Wider pelvic transverse and intertuberum diameter are risk factors for pelvic organ prolapse

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Abstract

Background: Pelvic floor’s shape and size are suspected of having associations with the occurrence of pelvic organ prolapse (POP). However, these relationships are not definitive and have never been evaluated. This study aims to identify the relationship between POP and pelvic floor size.

Methods: This is a cross-sectional study involving women with or without POP who underwent gynecologic visits at the outpatient clinic. POP was diagnosed using the POP-Q questionnaire, whereas pelvic floor diameter was measured from the x-ray, comprising anteroposterior (AP), transverse (TS), interspinous (IS), and intertuberous (IT) diameters.

Results: The TS and IT diameter of subjects with POP are significantly wider (p<0.001 and p=0.016), on the other hand, the AP and IS diameter were similar among two groups (p=0.36 and p=0.58). The subjects who have TS and IT diameter each above 12.185 and 10.140 cm have a higher risk of POP when compared to those who have TS and IT diameter lesser than the corresponding values (PR₃ 3.85, 95% CI 1.47-20.11; p<0.001; PR₄ 2.49, 95% CI 1.12-5.53; p=0.013), with both, have partial correlation but TS more significant (Lambda 0.7; p-value 0.001 and Lambda 0.4; p-value 0.075). There was a relationship between a pelvic floor with POP. Subjects with POP have wider TS and IT diameters when compared to non-POP subjects.

Conclusion: TS and IT diameters above 12.185 cm and 10.140 cm increase the risk of POP.

Keywords: Pelvic organ prolapse, anteroposterior diameter, transverse diameter, interspinous, intertuberous

Introduction

Pelvic organ prolapse (POP) or also known as urogenital prolapse is a downward slippage of female pelvic organs (i.e., uterus, bladder, urethra, and rectum) into or out of the vagina as a consequence of weakness on the corresponding muscle, fascia, and the supporting ligaments beneath them. POP is a disease with a high burden of multifactorial impacts, either from a social or economic perspective, in addition to a significant decrease in the patient’s quality of life. One study found that POP prevalence ranges from 43 to 76 percent and increases throughout life.
The increased incidence of POP overages indicates that there is any degenerative factor concerning its pathogenesis. POP is frequently associated with pelvic muscles and connective tissue damage, even though pelvic bones also pose a contributive role to its existence. However, the evidence supporting the latter theory is limited, although convincing. Several studies demonstrated that POP patients possess a more significant average TS and IS diameter compared with non-POP subjects.\textsuperscript{3,4} Several mechanisms have been proposed to explain the role of pelvic bones profile and the underlying risk of POP, which comprises: influence on birth mechanisms, bridge theory, and mass pressure theory. All of those three mechanisms are regarded as valid and proportional, yet several contradictive results still aroused from between one and another.

The fact that there is data disparity related to which type of pelvic bone diameter poses the most significant effect on POP incidence makes it difficult to withdraw a specific pathophysiological process of particular pelvic bone profile causing the POP itself. Furthermore, to the best of our knowledge, there has been no study conducted to measure the average pelvic bone diameter of Women and its correlative measurements to the incidence of POP among this population yet. Therefore, the authors intended to investigate the pelvic bone diameters of the corresponding targeted population and attempt to seek the correlation between POP incidence.

**Method**

This study was an analytic cross-sectional observation which compared four types of pelvic bone diameters (AP, TS, IS, and IT) as risk factors of Women either those who suffer from POP or without POP, all of who routinely undergo a medical check-up at the Obstetric and Gynecologic outpatient clinic in Sanglah General Hospital between the study period of September 2010 to July 2011. The consecutive random sampling method was applied in sample recruitments from the aforementioned targeted population. Several inclusion criteria were established, i.e., women with or without POP and are willing to participate in this study.

Those who possess either one of these exclusion criteria: 1) suffered from connective tissue disease (e.g., Ehlers-Danlos syndrome and/or Marfan’s syndrome), 2) had a history of pelvic bone fracture, 3) had a pelvic bone deformity, 4) had a history of chronic cough and/or constipation, 5) had a history or occupation involving strenuous activities could not participate the study.

Women who fulfilled both the inclusion and exclusion criteria are eligible to participate in this study and asked to sign the informed consent form. A thorough and detailed history taking was conducted, which consists of age, menopausal status, smoking habit, occupation, hormonal replacement therapy, BMI, family history, parity, mode of giving birth, the number of vaginal delivery, birth weight of the baby delivered, and past illness history.

