PELVIMETRY BY IMAGING - CURRENT STATUS

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ABSTRACT

The role of pelvimetry in the management of complicated pregnancy warrants investigation. There is probably agreement that there is a role in the assessment of a breech pregnancy where vaginal delivery is contemplated. Conventional pelvimetry is still carried out in many centers throughout the world. The radiation dose to the fetus and mother has caused concern leading to changes such as the use of intensifying screens, air gap technique, computed tomography (CT) pelvimetry, digital pelvimetry and now magnetic resonance imaging (MRI) pelvimetry. The advantages of MRI have been the absence of radiation, shorter duration of examination and the absence of distortion of measurements from magnification. The ability to define the soft tissue may also be important though this has not yet been determined. One of the major limitations of MRI was the question of cost but this was based on the older longer sequences. Presently with the availability of newer shorter sequences, the examination could be carried-out much faster and therefore should be really cost-effective.

The role of pelvimetry in the management of complicated pregnancy is still uncertain.[1-4] Krishnamurthy et al[4] found that 66% of patients with radiologically inadequate pelvises delivered the next pregnancy vaginally without any problems and that X-ray pelvimetry cannot reliably effectively identify women who cannot delivery vaginally. There needs to be a distinction made between pelvimetry for vertex and breech presentations. It no longer considered to be of any value in the cephalic presentation, where a trial of labour can be allowed in all cases as it is felt that the foetal head is the best pelvimeter.[5] The most important indication is probably in the management of breech deliveries where vaginal delivery is indicated.[6] There may also be a minor role for the assessment of pelvic deformity secondary to trauma or metabolic bone disease.[7] This is in contrast to a resurgence to clinical pelvimetry alone even in breech deliveries[8] though here the subjectivity may be even more than be of practical value[2]. Pelvimetry can either be done antepartum, intrapartum or postpartum. There are several different types of pelvimetry available e.g. clinical, ultrasound, X-ray, computed topographic (CT) and Magnetic Resonance Imaging (MRI). We will discuss only the latter types of radiological pelvimetry.

The first imaging modality used in pelvimetry was film screen X-ray pelvimetry to assess the dimensions of the maternal pelvis. This is still by far the most commonly used modality because of the simplicity, easy access and low cost. Further the relationship of the presenting part to the maternal pelvis is better assessed unlike with CT or MR pelvimetry. The lateral view is the single view done antepartum while the two views (AP

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& lateral) are done postpartum. The major disadvantage of X-ray pelvimetry is the presence of ionizing radiation.[9] There is however no threshold to carcinogenesis by ionizing radiation and that the fetus is not less radiosensitive in the third trimester compared to the first.[10] X-ray pelvimetry is a major contributing of ionizing radiation to the foetus. The dose is dependent to a great extent on the radiographic technique e.g. the radiographic exposure factors, area of exposed film as well as the focus film distance. The total dose has been reduced by the use of strict collimation, fast film-screen combinations, as well as the use of a gridless technique. The air-gap technique has been shown to give a similar dose to the average CT lateral scanogram and is potentially a reliable low dose technique.[11] It is also easy to perform with simpler positioning. This may be the choice in patients who may be too large for the CT or MR gantry or places where CT is not available. The interspinous and intertuberous distances measured on the AP views may not be accurate[5] but these differences are not significant. The conjugate diameter appears to be longer during pregnancy than post- or ante-partum. This difference is significant and averages around 5%.[5] The clinical relevance however is questionable. There is also a feeling that the minimum dimensions for X-ray pelvimetry may be too conservative. X-ray pelvimetry is unable to define the soft tissue. There are also inaccuracies of the measurements compared to the sectional imaging modalities especially the bispinous diameter.[5,12] This is caused by numerous factors including rotation of the patient, poor definition of bony landmarks, inaccuracies in correcting for magnification, operator errors in making and recording the measurements. Morever this examination is quite uncomfortable for the patients soon after delivery especially if surgery has been carried out.

Digital X-ray pelvimetry has also been advocated with some centers reporting very low doses.[13] This is dependent on the ease in which to position the patient plus the need for specialized equipment which at the present moment is not easily available.

The next evolution in pelvimetry was the use of CT. This reduced the radiation dose by approximately two-thirds but is still significant.[14,15] This generally requires the use of AP and lateral scouts, the former to measure the anteroposterior dimensions while the latter is used to measure the transverse dimensions. The CT lateral scout gives on the average 25% of the dose compared to a conventional X-ray pelvimetry. The use of axial slices to measure the bispinous diameter is only done when necessary and this contributes to almost the entire dose (approx. 90%). There is therefore no justification for routine use of this view though using very low tube current and a bone algorithm images for measurement may be acquired with a significant reduction in dose (about 20 fold).[11] Another way to avoid using axial images is to correct for magnification of the bispinous diameter on the AP scout when possible.[16] This may be time consuming and require some training. Visibility of the ischial spines on the AP scout can be improved by tilting the CT gantry caudally.[16] In addition the typical location of the ischial spines on the axial is assumed to be at the level of the fovea of the femur though this is not the case in 16% to 35% of cases[11,17] and results in a significant difference in measurements. Thus review of the axial images by the radiologist while the patient is still in the gantry is advised. If the ischial spines are not visible on that slice then a further image needs to be acquired 10mm caudal.

