A study of lesser pelvic parameters and their correlation with age by reformatted computed tomography in western Indian Gujarati female population

Ritesh K. Shah, Jalpa N Desai, Ajay R Upadhyay

Abstract

Background & aims: Pelvic parameters vary according to age, race and population. The study is aimed at assessing female pelvic parameters using reformatted 3D CT images, compare the obtained values with other studies and correlate these parameters with age. Material & Methods: Reformatted three-dimensional CT images were obtained from stored abdominopelvic computed tomography [CT] scan images. Image analysis software was used to determine various diameters of the lesser pelvis. Data were analysed to derive mean ± SD, SE, 95% CI, paired t test and Pearson correlation test were used for comparison and correlation of variables. Results: Mean± standard deviation of obstetric conjugate diameter was 10.94±1.18 cm, transverse diameter of inlet was 12.46±0.81 cm, sagittal diameter of midplane was 11.74±0.80 cm, interspinous diameter was 9.78±0.75 cm, sagittal diameter of outlet was 8.99±1.02 cm and intertuberous diameter was 10.69±0.86. All the parameters except sagittal diameter of midplane and interspinous diameter showed correlation with age. Conclusion: The present study provides reference values for various pelvic parameters in western Indian Gujarati female population. Parameters obtained in present study vary greatly from previous studies from other populations. The results demonstrated that significant age-related changes occurred in pelvic inlet and outlet parameters. Keywords: pelvimetry, transverse diameter, sagittal diameter, interspinous diameter, intertuberous diameter

Introduction

Bony pelvis comprises of hipbones, sacrum, coccyx and the cavity formed within. The female pelvis represents a compromise between bipedal locomotion and obstetric requirements. This results in higher dimensions of lesser pelvis in females than in males during evolution. As the maternal bony pelvis plays an important role during parturition and normal child birth, it is important to conduct anatomical studies on female pelvic structure. Though clinical pelvimetry is the most widely used method; it has been found to have limited value and is prone to subjectivity.

The pelvic parameters similar to other bony parameters vary significantly in different races and populations due to differences in genetic makeup, nutritional and environmental factors, physical work etc. In past, many researchers have used different techniques in order to study various pelvic parameters in different populations. Pelvimetry in cadavers and dry bony pelvis has been used to determine the basic pelvic specifications in different populations. With the help of radiological advances, it has become possible to precisely analyse pelvic parameters in living subjects by using X-ray, ultrasound, computed tomography and magnetic resonance imaging. Recent studies have found that computed tomography can capture accurate details of bony features along with less distortion than conventional X rays technique.

The variations in the pelvic parameters of western Indian Gujarati women have not been reported in literature. Aim of our study is to determine normal values for the various diameters of lesser pelvis in western Indian Gujarati population, compare these parameters with those from the other populations and determine whether there are significant age related changes in these parameters.

Materials and Methods

It is an anatomical, retrospective and observational study using CT images available in the database of Department of Radiology, GCS Medical College, Ahmedabad, of female subjects who underwent image study for other reasons. A sample size [with prior
calculation] of 110 abdomino-pelvic CT images with age more than 20 years were analysed in the study. Any CT images showing pelvic bony diseases or pelvic fracture were excluded from the study.

Study was done using reformatted 3D CT images that extracted only bony details. An experimental study to test the validity of the measurements was done using a female bony pelvis which was scanned. Various measurements were taken on 3D CT images of this female pelvis and validated with actual measurements. Following parameters were obtained from reformatted 3D CT images:-

1. Obstetric conjugate diameter [OCD]:- Distance between the centre of the sacral promontory and the most prominent point on posterior surface of the pubic symphysis [Fig.1]
2. Transverse diameter of inlet [TD]:- Distance between the widest points on the pelvic brim [Fig.2]
3. Sagittal mid plane diameter [A-P midplane]:- Distance between the lower end of the pubic symphysis to the approximately middle of the fourth sacral vertebra [Fig.1]
4. Interspinous diameter [ISD]:- Distance between the medial edges of two ischial spines [Fig.3]
5. Sagittal outlet diameter [A-P outlet]:- Distance between lower end of pubic symphysis and tip of the coccyx [Fig.1].
6. Intertuberous diameter [ITD]:- Distance between the inner margins of two ischial tuberosities [Fig.3].

All the diameters were measured automatically by the image analysis software. Statistical analysis was done using computer program Medcalc version 14. Subjects were divided into two age groups namely 20-40 and above 40 years of age. Descriptive data such as mean, standard deviation, standard error of mean etc. were obtained for all the samples as well as for each group. Two-tailed Student's t-tests were used to compare each parameter for two age groups. Linear regression graphs were plotted to show relationship of each parameter with age. This study was approved by
Fig. 4 Age-related changes in sagittal diameters of lesser pelvis. (A) Obstetric conjugate diameter. (B) Sagittal diameter of midplane. (C) Sagittal diameter of outlet.

