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Pregnancy complicated by severe osteogenesis imperfecta poses a challenge for the anaesthetist: A case report

Rou Yu, Jieshu Zhou and Qing Zhu

Abstract

Pregnant women with severe osteogenesis imperfecta (OI) are uncommon, and there are limited data regarding anaesthesia for caesarean section in these high-risk individuals. The presence of anatomical and physiological abnormalities can pose technical challenges for the anaesthetist. This report describes the successful implementation of epidural anaesthesia in a parturient with severe OI. To our knowledge, this is the first documented use of ultrasound-assisted neuraxial anaesthesia and wrist blood pressure monitoring in such patients undergoing caesarean section. Understanding the pathophysiological changes associated with OI is crucial for ensuring safe administration of anaesthesia to these women.

Keywords

osteogenesis imperfecta, caesarean section, neuraxial anaesthesia, anaesthetic management

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Background

Osteogenesis imperfecta (OI) or brittle bone disease, is a rare genetic connective tissue disorder.[1] The disease is characterized by extremely fragile bones that are prone to easy fracture, often occurring with minimal trauma or without any apparent cause. The clinical phenotype of OI can vary from mild osteoporosis to severe deformities or even fatal outcomes during the perinatal period.[1] A cross-sectional study involving

Department of Anesthesiology, West China Second University Hospital, Sichuan University, China; Key Laboratory of Birth Defects and Related Diseases of Women and Children, Ministry of Education (Sichuan University), Chengdu 610041, Sichuan, China

Corresponding author:
Qing Zhu, Department of Anesthesiology, West China Second University Hospital, Sichuan University, No. 20, Section 3, South Renmin Road, 610041, Chengdu, Sichuan, China; Key Laboratory of Birth Defects and Related Diseases of Women and Children, Ministry of Education (Sichuan University), Chengdu 610000, Sichuan, China.
Email: zhuqing@scu.edu.cn

132 women, found that there were increased risks of complications to mother and baby in pregnancies complicated by OI.[2] Caesarean section is the recommended mode of delivery for most obstetric patients with OI as malformed pelvis is associated with an increased risk of cephalopelvic disproportion and maternal pelvic fracture during vaginal delivery.[3] Therefore, anaesthesiologists should be aware of the potential challenges of skeletal deformities, dwarfism and systemic diseases associated with OI.[3] In this case report, we describe the anaesthetic management of a parturient with severe OI who underwent a caesarean section and discuss how the pathophysiology of OI influenced the anaesthetic procedures.

Case report

A pregnant woman in her 30's with severe OI was admitted to the obstetric unit of our hospital at 34 weeks gestation for premature rupture of membranes (PROM). The woman had a history of multiple long bone fractures resulting from low-impact incidents or falls. She was confined to a wheelchair, was of short stature (height, 85 cm; weight: 43 kg), had significant deformities in all extremities and had severe scoliosis. She also had a triangular facial configuration, prominent dentition, and dentinogenesis imperfecta. As part of her prenatal care, she was referred for genetic counselling. Analysis of the maternal genomic DNA sequence identified a G>C transition at position 781 in exon 38 of the *COL1A2* gene (c.2341G>C) (Figure 1). Sequence analysis of her spouse and foetus showed a lack of concordance in variant information. She had no history of cardiovascular or respiratory disease and her haematological and coagulation tests were normal. An emergency caesarean section was scheduled for the parturient due to uterine contractions and cephalopelvic disproportion.

On arrival at the operating room, standard monitors were applied that included, continuous electrocardiogram (ECG), pulse oximetry and non-invasive blood pressure (BP) measurement devices. However, due to the woman's short stature, obesity, and limb deformities, it was not possible to use an automatic BP cuff. Consequently, a wrist BP monitor was used (Figure 2). Considering the anticipated difficulty in airway management and the woman's anxiety with regard to potential neonatal depression caused by anaesthetic agents, epidural anaesthesia was planned.

The woman was carefully positioned in the left lateral decubitus. The presence of marked scoliosis, limited lumbar spine flexion, and a relatively small stature, posed

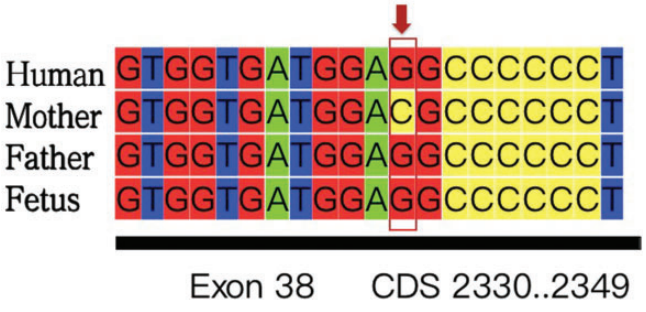

Figure 1. Diagram showing the nucleotide fragments of *COL1A2* gene (exon 38) from the National Center for Biotechnology Information (NCBI) reference sequence (GenBank NG_007405.1) for reference (human), mother, father, and foetus. Red rectangle indicates the position of the maternal variant (c.2341G>C).

