Narrative Review

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Pelvic Bone Considerations in Normal Vaginal Delivery: An Orthopedic Perspective

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Abstract

The maternal pelvis is a unique osteoligamentous structure that plays a fundamental role in normal vaginal delivery. While obstetric practice primarily focuses on maternal and fetal factors influencing labor, orthopedic understanding of pelvic anatomy, biomechanics, joint mobility, and pelvic morphology is equally important. The bony pelvis serves as the birth canal, and its dimensions, shape, orientation, and dynamic adaptations determine the ease with which the fetal head traverses the pelvic inlet, cavity, and outlet. Although true cephalopelvic disproportion (CPD) is relatively uncommon, abnormalities of pelvic architecture resulting from congenital deformities, trauma, metabolic bone disease, hip disorders, or previous pelvic fractures may significantly influence labor outcomes.

Recent evidence suggests that routine pelvimetry alone is a poor predictor of successful vaginal delivery. Modern obstetrics increasingly relies on dynamic assessment through clinical examination and intrapartum ultrasound rather than static measurements. Nevertheless, orthopedic evaluation remains valuable in women with previous pelvic injuries, skeletal dysplasia, acetabular abnormalities, or pelvic reconstructive surgery. This review summarizes pelvic anatomy, biomechanics, orthopedic conditions affecting childbirth, methods of pelvic assessment, and current evidence regarding delivery planning from an orthopedic perspective.

Keywords: Pelvis, Orthopedics, Normal delivery, Pelvimetry, Cephalopelvic disproportion, Pregnancy, Labor, Pelvic biomechanics

Introduction

The human pelvis represents one of the most remarkable evolutionary adaptations balancing upright bipedal locomotion with successful childbirth. Unlike other mammals, humans possess a pelvis that must simultaneously provide stability for weight transmission and sufficient dimensions for fetal passage during labor.

Normal vaginal delivery depends upon the harmonious relationship between three components:

- Passenger (fetus)
- Passage (maternal pelvis)
- Powers (uterine contractions)

Among these, the maternal bony pelvis constitutes the fixed component of the birth canal. Although ligaments, pelvic floor muscles, and hormonal influences permit limited enlargement during labor, the osseous framework remains the principal determinant of available space.

Historically, orthopedic surgeons contributed substantially to the understanding of pelvic architecture before modern obstetrics developed advanced imaging modalities. Today, orthopedic assessment is mainly required in women with pelvic trauma, congenital deformities, hip disorders, spinal abnormalities, or previous reconstructive procedures.

Anatomy of the Bony Pelvis

The pelvis is composed of:

- Two innominate bones
- Sacrum
- Coccyx

Each innominate bone consists of:
• Ilium
• Ischium
• Pubis

These bones unite at the acetabulum and articulate anteriorly through the pubic symphysis and posteriorly with the sacrum via the sacroiliac joints.

The true pelvis forms the obstetric birth canal and is divided into:
• Pelvic inlet
• Midpelvis
• Pelvic outlet

The false pelvis mainly supports abdominal viscera and contributes little to labor.

Orthopedic Anatomy Relevant to Childbirth

Important orthopedic landmarks include:

Pelvic inlet

Bounded by
• Sacral promontory
• Sacral ala
• Arcuate line
• Pectineal line
• Pubic crest

Major diameters include:
• Obstetric conjugate
• Anatomical conjugate
• Diagonal conjugate
• Transverse diameter
• Oblique diameter

Midpelvis

The narrowest portion of the birth canal.
Critical landmarks include
• Ischial spines
• Sacrum
• Sacrospinous ligaments

The interspinous diameter is considered the limiting dimension during labor.

Pelvic outlet

Formed by
• Coccyx
• Ischial tuberosities
• Inferior pubic rami
• Pubic arch

Important measurements include
• Intertuberous diameter
• Anteroposterior outlet diameter

Pelvic Types

According to Caldwell and Moloy classification:

Gynecoid pelvis
• Rounded inlet
• Wide pubic arch
• Straight side walls
• Favorable for vaginal delivery

Approximately 50% of women possess this morphology.

Android pelvis
• Heart-shaped inlet
• Narrow pubic arch
• Prominent ischial spines
Associated with prolonged labor and operative delivery.

Anthropoid pelvis
• Oval inlet
• Long anteroposterior diameter

Often associated with occipitoposterior fetal positions.

Platypelloid pelvis
• Flat inlet
• Wide transverse diameter
• Short anteroposterior diameter

May delay fetal engagement.

Pelvic Biomechanics During Pregnancy

Pregnancy induces remarkable orthopedic adaptations.

Hormonal influences

Relaxin
Progesterone
Estrogen
These hormones increase ligamentous laxity.

Sacroiliac joints

Motion increases by approximately 2–4 mm.

Pubic symphysis

Normal widening:
4–5 mm
Late pregnancy:
7–9 mm
Excess separation (>10 mm) may produce pelvic girdle pain or instability.

Coccyx

Posterior movement during second stage increases outlet diameter.

Pelvic Dimensions Important in Vaginal Delivery

Diameter	Normal value
Obstetric conjugate	10.5–11 cm
Diagonal conjugate	12.5–13 cm
Transverse inlet	13 cm
Interspinous diameter	10–10.5 cm
Intertuberous diameter	11 cm
AP outlet	11.5 cm

These values provide approximate guidance but should not be interpreted in isolation.