There is also an increased fetal dose from an AP scout which is probably caused by the fetus lying in the direct beam. The radiation dose can be kept to the barest minimum by using a PA scout instead and keeping the milliamperes (X-ray tube current) to the lowest levels[18] since there is a correlation between the energy imparted to patient and the total mAs given.[19] The speed of

table movement also appears to affect the total dose with higher doses with slower speeds i.e. the patient dose from the scouts is inversely related to the table speed.[11] Thus CT is a low dose technique provided that the total mas for the scouts is kept low. This in fact means that CT scanners with slow couch speed and or high mAs may result in similar doses to that of conventional pelvimetry. In addition the accuracy of measurements taken off the scout views need to be verified by using a uniform grid. The other disadvantage is greater cost and sometimes decreased accessibility. Even then the other advantages of CT pelvimetry are that it is more comfortable for the patient, requires a shorter time as well as allowing direct measurements off the console with less distortion.

Ultrasound is a tool widely used in obstetrics. It has the advantage that there is no radiation involved and the safety has been well established. Transvaginal ultrasound pelvimetry has been performed and the cephalopelvic index of diameter (CID) defined as the mean diameter of the mid-pelvis and the foetal biparietal diameter (BPD) seems to be a good predictor of outcome.[19] Although still in the preliminary stages together with the problems of obtaining good measurements in all cases this promises to be an alternative worth considering.

With the greater availability of MR machines, MR pelvimetry is now being increasing used. This modality does not use radiation which is its major advantage. MRI is not advised in the first trimester of pregnancy even though there is no data to suggest that there is any adverse effects to the fetus to the static magnetic fields, the gradient magnetic fields or the radiofrequency pulses.[20] This is not an absolute contraindication and may be carried out if a radiographic procedure would have to be done to reach a diagnosis. In addition its multiplanar capability allows scanning in any plane with the patient lying supine plus its superior soft tissue contrast to identify both bone and soft tissues. Obesity is not a problem with MR pelvimetry unlike x-ray pelvimetry. Further patient positioning is not critical as the scan planes can be adjusted if there is any rotation of the patient. The technique is easy to perform and can be carried out by the radiographers with minimal training. The radiologists only needs to be present in the difficult cases. This is thus a cost-effective strategy.

The measurements can be done straight from the console for all the planes without having any problems with magnification resulting in greater accuracy.[12] MR pelvimetry is also useful when the fetus, cervix, placenta (placental abruption or placenta praevia) or uterus need to be assessed.[21,22] There may also be a role for the assessment of pelvic masses during pregnancy. In addition rather than a small bony pelvis being the cause of failure of progress of labour soft-tissue dystocia seems to be the major factor in obstructed labour.[23] Most of the studies done comparing the value of pelvimetry have used the dimensions of the bony pelvis.[1,2,4-8,13-15,18] In a study done[24] there is a difference of 4.1% to as high as 27.0 % between the soft tissue to soft tissue dimensions to that of bone against bone. The greatest variation is for the transverse and bispinous diameters. MR pelvimetry in conjunction with the ultrasound estimation of fetal weight may play a role in the assessment of soft tissue dystocia.

The disadvantages of MR pelvimetry have been the cost, accessibility (due to the already increasing demands made by the other clinical specialties), availability and the contraindications like the presence of prosthetic heart valves, cardiac pacemakers, etc.. The latter disadvantage is not a major problem in this group of patients. The cost of the examination is partly dependent on the time taken to do the examination and if it can be completed in less than 5 minutes then the cost calculated based solely on time will be approximately 65 US Dollars in our setting. Therefore the actual

cost of MR pelvimetry is not much higher than that of x-ray pelvimetry with the other added benefits especially the absence of radiation and ease of performing.

Review of the literature shows that the scan times are between 5-20 minutes and these were base on gradient echo-sequences and the older spin-echo sequences.[5,12] However with the newer sequences using[24] the fast turbo spin-echo, tru-fisp and 2D gradient echo the total examination time can be reduced to less than 5 minutes with the actual scanning only taking about a minute at the most. The fast spin-echo seems to be the best overall in performance in terms of the presence of artifacts, superior contrast resolution, scanning times as well as the ability to define the cortical bone. This was despite using just the body coil without the use of any relaxants. The sequences used previously have been the T1 Spin echo[5] and T1 weighted gradient echo.[12] Claustrophobia is frequently quoted disadvantage but this has been partly overcome by placing the patient feet first into the bore of the magnet. Large female patients may not be able to get into the bore of the magnet. Another potential source of error which is not clinically important may be related to the inability to identify the junction between the sacrum and first mobile coccygeal segment This is also a problem with X-ray pelvimetry and CT.

