Correlation of Pelvimetry and Age Based on 3D CT Scan Examination

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ABSTRACT

Background: *The radiological pelvimetry is a measurement by using 3D Computed Tomography (CT) which will pelvis shape. The Pelvimetry size is not always constant, but it can change due to several factors, among others are age, heredity, number of pregnancies. The age changes can be related to the adaptation to the sitting position and compensation of the spino-pelvic balance change having the impact on the walking style stability.* ***Purposes:*** *The research aims to analyze the correlation between the pelvimetry and age based on CT scans 3D examination of patients from January 2021 to April 2022 in General Central Hospital of Dr. Wahidin Sudirohusodo, Makassar Indonesia.* ***Methods:*** *The research used the cross sectional design with Spearman correlation test.* ***Results:*** *There were 105 samples involved in the research. The most age group ranged from 40 to 49 years old with the percentage of 32.4%. The average size of the conjugate vera is 11.49 cm (SD±0.95), obstetric conjugate is 11.46 cm (SD±0.92), diagonal conjugate is 12.27 cm (SD±0.87), interspinous diameter is 10 .15 cm (SD±0.95), intertuberous diameter is 10.58 cm (SD±1.02), and transverse diameter is 11.99 cm (SD±0.88). The research result indicates that the conjugate vera, obstetrical conjugate, diagonal conjugate, and intertuberous diameter have the correlation with the age ($p<0.05$), while the interspinous diameter and transverse diameter do not indicate the correlation ($p>0.05$).* ***Conclusions:*** *The conjugate obstetrics and conjugate diagonalis have weak correlation, while the moderate correlation strength occurs in the intertuberous diameter.*

Keywords: *age; pelvimetry; 3 dimensional compute tomography scan*

INTRODUCTION

Hip or also called as pelvis is a part of the human body shaped like a basin with widening on both sides. Pelvis was formed by innominate bones, sacrum and coccyx, and three joints; sacroiliac joints, pubic symphysis and hip joints. These joints are supported by muscles and ligaments. The pelvis is wider in women than men, this is due to the function of this widened area as a baby's birth canal. The human pelvis has three fused parts, namely the ilium, ischium, and pubis. The three parts are joined in the acetabulum, which is a socket-like area of the hip joint (Bontrager, Kenneth L., 2020 & Kjeldsen, L. L. et al, 2021).

Currently there are two types of pelvimetry, which are clinical and radiological pelvimetry. Clinical pelvimetry is important in assessing the pelvic inlet, mid-pelvic and pelvic outlet. While radiological pelvimetry is a

measurement of the pelvis using 3D Computed Tomography (CT) and it will provide a clearer picture of the shape of the pelvis, give additional accuracy to pelvic measurements, and measure the transverse diameter of pelvic inlet and mid-pelvic which are hard to obtain manually. (Aubry et al, 2018., Perlman et al, 2018., Salk Ismail et al, 2016). The introduction of CT pelvimetry based on 3D models promises improvement over the previous pelvimetry modalities, and previous feasibility studies of 3D CT pelvimetry showed better accuracy and precision than the 2D CT. Compared with cross-sectional pelvis images, 3D models can provide a better anatomical view accurately to select measurement points (Liao K. D., et al. 2018). This examination can also predict surgical difficulty (ZhouX., et al. 2015).

By means of obstetric purpose, obstetric pelvimetry was divided into four imaginary planes that extend across the pelvis at different levels for descriptive purposes which are the pelvic inlet, the largest diameter plane, the smallest diameter plane, and the pelvic outlet (Salk, Ismail et al., 2016., Lorenzo L, et al 2021).

Pelvimetry size is not always constant but can change due to several factors. A study found that pelvimetry can change with age. An age-related trend was observed in the linear parameters of the pelvic cavity which confirms the anterior tilt of the sacral base and fixation of the sacrum in a more horizontal position due to aging. As previously found, the age-related process of ankylosis decreases the mobility of the sacroiliac joints which led to these changes. In addition, a significant change was found in the transverse outlet diameter where the distance between the ischial tuberosity (bitumen diameter) was shortened by aging. These changes can be attributed to the lifelong adaptation of the pelvic skeletal system to the sitting position that was related with an increased load on the ischial tuberosity. Age-related decrease in the subpubic angle is associated with narrowing of the bitumen diameter. Increased inlet transverse diameter and decreased outlet transverse diameter provide evidence for a much smaller, triangular shape of the pelvis in the coronal plane, which is described as an advantage for efficient bipedal movement (Kolesova, O., et al. 2017).