Fig. 5 Age-related changes in transverse diameters of lesser pelvis. (A) Transverse diameter of inlet. (B) Interspinous diameter. (C) Intertuberosous diameter.

data of the subjects which were divided into two groups i.e. Group A [n=55] included cases between 20 to 40 years of age and Group B [n=55] included those with age more than 40 years.

Age related changes in pelvic parameters were analysed where age was an independent variable while the different pelvic measurements were dependent variable for each linear regression model. OCD [p<0.0001], TD [p=0.048], sagittal outlet

the Institutional Ethics Committee of GCS Medical College, Hospital and Research Centre.

Results

In this study, 110 abdominopelvic CT images of female subjects were examined. Table 1 presents the descriptive analysis data for different pelvic parameters in all 110 subjects. Table 2 tabulates descriptive analysis
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Table-1. Morphometric data of various pelvic parameters of 110 western Indian females.

<table>
<thead>
<tr>
<th>Parameters [in cm]</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCD</td>
<td>7.71-14.68</td>
<td>10.94</td>
<td>1.18</td>
<td>0.11</td>
<td>10.72-11.17</td>
</tr>
<tr>
<td>TD</td>
<td>10.49-13.99</td>
<td>12.46</td>
<td>0.81</td>
<td>0.08</td>
<td>12.30-12.61</td>
</tr>
<tr>
<td>A-P midplane</td>
<td>9.82-13.68</td>
<td>11.74</td>
<td>0.80</td>
<td>0.08</td>
<td>11.59-11.89</td>
</tr>
<tr>
<td>ISD</td>
<td>8.3-12.09</td>
<td>9.78</td>
<td>0.75</td>
<td>0.07</td>
<td>9.64-9.92</td>
</tr>
<tr>
<td>A-P outlet</td>
<td>6.5-12.35</td>
<td>8.99</td>
<td>1.02</td>
<td>0.10</td>
<td>8.79-9.18</td>
</tr>
<tr>
<td>ITD</td>
<td>8.35-13.18</td>
<td>10.69</td>
<td>0.86</td>
<td>0.08</td>
<td>10.52-10.85</td>
</tr>
</tbody>
</table>

Table-2. Morphometric data of various pelvic parameters of western Indian females with age ranging from 20 to 40 years [n=55] and above 40 years [n=55].

<table>
<thead>
<tr>
<th>Parameters (cm)</th>
<th>Age</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCD</td>
<td>20-40</td>
<td>9.42-14.11</td>
<td>11.40</td>
<td>1.08</td>
<td>0.15</td>
<td>11.11-11.69</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td></td>
<td>&gt; 40</td>
<td>7.71-14.68</td>
<td>10.48</td>
<td>1.11</td>
<td>0.15</td>
<td>10.18-10.78</td>
<td></td>
</tr>
<tr>
<td>TD</td>
<td>20-40</td>
<td>10.49-13.87</td>
<td>12.25</td>
<td>0.95</td>
<td>0.13</td>
<td>11.1-12.51</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>&gt; 40</td>
<td>11.11-13.99</td>
<td>12.66</td>
<td>0.58</td>
<td>0.08</td>
<td>12.5-12.81</td>
<td></td>
</tr>
<tr>
<td>A-P midplane</td>
<td>20-40</td>
<td>9.82-13.6</td>
<td>11.61</td>
<td>0.90</td>
<td>0.12</td>
<td>11.37-11.85</td>
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<tr>
<td>(cm)</td>
<td>&gt; 40</td>
<td>10.41-13.68</td>
<td>11.87</td>
<td>0.67</td>
<td>0.09</td>
<td>11.68-12.05</td>
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<tr>
<td>ISD</td>
<td>20-40</td>
<td>8.3-12.09</td>
<td>9.77</td>
<td>0.75</td>
<td>0.10</td>
<td>9.57-9.97</td>
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<tr>
<td>(cm)</td>
<td>&gt; 40</td>
<td>8.47-11.54</td>
<td>9.79</td>
<td>0.76</td>
<td>0.10</td>
<td>9.58-9.99</td>
<td></td>
</tr>
<tr>
<td>A-P outlet</td>
<td>20-40</td>
<td>7.22-11.49</td>
<td>8.76</td>
<td>0.92</td>
<td>0.12</td>
<td>8.51-9.01</td>
<td>0.040</td>
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<tr>
<td>(cm)</td>
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<td>6.57-12.35</td>
<td>9.21</td>
<td>1.08</td>
<td>0.15</td>
<td>8.92-9.50</td>
<td></td>
</tr>
<tr>
<td>ITD</td>
<td>20-40</td>
<td>8.35-13.18</td>
<td>10.96</td>
<td>0.94</td>
<td>0.13</td>
<td>10.70-11.21</td>
<td>0.002</td>
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<tr>
<td></td>
<td>&gt; 40</td>
<td>8.65-12.39</td>
<td>10.42</td>
<td>0.69</td>
<td>0.09</td>
<td>10.23-10.61</td>
<td></td>
</tr>
</tbody>
</table>


