OBSTETRICS

# Does pregnancy and/or shifting positions create more room in a woman's pelvis?

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**OBJECTIVE:** The purpose of this study was to assess the impact of different positions on pelvic diameters by comparing pregnant and nonpregnant women who assumed a dorsal supine and kneeling squat position.

**STUDY DESIGN:** In this cohort study from a tertiary referral center in Germany, we enrolled 50 pregnant women and 50 nonpregnant women. Pelvic measurements were obtained with obstetric magnetic resonance imaging pelvimetry with the use of a 1.5-T scanner. We compared measurements of the depth (anteroposterior (AP) and width (transverse diameters) of the pelvis between the 2 positions.

**RESULTS:** The most striking finding was a significant 0.9-1.9 cm increase (7-15%) in the average transverse diameters in the kneeling squat position in both pregnant and nonpregnant groups. The average bispinous diameter in the pregnant group increased from 12.6 cm ± 0.65 cm in the supine dorsal to 14.5 cm ± 0.64 cm ($P < .0001$) in the kneeling squat; in the nonpregnant group the increase was from 12 cm ± 0.76 cm to 13.9 cm ± 1.04 cm ($P < .0001$). The average bituberous diameter in the pregnant group increased from 13.6 cm ± 0.93 cm in the supine dorsal to 14.5 cm ± 0.83 cm ($P < .0001$) in the kneeling squat position; in the nonpregnant women the increase was from 12.6 cm ± 0.92 cm to 13.5 cm ± 0.88 cm ($P < .0001$).

**CONCLUSION:** A kneeling squat position significantly increases the bony transverse and anteroposterior dimension in the mid pelvic plane and the pelvic outlet. Because this indicates that pelvic diameters change when women change positions, the potential for facilitation of delivery of the fetal head suggests further research that will compare maternal delivery positions is warranted.

**Key words:** birth, magnetic resonance imaging (MRI), maternal position, pelvimetry, pregnancy

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This study had its origins in our experience of vaginal breech birth over the last 10 years in a tertiary hospital in Frankfurt, Germany, where women were encouraged to give birth in an upright position. We noticed that babies who were born in this position encountered fewer mechanical problems during birth and had fewer admissions to the neonatal intensive care unit. We hypothesized from these observations that a nonsupine position may result in increased pelvic diameters that facilitate the birth of the baby.

Over the centuries, obstetricians and particularly midwives have encouraged women to adopt various positions during childbirth to increase pelvic dimensions and thereby facilitate birth.[1,2] Such position changes have been advocated for challenging births that included breech vaginal birth.[3-5] These considerations are relevant, given a recent revival of interest in vaginal breech birth.[6] Published guidelines for breech birth have favored the semi-lithotomy dorsal position, whereas some individual centers favor more upright positions.[6-8] Published evidence to support either approach is very limited.

Magnetic resonance imaging (MRI) has become the method of choice if obstetric pelvimetry is needed.[9] It is done conventionally with the woman on her back. There are few studies that have reported pelvic measurements in women who adopt other positions.[10] This is the first study of MRI pelvimetry in pregnant women to compare the conventional supine position with a different position.

Our primary objective was to compare anteroposterior and transverse pelvic dimensions between women who assumed the kneeling squat and supine dorsal positions. The secondary objective was to compare these changes between pregnant and nonpregnant subjects.

## METHODS

Pregnant women who requested a vaginal breech birth were included if they were >18 years old with a singleton fetus presenting in breech position and who had stated their preference for a

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FIGURE 1
**Kneeling squat position**

A 1.5-T magnetic resonance scanner (Magnetom Espree, Siemens, Erlangen, Germany).

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vaginal breech birth. After these women were seen and counseled in our breech clinic, the MRI was done on average at 37+3 weeks of gestation (range, 35+2—39+2 weeks of gestation). The same number of nonpregnant women were recruited with the use of flyers at the university site and were included if they were >18 years old with no clinical evidence of pregnancy. We excluded all women with metal prostheses or who had any contraindication for having a vaginal breech birth (eg, known fetal malformation and/or intrauterine growth retardation). All women provided written informed consent.