Therefore, age-related changes may be associated with adaptation to sitting position and compensatory changes in spino-pelvic balance that impact gait stability in the elderly.

METHOD

This is an analytical observational using cross-sectional study with secondary data based on medical records, the population of this study were female patients who underwent 3D CT-Scan at Dr. Wahidin Sudirohusodo hospital, and the research sample were the entire reachable population that met the inclusion criteria that were taken by simple random sampling technique with a total sample of 105 samples that met the inclusion and exclusion criteria. This research has obtained ethical feasibility (ethical clearance) from the ethics commission for biomedical research in humans, Faculty of Medicine, Hasanuddin University.

Obtained data were recorded and analyzed using the SPSS software. It was then processed using 2 analysis, univariate and bivariate analysis.

Univariate data analysis was done to analyze sample characteristics distribution, while bivariate data analysis (Spearman correlation test) aims to determine the correlation between the two variables, which were then distributed and presented using tables and narratives.

Definition of each variable was as follow. Conjugata vera is a distance from upper symphysis to promontorium; conjugata obstetrica is a distance from middle symphysis to promontorium; conjugata diagonal is a distance from lower symphisis to promontorium; interspinosus diameter is a parallel line of spina ischiadica; intertuberous diameter is a anteroposterior diameter through spina ischiadica; transverse diameter is a longest diagonal distance between pelvic inlet/linea terminalis.

Each variable was measured personally by author, with digital computing using CT scan and 3D reformat in cm.

RESULT

This study aims to analyze the relationship between pelvimetric and age based on 3D CT scan. We found that the age distribution of patients who underwent 3D pelvic CT scan were 19 patients in the 20 to 29 years group, 28 patients in 30 to 39 years, and 34 patients in the 40 to 49 years group. 50 to 59 years group has 24 patients. 20 to 29 years group have the least percentage, only 18.1%, while 40 to 49 years group have the highest percentage with 32.4% (Table 1).

Table 2 shows the distribution of pelvimetric measurement in patients who underwent 3D pelvic CT scan. We found the mean of the conjugata vera was 11.49 cm with SD ± 0.95, conjugata obstetrical 11.46 cm with SD ± 0.92, conjugata diagonal 12.27 cm with SD ± 0.87, interspinous diameter 10.15 cm with SD ± 0.95, intertuberous diameter 10.58 cm with SD ± 1.02, while the transverse diameter is 11.99 cm with SD ± 0.88.

For age correlation with conjugata diagonal, we found sig. (2-tailed) valuing at 0.041 or less than 0.05 which conclude that there is a correlation between age and conjugata diagonal. Furthermore, for the correlation of age with intraspinous diameter, sig. (2-tailed) valuing at 0.100 ($p > 0.05$) which conclude that there is no correlation between age and interspinous diameter (Table 3).

The correlation coefficient of age with tuberous diameter is -0.249 showing that there is a correlation between Conjugata vera and age, due to the sig. (2-tailed) value obtained was 0.001 ($p < 0.05$) so hypothesis 0 is rejected. Meanwhile, the correlation between age and transverse diameter was sig. (2-tailed) value of 0.601 ($p > 0.05$) so there is no correlation between age and transverse diameter (Table 3).

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DISCUSSION

From this study, four pelvimetric variables showed a correlation with age, which were conjugata vera, conjugata obstetric, conjugata diagonal, and intertuberous diameter. A previous study reported that women over 40 years-old have a narrower hip diameter, and younger women were more likely to have a wider pelvic diameter and will narrow with age (Vázquez B, 2016). Obstetric conjugate diameter (OCD) is the most commonly studied pelvic parameter, with size varies from 10.7 - 12.5 (Daghighi et al. 2013).

Shah et al, 2020, has investigated age-related hip diameter in Gujarati women, West India. His research stated that the sagittal diameter of the pelvic inlet decreased with age while the pelvic outlet increased. Age-related changes in OCD and sagittal outlet diameter may be associated with anterior tilt of the sacral base and fixation of the sacrum in a more horizontal position due to increased age (Shah, 2020).

Theoretically there are several factors affecting pelvis size, including height, pregnancy, body size, and the pelvic shape itself (Alt CD., et al. 2016., Shahla et al. 2019). This allows for more influence on the size of the pelvis itself. In addition, there were also studies showing that temperature and rainfall also have an influence on the size and shape of the os coxae, where research shows that individuals from cold environments have a tendency for wider pelvis (Musielak B et al. 2019). Other important factor is nutritional deficiency which affects the development of the pelvis causing a flatter pelvis. Another study has also shown the effect of activity on hip (Betti et al, 2017).