diameter [p=0.019] and ITD [p=0.038] were found to be significantly age-dependent. OCD and ITD were found to decrease with age whereas TD and sagittal outlet diameter increased with age. p-values <0.05 were considered to be statistically significant. No significant change with regard to advancing age was observed in sagittal midplane diameter [p=0.350] and ISD [p=0.479]. Except for the sagittal midplane diameter and ISD, all the other parameters show statistically significant difference with regard to age.
Fig. 4 presents age related changes in sagittal diameters in which graph A shows decrease in OCD with advancing age, graph B shows no significant change in sagittal midplane diameter with age and graph C shows increase in sagittal outlet diameter. Fig-5 presents age related trends of transverse diameters in which graph A showing increase in transverse diameter of inlet, graph B shows no significant change in interspinous diameter and graph C shows decrease in intertuberous diameters.

**Discussion**

Pelvimetry studies in past have been reported using different imaging technique like x-rays, ultrasound, computed tomography and magnetic resonance imaging. Compared to other conventional methods, multi-detector computed tomography method offers three dimensional representation of the human skeleton with excellent spatial resolution. This method is also accurate, less time consuming, easy to use without any prior preparation and gives more details of bony structures compared to MRI.

The mean of obstetric conjugate diameter in present study is 10.94 [±1.18 cm] which is nearer to that in female Turkish population but is lower than that found in female Mexican, German, Iranian, Korean and Swiss population. Salk et al. and Kolesova et al. reported higher mean values of sagittal midplane diameter than present study which is 11.74 [±0.80] cm. In present study, the mean value of sagittal outlet diameter is also lower than that in studies done by Kolesova et al., Mostafa et al. and Decker et al.

In our study, sagittal diameter of inlet decreases with advancing age and that of outlet increases with age. Statistically significant difference in these two parameters was observed between the two age groups. No significant change was found in sagittal midplane diameter between the two age groups [table 3]. Vazques Barragan MA et al. reported similar age related changes in OCD in his study in Mexican population. Oksana and Liu P et al. studied diagonal conjugate diameters that showed similar changes with advancing age. Oksana also reported increase in sagittal outlet diameter with advancing age. This age related changes in OCD and sagittal outlet diameter can be attributed to anterior tilting of sacral base and fixing of the sacrum in more horizontal position with advancement of age. This results in reduction in sagittal diameter of inlet associated with increase in corresponding diameter of the outlet, following the mutation mechanism.

In the present study, mean of transverse diameter of inlet is 12.46±0.81 cm SD which is lower than previously done studies. Interspinous diameter is the narrowest part of the midpelvis. The mean of interspinous diameter in our study is higher than that of Kim et al. but lower than Vazques Barragan MA et al., Lenhard M et al., Kolesova O et al., Keller TM et al. and Salk I et al. In the present study, intertuberous diameter is 10.69±0.86 cm SD which is more than that found in Korean women but less than the same found in Swiss, Turkish & Latvian women.

Transverse diameter of inlet increase with age but intertuberous diameter decrease with age and these changes are statistically significant. Increase in transverse diameter may be attributed to anterior tilting of sacral base along with shortening of sagittal diameter. The observed decrease in intertuberous diameter can be related to adaptation of the pelvic bone system for sitting position where the load increases on ischial tuberosities. Our study did not find statistically significant change in ISD with regard to age. This suggests that both sagittal as well as transverse diameter at midplane are age independent. This can be explained by more intensive evolutionary adaptation in females which probably resulted in preserving the proportion of this narrowest plane in the pelvic cavity as independent of age.

Our study presents various pelvic diameters in western Indian Gujarati female population which can be used for obstetric, forensic, anatomical and anthropological studies. The study also demonstrates age related changes in various pelvic parameters. It was observed that horizontalization of pelvic bone system and associated age-related changes in various sagittal and transverse diameter can contribute to the development of pelvic floor dysfunction and pelvic organ prolapse. Our study had limitations as
patients were not of a particular group, their physical parameters and clinical status with regard to pelvic floor diseases, number and outcome of childbirth were not available. Further clinical studies focusing on above mentioned factors are needed to assess changes in pelvic bone system.

Conclusion
In the present study, normal values of OCD, transverse diameter of inlet, sagittal diameter of midplane, ISD, sagittal diameter of outlet and ITD are reported. On comparing values derived in the present study with that of previous studies, it is observed that these parameters vary greatly in different races and populations. The study also found that with advancing age obstetric conjugate diameter decreases, transverse diameter of inlet increases, sagittal diameter of outlet increases and intertuberosus diameter decreases and all these changes are statistically significant. This study contributes towards understanding the usefulness of computed tomography based pelvimetry.

References


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