FIGURE 2
**Pelvic anteroposterior measurements according to the protocol used**

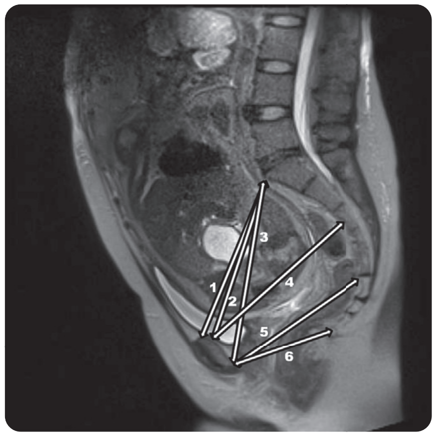


Table 1 provides the exact definition of the anatomic landmarks and the distance. *1,* Anatomic conjugate; *2,* obstetric conjugate; *3,* diagonal conjugate; *4,* anteroposterior diameter of mid plane; *5,* anteroposterior diameter of lower mid plane; *6,* anteroposterior outlet.

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The 70-cm inner bore diameter of the MRI limited women to adopt a kneeling squat position (Figure 1) that represented the most upright position possible. We compared these pelvimetry measurements with those obtained in the conventional supine dorsal position.

The examinations were performed with a 1.5-T MR scanner (Magnetom Espree; Siemens, Erlangen, Germany). The examination started with each woman in the supine dorsal position undergoing a specified imaging protocol (Appendix). Women were then asked to assume a kneeling squat position (Figure 1), and measurements were compared by adherence to the same imaging protocol as that used in the supine dorsal position. The duration of the examination did not exceed 10 minutes. All pelvic bony dimensions were measured on an Advantage Workstation (GE Healthcare, London, UK) by 2 readers using standard digital measurement techniques. The readers then agreed on the measurement.

The anteroposterior pelvic measurements were from the related anatomic planes (Table 1; Figure 2). Three different measurements were used for the pelvic inlet (anatomic conjugate, obstetric conjugate, and diagonal conjugate). Two measurements were used for the mid pelvic cavity (anteroposterior diameter of mid plane [APDM]) to the second sacral vertebra and an anteroposterior diameter of mid plane to the sacral tip (lower APDM) and 1 for the pelvic outlet (anteroposterior outlet).

The transverse pelvic measurements corresponded to the related anatomic planes (Table 2; Figures 3 and 4). These

TABLE 1
**Pelvic anteroposterior diameters used in obstetric magnetic resonance imaging pelvimetry[a]**

| Name | Other names | Distance between different anatomic planes |
|---|---|---|
| Anatomic conjugate | Pelvic inlet, true conjugate | Distance from the upper tip of pubic symphysis to the sacral promontory |
| Obstetric conjugate | Obstetric diagonal | Distance from the narrowest bony points formed by the sacral promontory and the inner pubic bone |
| Diagonal conjugate | Historically used as a digital measurement to judge what the inaccessible pelvic inlet would be | Distance from the lower border of pubic symphysis to sacral promontory |
| Anteroposterior diameter of mid plane | Mid cavity, widest part of the pelvis | The shortest distance from the mid point of the third sacral bone to the inner border of pubic symphysis |
| Anteroposterior diameter of lower mid plane | Some groups consider it to be part of the outlet (called in that case anteroposterior outlet) | Distance from the sacrococcygeal joint to the lower tip of the symphysis pubis |
| Anteroposterior outlet | Pelvic outlet, sagittal outlet | Distance from the tip of the coccygeus to the lower tip of the symphysis pubis |

[a] See Figure 2 for further information.

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**TABLE 2**
**Pelvic transverse diameters used in obstetric magnetic resonance imaging pelvimetry**

| Name | Other names | Distance between different anatomic planes |
|---|---|---|
| Bispinous diameter[a] | Bispinous outlet | Distance between the the ischial spines behind the hipjoint |
| Bituberous diameter[b] | Ischial tuberosity distance | Distance between the posterior part of the tuber ischiadici (sit bones) of the ischial bone: forming the base of a triangle with anterior angle |
| Anterior angle[b] | | The angle at the apex of the anterior triangle with the boundaries: • Apex: the lamina fibrocartilaginea interpubica of the pupic bone • Base: the bituberous diameter • Sides: formed by the pubic rami and ischial tuberosities |

[a] See Figure 3 for further information; [b] See Figure 4 for further information.