Cephalopelvic Proportion

Cephalopelvic disproportion results from mismatch between
- fetal head
- maternal pelvis

CPD may be
Absolute
or
Relative

Most suspected CPD results from malposition, inadequate uterine contractions, or labor dysfunction rather than true bony disproportion.

Clinical Pelvic Assessment

Clinical pelvimetry remains an essential bedside skill.
Assessment includes
- Sacral curve
- Sacral promontory
- Ischial spines
- Side walls
- Pubic arch
- Diagonal conjugate
- Intertuberous distance

Advantages
- Simple
- Inexpensive
- Immediate

Limitations
- Subjective
- Poor interobserver reliability
- Cannot predict labor outcome alone

Imaging Pelvimetry

X-ray pelvimetry
Historically popular
Currently limited due to
- radiation
- poor predictive value

CT pelvimetry
Provides excellent bony detail
Not routinely recommended owing to radiation exposure.

MRI pelvimetry
Advantages
No radiation
Excellent visualization
Useful in
- pelvic deformities
- skeletal dysplasia
- previous pelvic fractures
- complex orthopedic conditions

Routine MRI pelvimetry is not recommended in uncomplicated pregnancies.

Intrapartum Ultrasound

Recent research has shifted toward dynamic assessment.
Useful parameters include
- Head progression distance
- Angle of progression
- Head-perineum distance
- Fetal head position
- Cervical dilatation

Advantages
Objective
Repeatable
Predicts operative delivery better than static pelvimetry.

Orthopedic Disorders Affecting Normal Delivery

Previous Pelvic Fractures
Stable healed fractures generally permit vaginal delivery.
Potential concerns include
- pelvic asymmetry
- malunion
- retained fixation
- acetabular deformity

Cesarean section is not routinely indicated solely because of previous pelvic fracture.

Developmental Dysplasia of the Hip

Most women deliver vaginally.
Hip flexion should be carefully monitored in severe dysplasia or after reconstructive surgery.

Pelvic Osteotomies
Women undergoing
- periacetabular osteotomy
- Salter osteotomy
- triple pelvic osteotomy

often achieve successful vaginal delivery depending upon residual pelvic dimensions.

Ankylosing Spondylitis
Pelvic stiffness
Reduced sacroiliac mobility
Spinal rigidity
may complicate positioning and anesthesia more than vaginal delivery itself.

Scoliosis
Usually does not alter pelvic dimensions significantly but may complicate neuraxial anesthesia.

Osteogenesis Imperfecta
Requires multidisciplinary planning because of
- maternal fracture risk
- fetal skeletal abnormalities

Achondroplasia
Absolute pelvic narrowing frequently necessitates cesarean delivery.

Pelvic Tumors
Benign
Malignant

Large lesions occupying the birth canal may obstruct vaginal delivery.

Pelvic Floor and Orthopedic Considerations

Pelvic floor muscles support
- bladder
- uterus
- rectum

Childbirth may contribute to
- levator ani injury
- pubic symphysis dysfunction
- pelvic girdle pain
- stress urinary incontinence

Orthopedic rehabilitation and physiotherapy improve postpartum recovery.

Current Evidence

Recent systematic reviews demonstrate
- Routine clinical pelvimetry alone has limited predictive value.
- Routine X-ray pelvimetry does not improve maternal or neonatal outcomes.
- MRI is reserved for selected cases.
- Intrapartum ultrasound offers superior prediction of labor progression.
- Clinical judgment remains the cornerstone of delivery planning.

Practical Orthopedic Recommendations

Orthopedic consultation is advisable in women with
- previous pelvic fractures
- acetabular reconstruction
- pelvic ring fixation
- severe hip dysplasia
- skeletal dysplasia
- pelvic tumors
- severe spinal deformities

Most women with healed orthopedic conditions can safely attempt vaginal delivery after individualized assessment.

Future Directions

Emerging technologies include
- Three-dimensional pelvic modeling
- Artificial intelligence-assisted labor prediction
- Dynamic MRI
- Finite element biomechanical simulations
- Personalized orthopedic-obstetric planning

These innovations may better characterize fetopelvic relationships while minimizing unnecessary cesarean sections.

Conclusion

From an orthopedic perspective, the maternal pelvis is a dynamic load-bearing structure that undergoes remarkable biomechanical adaptations during pregnancy and labor. Although pelvic morphology influences childbirth, successful vaginal delivery depends on the interaction between fetal size, fetal position, uterine contractions, and pelvic mechanics rather than static bony measurements alone. Routine pelvimetry has limited predictive accuracy, whereas dynamic assessment with clinical examination and intrapartum ultrasound provides greater clinical utility. Orthopedic evaluation is particularly important in women with previous pelvic trauma, congenital deformities, hip disorders, skeletal dysplasia, or reconstructive surgery. A multidisciplinary approach involving obstetricians, orthopedic surgeons, radiologists, anesthesiologists, and physiotherapists optimizes maternal and neonatal outcomes while supporting safe vaginal birth whenever feasible.

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