Melchert et al[25] have used computer aided simulation of the vaginal delivery from MRI images using finite analysis to understand the dynamics of delivery. Pelvimetry as it is used presently does not reflect the actual dynamics of delivery and does not consider moulding of the fetal head, space requirements of maternal soft tissues, mobility of the pelvic joints (sacroiliac joints and symphysis pubis). They suggest computer aided simulation of the vaginal delivery from MRI images using finite analysis which allows evaluation of pelvimetric data with regards to birth dynamics.

REFERENCES

1. Parsons MT & Specally WN. Prospective randomized study of X-ray pelvimetry in the primigravida. Obstet Gynaecol 1985; 66:76-79
2. Thubisi M, Ebrahim A, Moodley et al. Vaginal delivery after previous caesarean-section: is X-ray pelvimetry necessary? Br J Obstet Gynaecol 1993;100:421-424
3. Morrison JJ, Sinnatamy, Hackett GA, et al. Obstetric pelvimetry in the UK: an appraisal of current practice. Br J Obstet Gynaecol.1995;102:748-750
4. Krishnamurthy S, Fairlie F, Cameron AD et al. The role of postnatal X-ray pelvimetry after caeserian section in the management of subsequent delivery. Br J Obstet Gynaecol 1991;98:716-718
5. van Loon AJ, Mantingh A, Thijn CJP et al. Pelvimetry by magnetic resonance imaging in breech presentation. Am J Obstet Gynecol 1990;163:1256-1260
6. Flanagan TA, Mulchahey KM, Korenbrot CC et al Management of term breech presentation. Am J Obstet Gynaecol 1987; 156:1492-1499
7. Compton AA. Soft tissues and pelvic dystocia. Clin Obstet Gynaecol 1987;30:69
8. Biswas A & Johnstone MJ. Term breech delivery. Aust NZ J Obstet Gynaecol 1993; 33:150-153
9. Boice JD & Land CE. Ionizing radiation. In: Schottenfeld D, Fraumeni JF, eds. Cancer epidemiology and prevention. Philadelphia: WB Saunders, 1982:137-238
10. Mole RH. Childhood cancer after prenatal exposure to diagnostic X-ray examinations in Britain. Br J Cancer 1990;62:171
11. Badr I, Thomas SM, Cotterill D, Pettett A, Oduko JM, Fitzgerald M & Adam EJ. X-ray pelvimetry - Which is the best technique? Clinical Radiology 1997;52:136-141

12. Wright AR, English PT, Cameron HM et al. MR pelvimetry- A Practical alternative. Acta Radiologica 1992;33:582-587
13. Wright DJ, Godding L, Kirkpateick C. Technical note: Digital radiographic pelvimetry - a novel, low dose, accurate technique. The British Journal of Radiology 1995;68:528-530
14. Kopelman JN, Duff P, Karl RT et al. Computed tomography in the evaluation of breech presentation. Obstet Gynacol 1986; 68:455-458
15. Raman S, Samuel D & Suresh K. A com parative study of X-ray pelvimetry and CT pelvimetry. Aust NZ J Obstet Gynaecol 1991;31:217-220
16. Davidson R. CT pelvimetry: a two view approach. Radiograph 1986:33;62-6
17. Federle MA, Cohen HA, Rosenwein MF, Brant-Zawadzki MN, Cann LE. Pelvim etry by digital radiography: a low dose examination. Radiology 1982:143;733-5
18. Weisen EJ, Crass JR, Bello EM et al Improvement in CT pelvimetry. Radiology 1991;178:259
19. Bian XM, Zhuang J, Cheng X. Pelvic measurements by transvaginal ultrasound. Chinese J Med 1991;71:453-454
20. National Radiation Protection Board: Lim its on patient and volunteer exposure dur ing clinical magnetic resonance procedures. Documents of the NRPB, vol 2, no. 1. Her Majesty's Stationary Office, Lon don 1991.
21. McCarthy SM, Filly RA, Stark SM, et al Obstetrical magnetic resonance imaging. Fetal anatomy. Radiology 1985;154:427
22. McCarthy SM, Stark SM, Filly RA, et al Obstetrical magnetic resonance imaging. Maternal anatomy. Radiology 1985;154: 421-426
23. Campbell JA. X-ray pelvimetry. J Natl Med Assoc 1975:68;514-520
24. Abdullah BJJ, Mahadevan J, Raman S & Chien D. Comparison of the various new MRI sequences in pelvimetry (Abs). Advances in MRI-Second I nternational Magnetom Vision User Conference, Rotterdam, June 13-14, 1997
25. Melchert F, Wischnik & Nalepa E. The prevention of birth trauma by means of computer aided simulation of the delivery by means of the nuclear magnetic resonance imaging and finite element analysis. J Obstet Gynaecol 1995;21:195-207