al. Anatomical variation with joint space measurements on ct. *Kobe J. Med. Sci.*, (2007) 53(5): 209-217.
- Pomeranz J Stephen, Taranto Richard, Imaging on trial: MRI versus CT. *GCPj*. January (2008) 22-25.
- Prassopoulos P.K., Fafila C.P., Voloudaki A.E., and Gourtsoyiannis N.C. Sacroiliac joints: anatomical variants on CT. *J Comput Assist Tomogr.*, (1999) 23: 323-327.
- Sacroiliac joint, in Romanes G.J., *Cunningham's manual of practical anatomy (Volume 2)*. Reprinted 15th edition, Oxford University Press, (1987) 242.
- Steven P. Cohen. Sacroiliac Joint Pain: A Comprehensive Review of Anatomy, Diagnosis, and Treatment. *AnesthAnalg* (2005) 101: 1440-53.
- Trotter Mildred. Accessory Sacro-iliac Articulations. *American Journal of Physical Anthropology*, March (1937) 13(2):247-261.
- Van Der Linden S., Valkenburg H.A., and Cats A. Evaluation of diagnostic criteria for ankylosingspondylitis: a proposal for the modification of the New York criteria. *Arthritis Rheum.*, (1984) 27: 361-368.
- Vleeming et al. The sacroiliac joint: an overview of its anatomy, function and potential clinical implications. *J. Anat.*, (2012) 221: 537-567.
- Vleeming et.al. 2012. The sacroiliac joint: an overview of its anatomy, function and potential clinical implications. *J. Anat.* (2012) 221: 537-567.