The gynecologic examination was then performed by using POP-Q to diagnose POP as well as classify the subject into a POP or non-POP group. Subsequently, all subjects underwent radiological evaluations, i.e., anteroposterior and lateral pelvic x-ray. The result of the pelvic size was then collected and analyzed statistically.

The studied independent variable consists of the pelvic size which is defined as the distance measured in centimeter-scale and comprises AP (distance between the promontory and upper border of symphysis), TS (the longest distance from the pelvic inlet), IS (distance between two ischiadic spines), and IT (distance between ischiadic tuberosities) diameters. All of the measurements, as mentioned above, were taken from the anterior and lateral pelvic x-ray of each subject.

The dependent variable consists of the established diagnosis of POP and non-POP. POP is defined by the downward slippage of pelvic organs into or out of the vagina and is classified into grade 0 to IV as quantified by the POP-Q system. Zero degrees POP means there is no evidence of POP, a first degree means the descent of pelvic organs with the most distal prolapse $> 1$ cm above hymen circle, second degree is the descent of the lowermost pelvic organ $\leq 1$ cm below hymen circle, third grade POP is the descent of pelvic organ with the lowermost part $> 1$ cm below hymen circle but less than (TVL-2) cm. In contrast, fourth grade POP is marked by the descent of the whole pelvic organs, and the whole vaginal wall is everted.

Data were collected and classified according to the assigned scheme, and statistical analyses were then performed as follows. All data were tested for its normality and homogeneity using Shapiro-Wilk and Levene’s test for homogeneity, respectively. Pelvic bone diameter differences were then tested using an independent T-test. Furthermore, the POP risk was quantified to those diameter(s) which possess(es) marked differences by using the chi-square test and prevalence ratio, with earlier cut-off point determination using the ROC curve. The final analysis was conducted to find whether or not there is any correlation between the identified pelvic diameter and POP prevalence using $\chi^2$ lambda correlation statistics. The established confidence interval was 95% with $p$-value $< 0.05$ was deemed statistically significant. All tests were conducted using SPSS 17.0 (SPSS Inc, Chicago, IL).
Results

According to sample calculations, at least 16 subjects from each group were needed to be representative. Thus, the total number of required samples were 32 subjects. The baseline profile of each group for variable classification was displayed in Table 1. Normality and homogeneity tests showed that all variables fell between normal limits, except the markedly significant differences among TS and IT diameter homogeneity.

To determine the risk of POP on TS and IT diameter, we previously measured the cut-off point of each mentioned diameter using the ROC curve. We obtained each value, i.e., 12.185 and 10.140 cm, consecutively. After we obtained the cut-off point using the ROC, we subsequently performed the chi-square test to quantify the risk of POP occurrence by using the previously obtained ROC curve. As a result, subjects with equal or more significant than the cut-off point (i.e., TS: 12.18 cm; IT: 10.14 cm) were at higher risk to suffer POP when compared with those who had a diameter of less than the predefined cut off values (TS: prevalence ratio [RP] 3.85; 95% CI 1.47-20.11, p<0.001; IT: RP 2.49; 95% CI 1.12-5.53, p<0.013) (Table 2 and Table 3).

Table 1. Distribution of age, parity, BMI, occupation, AP, TS, IS, and IT diameters in the POP or non-POP group

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Groups</th>
<th>POP (n=16) mean (SD)</th>
<th>Non-POP (n=16) mean (SD)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td>51.19 (3.75)</td>
<td>52.75 (5.39)</td>
<td>0.35</td>
</tr>
<tr>
<td>Purity</td>
<td></td>
<td>2.38 (0.72)</td>
<td>2.12 (0.72)</td>
<td>0.33</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
<td>22.89 (0.67)</td>
<td>22.52 (1.16)</td>
<td>0.28</td>
</tr>
<tr>
<td>occupations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td></td>
<td>9 (52.9)</td>
<td>8 (47.1)</td>
<td>0.72</td>
</tr>
<tr>
<td>Housewife</td>
<td></td>
<td>7 (46.7)</td>
<td>8 (53.3)</td>
<td></td>
</tr>
<tr>
<td>AP</td>
<td></td>
<td>11.41 (0.26)</td>
<td>11.34 (0.1)</td>
<td>0.36</td>
</tr>
<tr>
<td>TS</td>
<td></td>
<td>12.36 (0.26)</td>
<td>11.90 (0.18)</td>
<td>0.001</td>
</tr>
<tr>
<td>IS</td>
<td></td>
<td>11.29 (0.37)</td>
<td>11.39 (0.6)</td>
<td>0.58</td>
</tr>
<tr>
<td>IT</td>
<td></td>
<td>10.32 (0.46)</td>
<td>9.88 (0.53)</td>
<td>0.016</td>
</tr>
</tbody>
</table>

