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Assessment of the variability in the dimensions of the intact pelvic canal in South Africans: A pilot study

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ABSTRACT

Cephalopelvic disproportion is common among Africans and is a major cause of maternal and perinatal mortality and morbidity. As the dimensions of the pelvis may vary between populations and according to stature and age, they need to be considered during childbirth and also in the planning and performance of pelvic and perineal procedures. The aim of this study was to assess the possible variations in the dimensions of the intact pelvic canal in South Africans and their implications. Eighty intact cadaver pelves, belonging to 40 white South Africans (20 males and 20 females) and 40 black South Africans (20 males and 20 females) were used for both metric and geometric morphometric analyses. Pelvic inlet shapes did not differ significantly between groups but pelvic inlet and midpelvic dimensions were the greatest in white South Africans and females. The pubic symphyseal length was the greatest in white males and the smallest in black females, resulting in a smaller pelvic cavity anteriorly than for white females. Pelvic outlet shapes varied significantly between sexes in white South Africans and between white and black males. Females presented with the greatest dimensions. Black South African females presented with an elongated anteroposterior outlet diameter. Certain transverse pelvic diameters correlated positively with age in white males and with height in females. In planning childbirth options, the smaller pelvic inlet of black females and stature-dependent diameters should be considered. Pelvic and perineal surgery may be technically more challenging because of smaller pelvic dimensions in black South Africans, especially in males.

Introduction

Measurable differences in the size and shape of the skeletal components of the pelvis between groups, including black and white South Africans, have been documented in the literature (Patriquin et al., 2002, 2003, 2005). Apart from the variations noted between population groups, other factors such as stature and ageing may also have an influence on pelvic skeletal dimensions (İşcan, 2005; İşcan and Steyn, 2013). These variations in pelvic dimensions among South Africa's population groups and with stature and ageing become important when decisions regarding method of parturition are made or pelvic procedures are planned. Stature, for instance, is often used as an early warning for possible cephalopelvic disproportion: the disproportion of the foetal head size as compared to the size of the maternal pelvis during delivery. Cephalopelvic

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disproportion is not an uncommon finding in Africans and could be a major cause of maternal and perinatal mortality and morbidity as indicated by Leong (2006). Constrictive pelvic dimensions could not only have far-reaching implications in obstetrics practice, but could also play a role in surgical procedures involving male and female pelvic structures.

The classic dimensions that are considered of importance are the diameters of the pelvic inlet (anteroposterior and transverse), midpelvis (interspinous distance) and pelvic outlet (anteroposterior and transverse). Several authors have related the size of the anteroposterior inlet diameter to the height of the woman and the obstetric outcome (Adadevoh et al., 1989; Bernard, 1952; Merchant et al., 2001; Stewart et al., 1979). The interspinous distance is also important to consider in parturition, as it is normally the narrowest part of the pelvic canal through which the foetal head must pass during birth. A narrow pelvic outlet may further predispose a woman to a difficult vaginal delivery. A rapid assessment of the outlet adequacy may be made by estimating the angle of the subpubic arch (Frudinger et al., 2002). The smaller the angle, the closer together the ischial tuberosities are and, therefore, the narrower the pelvic outlet.

Specific dimensions of the bony pelvis – relating to pelvic procedures in both males and females and during childbirth – have not been investigated in South Africans. It is therefore of value to study the possible variations in the dimensions of the pelvis among population groups, as well as their correlation with stature and ageing. These diameters and their relationships will be helpful in assessing the possibility of a favourable outcome in vaginal deliveries. They will also be useful when surgical procedures in both sexes are planned, as a small pelvic canal, for example, may impede visibility, access and space for surgical excision (Hong et al., 2007; Killeen et al., 2010; Salerno et al., 2007).

The purpose of this study was to assess certain clinically relevant dimensions on defleshed, but intact South African cadaver pelves and to take note of variations between populations and sexes and the effects of short stature and ageing. The possible implications of the variations between groups are considered in the discussion section.

Materials and methods

A total of 80 intact cadaver pelves from the anatomy departments of both the University of Pretoria and the former Medunsa Campus, University of Limpopo now called Sefako Makgatho Health Sciences University (SMU) were sampled. Cadavers used in this study were obtained between 2005 and 2009 as unclaimed or donated bodies from the surrounding hospitals. The sample was evenly distributed between the sexes and between black and white South Africans. The population group and sex of all individuals were known. Seventy-two of the 80 individuals had known age at death. Pelves that exhibited pathological features were excluded.

Stature was derived by regression analysis using physiological left femur length measurements. Lundy and Feldesman (1987) developed regression formulae incorporating femur lengths for the estimation of antemortem stature in male and female black South Africans, whilst Dayal et al. (2008) similarly developed formulae for male and female white South Africans. The living stature was then determined by adding Raxter's value for soft tissue (Bidmos and Manger, 2012).

The physiological femur length was measured on an osteometric board using the standard technique described in most anthropometry textbooks. The physiological femoral length was defined as the distance from the most superior point on the head of the femur to the most inferior point on the distal condyles. The posterior surface of the femur was placed parallel to the long axis of the osteometric board. The medial and lateral condyles were pressed against the vertical end board while applying the movable upright to the femoral head until the length was obtained (Moore-Jansen et al., 1994).

The pelves were defleshed and stripped to the bone without disarticulation to facilitate the identification of bony landmarks and the measurement of the distances between them. Diameters were measured from bone to bone but did incorporate joint components such as cartilage and ligaments, which would reflect the natural situation and would be more accurate when comparisons with clincial studies were made. Care was taken to keep the specimens moist with embalmimg fluid and covered by linen and waterproofed sheets to prevent dessication of the ligaments and cartilage joints.

The following ten points were marked with pins and then digitised by using a 3DXL MicroScribe® digitiser on intact pelves (Figs. 1 and 2): A: midpoint of the sacral promontory; B: most superior point in the midline of the pubic symphysis; C_L and C_R: left and right widest points on the pelvic inlet; D: most inferior point in the midline of the pubic symphysis; E_L: most inferior point on the ischial tuberosity (left); E_R: most inferior point on the ischial tuberosity (right); F_L: ischial spine (left); F_R: ischial spine (right); G: lowest limit of coccyx.

Distances and angles were calculated using standard mathematical techniques, based on the points measured on a three dimensional Cartesian coordinate system. The following distances were calculated between the various landmarks: AB: pelvic inlet anteroposterior (AP) diameter; C_LC_R: pelvic inlet transverse diameter; BD: length of pubic symphysis; DE_L: distance from the most inferior point in the midline of the pubic symphysis to the most inferior point on the left ischial tuberosity (length of the ischiopubic ramus); E_LE_R: intertuberous (transverse outlet) diameter; F_LF_R: interspinous (midpelvis) diameter; DG: pelvic outlet AP diameter and the subpubic angle between points E_L, E_R and D.

Basic descriptive statistics of all the data were calculated; i.e. the mean and standard deviation. Statistical comparisons of characteristics were made between the various sex-population groups, as well as linear correlations to stature and age using ANOVA. Inter-observer errors were tested on a later occasion by another observer familiar with the method. Thirty randomly selected intact pelves were re-measured and the reliability coefficients calculated.

The digitised landmarks were further considered for shape analyses. The landmarks were grouped into those describing the pelvic inlet landmarks (Fig. 3), pelvic outlet landmarks including ischial spines (Fig. 4) and pelvic canal landmarks (which included those of the pelvic inlet, midpelvis and outlet) (Figs. 5 and 6). Shape analyses were performed on all the intact