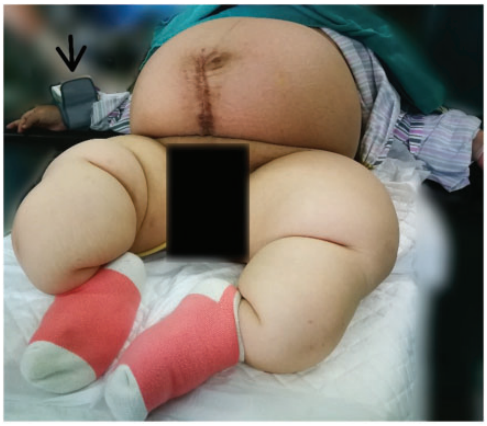

Figure 2. Black arrow indicates the wrist blood pressure (BP) monitor on this pregnant woman with Type 3 OI.

challenges in identifying the intervertebral space through palpation of spinal landmarks. Prior to the procedure, we performed an ultrasound scan to assess the anatomical relationship of the lumbar spine (Figure 3). Based on ultrasound imaging, the paramedian approach was employed to access the L1-2 epidural space. Following three attempts, successful placement of an epidural catheter was achieved, and it was positioned 3 cm within the epidural space. Although catheter aspiration had been performed in the lateral position, intravascular insertion occurred when the woman's position was changed to supine. The mispositioned catheter was corrected by slightly withdrawing 0.5 cm, and a negative response was observed during an epidural test dose with 3 ml of 1.5% lidocaine with 1:200,000 epinephrine. Subsequently, a total of 6 ml of 3% 2-chloroprocaine was incrementally injected over a period of 10 minutes to achieve T4 bilateral sensory block. The caesarean section was performed smoothly without the mother experiencing any discomfort and resulted in the delivery of a healthy infant. Post-operative recovery proceeded without any complications and, the

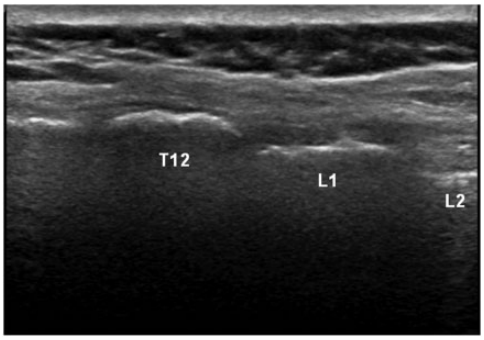

Figure 3. Ultrasonographic images of the T12-L1, L1–2 intervertebral space (longitudinal view).

mother and baby were discharged home after 4 days. The reporting of this study conforms to CARE guidelines.[4] The patient provided written informed consent for publication of this anonymised case report and accompanying images. Ethical committee approval was not required for this case report.

Discussion

OI is a group of autosomal dominant or recessive genetic diseases characterized by the presence of brittle bones with the birth prevalence of 6-7 per 100,000.[5,6] In the majority of cases, OI occurs secondary to mutations in the collagen genes, *COL1A1* and *COL1A2,* and is often classified into four main types based on clinical features and severity.[6,7] However, several new genes, including rare recessive and X-linked variants, have now been identified in patients with OI.[8] Consequently, the classification has been expanded to include these rarer types. To meet both genetic and clinical requirements, the International Nomenclature Group for Constitutional Disorders of the Skeleton, has proposed five categories based on the severity of fractures and bone deformities, the timing of onset, and the presence or absence of blue sclera; most of the rare pathogenic variants of OI have been listed as subtypes.[1,5] Type 1

is the most frequent and individuals tend to have blue sclerae and usually no bone deformation.[1] Type 2 is the perinatal lethal form. Type 3, is the most severe form; fracture frequency is high and, it has a progressively deforming presentation. Type 4 is a heterogenous group and its severity varies; mild to moderate bone fragility is observed in many cases and sclerae are normal. Type 5 is characterized by calcification of the interosseous membranes and/or hypertrophic callus.[1,9] Currently, there is no cure for OI. Supportive interventions are aimed at increasing bone mass and enhancing skeletal strength and they are considered beneficial in alleviating symptoms.[10]