BMI: body mass index

We want to know whether there is a relationship between TS diameter and IT diameter with the incidence of POP. Both variables are nominal types, so the Lambda X2 correlation method is used to determine the correlation between the two. As a result, the TS diameter is significantly correlated with the incidence of POP (Table 4).

Finally, we would like to identify the correlation between TS and IT diameter with POP occurrence. Both variables were the nominal type. Therefore we performed the lambda X2 correlation test. We found a robust and statistically significant correlation between TS diameter with the POP occurrence.

Table 2. The risk of POP occurrence on TS diameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Category</th>
<th>POP</th>
<th>Non-POP</th>
<th>PR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS</td>
<td>≥ 12.18</td>
<td>12</td>
<td>2</td>
<td>3.85</td>
<td>1.47 – 20.11</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>&lt; 12.18</td>
<td>4</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. The risk of POP occurrence on IT diameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Category</th>
<th>POP</th>
<th>Non-POP</th>
<th>PR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT</td>
<td>≥ 10.14</td>
<td>12</td>
<td>5</td>
<td>2.49</td>
<td>1.12 – 5.53</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>&lt; 10.14</td>
<td>4</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. The risk of POP occurrence on TS diameter in the ROC curve, the cut-off point at 12.18 obtained sensitivity and specificity of 100% so that it was chosen as the cut-off value.

Figure 2. The risk of POP occurrence on IT diameter in the ROC curve, the cut-off point at 10.14 obtained sensitivity and specificity of 100% so that it was chosen as the cut-off value.

Discussion

In general, all of the baseline profiles for each group studied (POP and non-POP) were comparable, except for the TS and IT diameter, either the POP or non-POP group. These results were following Sze et al., in which they had found that women with POP tended to have larger TS diameter compared with women without POP (12.9 ± 0.7 cm; 12.5 ± 0.6 cm, p<0.006). However, the rest of the other types of diameter (AP: 12.5 ± 1.3 vs. 12.8 ± 1.0 cm; IS: 11.5 ± 0.8 vs. 11.2 ± 0.9 cm; IT: 10.0 ± 1.0 vs. 9.8 ± 0.8 cm) did not demonstrate any significant results. On the other hand, the similar study done by Maryuni obtained a different result for IT diameter between the POP and non-POP group (i.e., 10.13 ± 0.83 vs. 9.3 ± 1.01 cm, respectively), but no difference found between the rest of the diameter types (AP: 11.61 ± 1.16 vs. 11.68 ± 1.04 cm; IS: 11.29 ± 1.19 vs. 10.96 ± 0.89 cm;
and TS diameter: 12.30 ± 0.68 vs. 12.16 ± 0.55 cm).

In this study, we did not find any marked difference between AP and IS diameter. Similarly, the study conducted by Sze and Maryuni also did not find any marked differences between those two diameter types.\textsuperscript{3,5} They had argued that the lack of sample numbers might become the underlying cause of the failure to find any significant differences between groups. Furthermore, their studies involved the use of a CT scan, which arbitrarily has lower accuracy when compared with MRI. Even simpler, our study only used two-dimensional pelvic x-ray views (i.e., anterior and lateral) to measure all four types of diameter, which had lower accuracy when compared with CT scan and or MRI records.

Women were known for their extreme workload which does not properly fit for their anatomical condition, like becoming a courier who placed a cumbersome object on the top of their head as frequently seen on the traditional market, or villagers who work as a stone courier. All those activities will increase the intraabdominal pressure which subsequently influences the descent of pelvic organs. The working load is further aggravated by certain social practices for Hindus, like placing the ceremonial materials on the top of their head and other activities related to the procession, which all of them may be potentially linked to the occurrence of POP. However, in our study, we had found that the subject’s occupation had a homogenous distribution, thus did not affect the obtained results between independent and dependent variables initially.