Hampel et al, 2018 in their study also reported that there was no significant relationship between women pelvimetric value with nulliparous and with primiparous. One of the supporting theories explained that bones are high-density structures which dimensions were supposed to be stable even under traumatic events such as vaginal birth. However, on the other hand parity factors can affect pelvimetry measurement due to variations in hormonal influences during pregnancy can alter the ligaments and soft tissues attached to other bones. Other studies suggest that altered pelvic dimensions were related to nutritional status and obstetric practices during pregnancy (Mitteroecker P. et al. 2017).

CT pelvimetry results in a better estimation of the obstetric diameter of the pelvic inlet, and reduces the radiation dose to the mother and fetus (ACOG 2016, Pattinson, Robert C et al. 2017, Salk Ismail, et al 2016).

Kolesova et al, 2017 in their study about age-related trends of pelvic architecture in women and men using CT pelvimetry, showed that age-related changes were more significant at the pelvic inlet and outlet with less changes in the middle cavity. In general, common age-related trend was observed in both female and male pelvis, except for the

ischial spine diameter which only decreased in male patients. For parameters associated with pelvic floor diseases, age-related changes were associated with pathologic cause (Kolesova, 2017).

Our study has limitation, in which it only analyzes one type of variable (age). The future research is suggested to add other variables related to heredity and childbirth factors. It is recommended that this research to be continued by conducting a comparative study between the size of the pelvis in young and old women but with a certain number of parturitions to see the diameter of each pelvis size.

CONCLUSION

It can be concluded that conjugata vera, conjugata obstetric, and conjugata diagonal have a weak correlation with age based on 3D pelvic CT scan, while the intertuberous diameter has a moderate correlation with age based on 3D pelvic CT scan. Interspinous and transverse diameter showed no correlation with age based on a 3D pelvic CT scan.

REFERENCES

Alt, C. D., Hampel, F., Radtke, J. P., Hallscheidt, P., Schlehe, B., Sohn, C., Brocker, K. A. 2016. Early postpartum pelvic floor changes in primiparous women after vaginal delivery using 3T MRI. *Neurourol Urodyn*. 36:2064–2073.

American college of obstetricians and gynecologists' committee on obstetric practice. Committee opinion No. 656. guidelines for diagnostic imaging during pregnancy and lactation. 2016. *Obstet. Gynecol*. 127 (2). e75–e80.

Aubry, S., Padoin, P., Petegnief, Y., Vidal, C., Riethmuller, D., Delabrousse, E. 2018. Can three-dimensional pelvimetry using low-dose stereoradiography replace low-dose CT pelvimetry? *Diagn Intervent Imaging*. 99(9):569–76.

Betti, L. 2017. Human Variation in Pelvic Shape and the Effects of Climate and Past Population History. *The Anatomical Recor*. 300(4), 687–697.

Bontrager, K. L. 2020. Textbook of Radiographic Positioning and Related Anatomy Eighth Edition. United States American. *Elsevier Mosby*. 10 th Ed.

Daghighi, M. H., Poureisa, M., Ranjkesh, M. 2013. Association between obstetric conjugate diameter measured by transabdominal ultrasonography during pregnancy and the type of delivery. *Iran. J. Radiol*., 10(3):185-7.

Hampel, F., Hallscheidt, P., Sohn, C., Schlehe, B., Brocker, K.A. 2018. Pelvimetry in nulliparous and primiparous women using 3 Tesla magnetic resonance imaging. *Neurourology and Urodynamics*.

Kjeldsen, L. L., Blankholm, A. D., Jurik, A. G., Salvig, J. D., & Maimburg, R. D. 2021. Pelvic capacity in pregnant women, identified using magnetic resonance imaging. *Acta Obstetricia et Gynecologica Scandinavica*, 100(8), 1454–1462.

Kolesova, O., Kolesovs, A., & Vetra, J. 2017. Age-related trends of lesser pelvic architecture in females and males: a computed tomography pelvimetry study. *Anatomy & Cell*

Biology, 50(4), 265. doi:10.5115/acb.2017.50.4.265

Lorenzon, L., Bini, F., Landolfi, F., Quinzi, S., Balducci, G., Marinozzi, F., ... & Iannicelli, E. 2021. 3D pelvimetry and biometric measurements: a surgical perspective for colorectal resections. *International Journal of Colorectal Disease*. 36:977–986.

