

## A SMALL OUTLET DIMENSION OF SQUIRREL MONKEY BONY PELVIS IS ASSOCIATED WITH DEVELOPMENT OF PELVIC ORGAN PROLAPSE

**Hypothesis / aims of study:** The squirrel monkey develops pelvic organ prolapse (POP) associated with age and parity. They deliver large infants relative to maternal size (110 gms versus 800 gms female). Others have demonstrated that females delivering stillbirths also have smaller pelvic outlets than those delivering livebirths suggesting that females with small pelvic dimensions have complicated deliveries potentially compromising maternal pelvic anatomy. We test the hypothesis that older females with POP have reduced pelvic dimensions so that obstetrical events produce sufficient compromise to result in POP.

**Study design, materials and methods:** The bodies of ten female squirrel monkeys dying by natural causes between 18 and 22 years of age were examined by computed tomography. All had been captured in the wild and were parous in captivity, but complete obstetrical history was unknown. Commercial software was used to display 3D views and measure five diameters (lateral view of inlet and mid-pelvis, and anteroposterior view of inlet, mid-pelvis, and outlet) in mm using previously published reference points. In the lateral orientation an inlet distance was defined as the line from the posterosuperior border of the symphysis pubis to a point just below the sacral promontory. A mid-pelvis distance was measured from the posterosuperior border of the symphysis pubis to the first segment of the coccyx directly cranial to the heads of the femur. In the anteroposterior orientation, the inlet distance was defined as the line between the superior angles formed by the sacrum and the ilium, the mid-pelvis was the line between the medial edges of the ischium at the level of the femur heads (squirrel monkeys lack ischial spines), and the outlet is the line between the inferior lateral margins of the obturator foramina at the level of the subpubic arch. Measurements were compared using analysis of variance with Dunnett's post-hoc test to compare means.

**Results:** Of 10 females examined, 4 had had no POP before death, and 6 had had POP of anterior (N=4) or anterior and posterior (N=2) segments. The mean (SE) for lateral inlet and mid-pelvis were 33.7 (0.7)mm and 25.8 (0.7) mm for animals without POP and 32.4 (0.6) mm and 24.7 (0.5) mm for animals with POP. In the anteroposterior view, the inlet, mid-pelvis, and outlet were 24.1 (0.8) mm, 22.5 (0.7) mm, and 17.9 (0.7) mm, respectively for animals without POP and 22.0 (0.7) mm, 20.2 (0.9) mm, and 15.5 (0.6) mm, respectively for animals with POP. Using analysis of variance, there was a difference ( $p=0.048$ ) in measurements between animals with and without POP. The dimensions differ ( $p < 0.0001$ ) among sites as expected and there is no site by POP interaction ( $p = 0.73$ ). While animals with and without POP differed ( $p = 0.046$ ) in outlet size as measured in the anteroposterior view, the other dimensions did not differ ( $p > 0.10$ ) because of insufficient power to detect 5 to 10% differences with this limited sample of older animals.

**Interpretation of results:** Female squirrel monkeys at the upper limits of life span have accumulated an obstetrical history during concurrent pelvis growth from an adolescent to adult size. Some animals maintain a small bony pelvis throughout life. This study demonstrates in a small series that 6/6 animals with POP had pelvic outlet measurements  $< 17$  mm while only  $\frac{1}{4}$  animals without POP had outlet  $< 17$  mm suggesting that smaller outlet dimensions may put females of this species at increased risk of POP. Flat plate X-ray projections for pelvimetry measurements in a different series of animals demonstrate that young animals between 2 and 5 years of age are still undergoing growth in pelvis size with outlet increasing from an average of 15.6 mm (SD of 1.1, N=52 females) at 2 years of age to 17.4 mm (1.3, N=64), 18.8 mm (1.5, N = 76), and 19.2 mm (1.5, N = 71) at 3, 4, and 5 years of age, respectively. During the breeding season females at all of these ages are capable of becoming pregnant with initial delivery through this smaller pelvis. While our observations focus on pelvic size in older animals, it suggests that pubertal and adolescent females may be at risk for initiating parturition injuries.

**Concluding message:** Older females with accumulated life and obstetrical experiences that developed POP have smaller pelvic dimensions than those without POP. This observation supports the hypothesis that females with small pelvic dimensions are more likely to have delivery complications and pelvic floor injuries that contribute to future development of POP. Also, young female squirrel monkeys like their human counterpart can become pregnant before their pelvic dimensions reach adult size which may put them at risk for development of POP even though later in life their pelvic size might grow to exceed dimensions seen in this series to be associated with POP. As POP in the squirrel monkey becomes apparent remote from the events of parturition, the mechanism for transduction of small pelvic outlet dimensions into loss of support for pelvic structures is unknown. However, experiments can now be designed with a focus on this subset of animals.

**FUNDING:** NIH, Noble Endowment for Research in Ob/Gyn

**DISCLOSURES:** NONE

**ANIMAL SUBJECTS:** This study followed the guidelines for care and use of laboratory animals and was approved by Scott & White Institutional Animal Care and Use Committee