Our patient presented with severe clinical OI phenotype, she had a missense mutation in *COL1A2*, which led to a loss-of-function of codifying for type-I procollagen and impaired bone formation. Her phenotype was consistent with a diagnosis of Type 3 OI.[1] She had a triangular face, scoliosis, dentinogenesis imperfecta and extremely short stature. Published reports of the anaesthetic management of caesarean section in pregnant women with Type 3 OI are scarce.[11–13] The perioperative management of these women necessitates a multidisciplinary approach and the development of a tailored and comprehensive anaesthesia protocol. Importantly, pre-existing disorders of OI can interact with significant anatomical and physiological changes during pregnancy that may exacerbate bone abnormalities, cardiac and pulmonary insufficiency. In addition, the developing foetal skeleton requires approximately 30 g of calcium by term that results in the transfer of calcium from the mother to the foetus and, is accompanied by maternal bone resorption, which will increase fracture risk for pregnant women with OI.[14] Other considerations in these high-risk mothers include, movement, positioning, and invasive procedures which should be executed with gentleness and caution. For example, in our case, the conventional cuff sphygmomanometer was not suitable for the patient and we used a wrist electronic BP monitor. This device has been proven to be adaptable to abnormal limbs and can effectively prevent additional bone fractures with high sensitivity to forearm positioning. In our case, the pregnant woman was placed in a supine position for surgery, with her right arm and wrist at heart level to ensure accurate BP measurements.

Additionally, anaesthetists should be aware that women with dwarfism and severe chest and spinal abnormalities may experience significant restrictive hypoventilation that may exacerbate as pregnancy progresses. Intraoperative attention should also be given to a hypermetabolic state (i.e., hyperthermia and hyperhidrosis) because some patients with OI may present with hyperthyroidism.[15] However, these patients are unlikely to be susceptible to malignant hyperthermia.[16] Health professionals should also be aware that in these pregnant women, certain uncommon abnormalities such as, vascular fragility and reduced collagen levels in the uterine myometrium, may lead to spontaneous uterine rupture, uterine atony, antepartum and postpartum hemorrhage.[17]

While caesarean section is the preferred mode of delivery for obstetric patients with OI, due to cephalopelvic disproportion, and possibility of maternal pelvic fracture during vaginal delivery,[3] because of concerns about neonatal depression caused by anaesthetic agents, our patient expressed anxiety about anaesthesia, her pregnancy and preterm labour. Therefore, we decided to use neuraxial anaesthesia which was judged to be a reasonable option for this mother and her baby. This type of anaesthesia can help avoid complications associated with difficult airway manipulation and general anaesthesia-induced damage to fragile teeth, mandible and cervical vertebra, particularly fractures resulting from

succinylcholine-induced fasciculations. Nevertheless, conditions such as dwarfism, spinal abnormalities, obesity, and uterine enlargement can pose technical challenges for neuraxial anaesthesia because of the altered relationship between surface anatomy and the vertebral column. To overcome these challenges, we undertook ultrasound scans of the lumbar spine to identify the optimal site for epidural puncture and determine the appropriate needle angulation. Indeed, ultrasonography has been shown to be useful as an adjunctive tool to enhance procedural success in neuraxial blocks in obstetrics.[18] Additionally, our patient had scoliosis which can lead to spinal canal narrowing and short stature, both of which pose challenges for the accurate estimation of the appropriate dose of local anesthetics.[19] Single-shot spinal anaesthesia may lead to inadequate or unexpectedly high block, making titrated neuraxial anaesthesia the preferred choice. Due to these considerations and our unit's standard practice, continuous epidural anaesthesia was chosen, but there was inadvertent migration into a vein when the patient changed position following the placement of an epidural catheter. Although this occurrence is uncommon, it raises theoretical concerns regarding accurate catheter placement during combined spinal-epidural anaesthesia, because functional verification of the epidural catheter cannot be achieved until spinal anaesthesia subsides. Accordingly, it is essential to maintain precautionary measures for general anaesthesia at all times including an experienced anaesthesia team, rescue medications and emergency equipment for difficult airways.

In conclusion, pregnant women with severe OI pose significant challenges for anaesthetists because of the presence of numerous anatomical and physiological abnormalities. A thorough understanding of the pathophysiological changes associated with OI is crucial for the safe administration of anaesthesia in these high-risk women. Technical difficulties may arise when considering either neuraxial or general anaesthesia options for parturients with OI, and the choice of anaesthetic technique depends on factors such as comorbidities, delivery urgency, and skills and resources available to the anaesthesiologist. In cases where there are no contraindications, titrated neuraxial anaesthesia may be preferred, and ultrasound-assisted techniques may be useful in facilitating the procedure's success.

Declaration of conflicting interests

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ORCID iD

Rou Yu https://orcid.org/0000-0003-4349-287X

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