Liao, K. D., Yu, Y. H., Li, Y. G., Chen, L., Peng, C., Liu, P., Wang, Y. 2018. Three-dimensional magnetic resonance pelvimetry: A new technique for evaluating the female pelvis in pregnancy. *European Journal of Radiology*. 102, 208–212.

Musielak, B., Kubicka, A. M., Rychlik, M., Czubak, J., Czwojdziński, A., Grzegorzewski, A., & Jóźwiak, M. 2019. Variation in pelvic shape and size in Eastern European males: a computed tomography comparative study. *PeerJ* ;7:e6433.

Mitteroecker P., Huttegger S.M., Fischer B., and Pavlicev M. 2017. Reply to Grossman: the role of natural selection for the increase of caesarean section rates. *Proc Natl Acad Sci USA*; 114: pp. E1305.

Pattinson, R. C., Cuthbert, A., & Vannevel, V. 2017. Pelvimetry for fetal cephalic presentations at or near term for deciding on mode of delivery. *The Cochrane database of systematic reviews* vol. 3,3 CD000161.

Perlman, S., Raviv-Zilka L, Levinsky D, Gidron A, Achiron R, Gilboa Y, et al. 2018. The birth canal: correlation between the pubic arch angle, the interspinous diameter, and the obstetrical conjugate: a computed tomography biometric study in reproductive age women. *The Journal of Maternal-Fetal & Neonatal Medicine*, *32*(19), 3255-3265.

Salk, I., Cetin, A., Salk, S., & Cetin, M. 2016. Pelvimetry by Three-Dimensional Computed Tomography in Non-Pregnant Multiparous Women Who Delivered Vaginally. *Polish Journal of Radiology*. 81: 219-227.

Shah, R. K., Desai, J. N., & Upadhyay, A. R. 2020. A study of lesser pelvic parameters and their correlation with age by reformatted computed tomography in western Indian Gujarati Female Population. *National Journal of Clinical Anatomy*. Vol 7(3). 146.

Mirgalobayat, S., Ghahari, L., Allahqoli, L., Mostafavi, S. R. S., Safari, K., Rikhtehgar, M., ... & Madadiane, M. 2019. Evaluation of the link between pelvimetry based on computed tomography and predicting status' delivery. *J Contemp Med Sci*| Vol. 5, No. 6: 313–316.

Vázquez Barragán, M. Á., Garza Báez, A., Morales Avalos, R., Martínez González, B., Jacobo Baca, G., Pinales Razo, R., ... & Guzmán López, S. 2016. Pelvimetry by Reformatted Computed Tomography in 290 Female Pelvis: Morphometric Variations Regarding Age. *International Journal of Morphology*, 34(1), 298–304.

Zhou, X., Su, M., Hu, K., Su, Y., Ye, Y., Huang, C., ... & Jiang, Y. 2015. Applications of computed tomography pelvimetry and clinical-pathological parameters in sphincter preservation of mid-low rectal cancer. *Int J Clin Exp Med* 8:2174–2181

Table 1. Patients' Age Distribution who underwent pelvic 3D CT-Scan examination

Age (n=105)	Frequency	Percentage (%)
20 s/d 29-year-old	19	18.1
30 s/d 39-year-old	28	26.7
40 s/d 49-year-old	34	32.4
50 s/d 59-year-old	24	22.9

Table 2. Patients' pelvimetric measurement distribution using 3D CT-Scan examination

Pelvim	Mean	SD	Median	Min	Max
Konjugata	11.49	0.93	11.60	9.20	13.80
Konjugata Obste	11.46	0.92	11.40	9.60	14.20
Konjugata Diag	12.27	0.87	12.20	9.50	14.10
Interspinosus dian	10.15	0.95	10.10	7.10	12.40
Intertuberous dian	10.58	1.02	10.60	7.80	13.00
Transversa dian	11.99	0.88	12.00	8.80	14.40

Table 3. Correlation of age and patients' pelvimetric using 3D CT-Scan examination

Pelvimetric	Correlation (r) **	P value**
Konjugata Vera	-0.283	0.003*
Konjugata Obstetrika	-0.226	0.021*
Konjugata Diagonal	-0.199	0.041*
Interspinosus diameter	-0.161	0.100
Intertuberous diameter	-0.315	0.001*
Transversa diameter	0.052	0.601

* Significant

** Spearman correlation test