Several experts commented that the larger the size of someone’s pelvic bone diameters, means more stress is exerted on the pelvic basement, ligaments, and fascia, thereby accelerating the structural weakness upon those components which subsequently increases the risk of POP. Nonetheless, Sze et al.,\textsuperscript{3} proposed a different theory, i.e., a large pelvic bone diameter will increase the likelihood of a baby weighing more than 300 grams to move downward which potentiates more damages to the corresponding pelvic muscles. Sze et al\textsuperscript{3} also consider small pelvis as a protective factor in the occurrence of POP. Another compelling theory was proposed by Baragi et al.,\textsuperscript{6} in which a larger pelvic size or diameter may exert higher total pressure on the pelvic muscle due to its given larger surface area.

Meanwhile, Petros stated that pelvic organs (vagina and bladder) are analogous to a bridge maintained by ligaments and fascia which act as a hanging rope.\textsuperscript{7} Therefore every condition that exerts a certain amount of damage to the corresponding ligaments and fascia, like the giving birth process, potentially disrupt the pelvic organs position and might predispose POP. Furthermore, pelvic size is a determinant factor of POP concerning pelvic fascia, muscles, and ligaments. The larger the pelvic size, the higher the extent of pelvic muscles, ligament, and fascia are stretched, thus will accelerate its intrinsic weakening process. This condition is even worse in a subject who has a less than state-of-the-art pelvic structure anatomy, in which a stretch of one of the pelvic muscles will also be disrupted and causes the vagina to be improperly seated.

In general, it is perceivable that the vast majority of the pelvic diameters on this study are relatively smaller than those found on Sze et al.,\textsuperscript{3} but similar to the size obtained by Maryuni.\textsuperscript{5} The racial differences may account the differences to those of Sze et al.,\textsuperscript{3} in which most of the subjects were whites, whereas Maryuni’s subjects were Asians and ultimately this study was conducted specifically on Balinese race.\textsuperscript{3,5}

Based on the statistical analyses, a pelvic with a TS diameter more significant than 12.185 cm is 3.85 times more likely to suffer from POP, and subjects with a pelvic IT diameter larger than 10.140 cm are 2.49 times more likely to suffer from POP. The study conducted by Sze & Wahyuni only attempted to identify the role of different pelvic size with the occurrence of POP without subsequent cut-off point determination and quantify the risk of suffering from POP by using these reference numbers.

The analyses demonstrated that IT diameter has a weak correlation with the POP occurrence and was statistically insignificant. On the other hand, the TS diameter possesses a strong and statistically significant correlation with POP occurrence. According to the Lambda correlation test, the relationship between IT diameter with POP occurrence is lesser in magnitude when compared with the relationship between TS diameter and POP occurrence. These results are consistent with the previous POP risk analyses in which TS diameter exerted a higher risk for POP occurrence, compared with IT diameter.

We were unable to identify the causal relationships between those two variables by using the Lambda correlation test. However, this is not regarded as a serious issue since the previous analyses have shown consistent linearity between TS and IT diameter concerning the risk of POP occurrence.

We only included 16 subjects on each group, and samples were taken consecutively. This accounts for the subsequent difficulty to generalize the evidence to the bigger Women population. Besides, pelvic x-ray evaluations to measure the AP, TS, IS, and IT diameters were done using a caliper. Since it was measured with an analog instrument, the accuracy obtained from the measurements (i.e., two digits behind the comma) is deemed inadequate when compared with
other studies that used CT Scan pelvimetry that indeed yielded a more accurate result. These limitations are by the nature of the preliminary study. Therefore we tend to use the most straightforward and most efficient methods available to collect the data.

The fact that both TS and IT diameter correlates positively with POP occurrence indicates that these two models could be evaluated routinely in clinical practice to predict the POP occurrence. However, a diagnostic study that evaluates these parameters is required to ensure validity.

Also, we need to consider the synergistic effects by the combination of the TS and IT diameter about the POP occurrence, since this study only evaluated the risk profile and correlation individually for each parameter (standalone) and, thus have not taken into account for the plausible potentiation effect of these parameters when combined altogether (could be in the form of logarithmic or exponential). If this is proven to exist, these parameters may become an early warning sign or red flag of higher risk (and likelihood) of those women suffering from POP in the future.

**Conclusion**

The pelvic TS and IT diameter possess a markedly different role in the occurrence of POP, while the relationships are insignificant for AP and IS diameter. However, only the TS diameter, which possesses a strong and statistically significant correlation with the POP occurrence, whereas IT diameter only has a weak and non-significant correlation with the POP occurrence.

**Acknowledgment**

No acknowledgment

**References**


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