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were the bispinous and the bituberous diameters and an anterior angle.

In addition to these measurements, the lumbosacral line contour was assessed and categorized as 1 of classical C form, straight form, or a form in between.[11] In the pregnant group maternal and neonatal outcome data were collected and analyzed (Table 3).

The data were assessed for the normal distribution assumption by the Skewness Kurtosis test in which normally distributed, continuous variables were presented as means with their corresponding standard deviation (SD). The Student *t* test was used to compare paired measurements in the 2 groups (pregnant and nonpregnant) and the 2 different positions. Wilcoxon's signed rank sum test was used for the comparison of measurements not normally distributed. Further the paired Student *t* test was used to compare the changes in pregnant and nonpregnant women, which were defined as the differences between the respective measurements in supine dorsal and kneeling squat position in each woman. All tests were 2-sided and used a significance level of .05. All results are presented as means and standard deviations or medians with corresponding 25−75% ranges. Statistical analysis was performed using SPSS software (20/Stata/IC 13.0; StataCorp LP, College Station, TX).

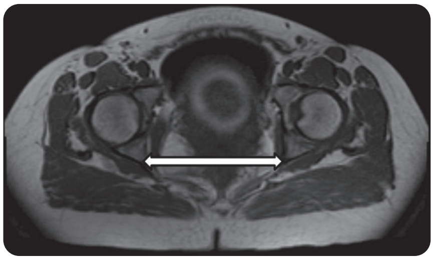
## RESULTS

Data from 50 pregnant women and 50 nonpregnant women that were collected between May 1, 2011, and Aug. 31, 2012, were analyzed for the anteroposterior measurements. Fewer data were available for the transverse plane because of difficulties visualizing the appropriate plane (Tables 4 and 5) MRI pelvimetry proved feasible in all cases, both in the supine dorsal and in the kneeling squat positions (Figure 1). It should be noted that the volunteer nonpregnant women were on average younger (5.5 years; $P < .0001$) and heavier (12.4 kg; $P < .0001$) than the pregnant group (with the use of the first recorded weight during pregnancy, which usually reflects the prepregnancy weight).

### Anteroposterior measurements

In both the pregnant and nonpregnant groups, all 3 anteroposterior inlet measurements decreased (range, 0.1−0.4 cm) when the women changed from supine to the kneeling squat position (Table 4). The obstetric conjugate in the pregnant group in the kneeling squat position measured 12.2 ± 0.83 cm and in the supine dorsal position measured 12.62 ± 0.8 cm ($P < .0001$). In the nonpregnant group, the obstetric conjugate was 12.42 ± 1.06 cm in the kneeling squat position and was 12.6 ± 1.13 cm ($P < .0001$) in the supine dorsal position. The anatomic conjugate was 12.96 ± 0.79 cm in the kneeling squat position and 13.11 ± 0.84 cm in the

**FIGURE 3**
**Pelvic transverse diameter-bispinous diameter**



The *arrow* indicates the landmarks of our meassurements as specified in Table 2.

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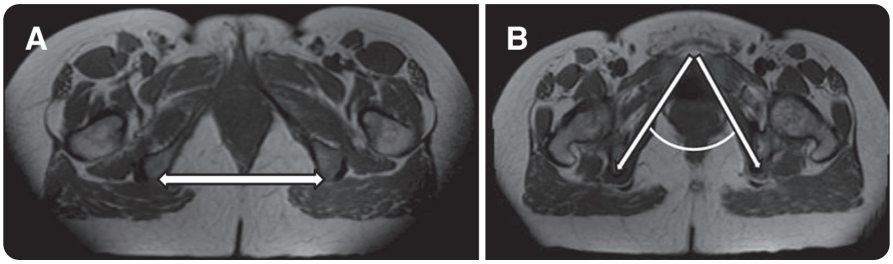
**FIGURE 4**
**Pelvic transverse diameter-bituberous and anterior angle**




**A,** Diameter-bituberous and **B,** anterior. The *arrow* indicates the landmarks of our meassurements as specified in Table 2.

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