Osteogenesis Imperfecta

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Presentation and Symptoms

Definition

Osteogenesis imperfecta (OI) is a rare congenital defect caused by mutations in one of the two genes (COL1A1 or COL1A2) that encode for type I collagen [1, 2]. However many other mutations in proteins involved in collagen processing and osteoblast function have been identified. Inheritance is autosomal dominant or recessive [2]. This type of collagen is structural and present in bones, dentin, sclera, ligaments, and tendons. Disease severity is highly variable depending on the penetration and expression of the defect.

Presentation

Manifestations of OI during pregnancy will greatly depend on the type of OI and the degree of expression (phenotype).

Signs Associated with OI

1. There are five types of OI (Table 115.1). Type I is the most common during pregnancy [2].
2. Disease expression varies from mild to severe. Signs range from mild osteoporosis to bone fragility with multiple fractures ("brittle bone disease") [3].
3. Patients with type I OI may have milder disease with lack of major bone deformities. Despite this fact, vertebral fractures are common and can lead to mild scoliosis [4].
4. Patients with the most severe form of the disease (type III) usually die from skeletal chest wall deformity leading to restrictive lung disease, pulmonary hypertension, and cardiorespiratory failure [1, 5]. It was estimated that two thirds of patients with this type of OI died by the end of the second decade [5]. The use of bisphosphonate therapy has prolonged their life expectancy [5].

Table 115.1 Classification of osteogenesis imperfecta [5, 8]

Type	Possible clinical features
1	Bone fragility and low bone mass
	Mild-to-moderate fracture frequency: ≥1/year
	Blue-gray sclera
	Conductive hearing loss
	Mild-to-moderate spine deformities
	Dentinogenesis imperfecta (DI)
	Usually of normal stature
2	1/5 of fetuses are stillborn and 90% of survivors die by 4 weeks of age
3	Bone fragility and multiple fractures result in severe skeletal deformity
	Short stature as result of fractures
	Progressive kyphoscoliosis
	Death often secondary to chest wall deformities—kyphoscoliosis, pulmonary
	hypertension, and cardiorespiratory failure
4	Recurrent fractures
	Variable degrees of deformity of long bones and spine
	Posterior fossa compression syndromes secondary to basilar impression with elevation of the floor of the posterior cranial fossa (higher risk if DI is present)
	Severity highly variable within families

5. The major neurologic complication in patients with OI type III is brain stem compression [1].
6. Cardiac valvular dysfunction and aortic root dilation have been reported, primarily in patients with OI type III [5].
7. Additional extraskeletal manifestations of OI may involve the eye (blue sclera), dentition (dentinogenesis imperfecta), hearing impairment, and Wormian bones on skull radiographs [4, 5]. Laxity of the ligament, tendons, and skin may be present [6].
8. Forty percent of patients with OI develop hyperthyroidism [7].

Incidence

The incidence for all types of OI has been estimated to be 1:10–12,000, whereas the incidence of each specific type is

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1:28,500–60,000 [9]. OI type I is the most common form with an incidence of 1:28,000 [3].

Interaction with Pregnancy

Effect of Pregnancy on OI

1. Physiologic changes of pregnancy (i.e., decreased functional residual function, increased minute ventilation, and oxygen consumption) could further compromise the baseline respiratory status of the parturient if kyphoscoliosis and restrictive lung disease are present [6–8].
2. In the mild forms, the incidence of fractures is not increased during pregnancy, but obstetrical manipulation may result in fractures [3, 10].

Effect of OI on Pregnancy

1. Given that OI is so rare, there is a paucity of literature on the effect of OI on pregnancy. However, cesarean delivery (CD) seems to be more common among parturients with OI as a consequence of pelvic deformities, increased incidence of cephalopelvic disproportion, as well as fetal malpresentation [6, 8–10]. The majority of CDs are performed secondary to obstetric indications rather than to avoid maternal complications [2].
2. *Bleeding secondary to platelet adhesion abnormalities and vessel fragility has been reported* [7, 8].
3. *Uterine rupture and postpartum hemorrhage (PPH) have been reported* [1, 7].
4. Preeclampsia appears to be more common as is GDM [2].
5. Premature ruptures of membranes, infection, and preterm delivery have also been noted [2].
6. Third- and fourth-degree pelvic tears, joint dislocations, and fractures are not uncommon [2].

Testing

1. Given that PPH is a risk in parturients with OI, *coagulation studies* including *platelet function tests* may be helpful, particularly if there is a history of abnormal bleeding. In addition, blood should be available for delivery.
2. *Pulmonary function testing* is warranted in parturients with severe RLD.
3. An *electrocardiogram* and *echocardiogram* should be obtained if congenital or acquired heart disease or cor pulmonale is present.
4. *Thyroid function testing should be performed*.
5. A radiograph of the head and neck can rule out atlantoaxial instability and odontoid fracture.
6. If imaging is available, the degree of thoracic and lumbar scoliosis can be determined.
7. MRI of the brain and cervical spine helps assess the presence of posterior fossa syndrome and/or cervical cord compression.

Management

Medical

1. Bisphosphonates use is not recommended during pregnancy [10].

Anesthetic Management

1. The anesthetic management should be tailored to the patient's comorbidities and deformities.
2. Independent of the anesthetic technique or mode of delivery special attention should be paid to avoiding new fractures.
   (a) *It is important to position patients such that all pressure points are well padded and protected to avoid new fractures during the delivery process*.
   (b) The use of noninvasive blood pressure cuffs and tourniquets may pose a risk for the fracture of long bones; hence arterial cannulation is recommended [6, 8].
3. The safe use of neuraxial analgesia has been documented in several case reports of parturients suffering OI types I, III, and IV [6–8, 11]. Before performing a neuraxial technique, any *coagulopathy should be ruled out* by a thorough history and laboratory studies.
4. Positioning the patient for performing a neuraxial technique may be difficult particularly for patients that are wheelchair bound secondary to multiple lower extremity and/or pelvic fractures.
5. Parturients with significant scoliosis may make neuraxial techniques technically difficult or impossible to accomplish [12].
6. The presence of scoliosis and short stature presents a challenge to the anesthesiologist, as the ideal dose and/or volume to achieve a surgical level is unknown. Hence a neuraxial anesthetic technique that permits titration to a surgical level such as an epidural or a continuous spinal technique has been suggested [6, 11].
7. General Anesthesia
   (a) Patients with OI may have *reduced range of motion and cervical instability*, brittle teeth, and *micrognathia* making direct laryngoscopy difficult [3].
   (b) The successful use of a video-assisted laryngoscopy has been described [8].

(c) The use of an awake fiber-optic intubation should be contemplated for parturients with documented or unfavorable airway exam.
(d) Depolarizing muscle relaxants (i.e., succinylcholine) should be used cautiously as fasciculations could result in fracture. A defasciculating dose prior to its use is recommended or best avoided.
(e) Temperature should be carefully monitored intra- and postoperatively as this cohort is known to exhibit a chronic hypermetabolic state [3] that frequently manifests as fever. However, there seems to be no link between OI and malignant hyperthermia [8].
(f) Emergence could be complicated by fractures caused by coughing, bucking, and an excitatory state. Plans should be made for a smooth emergence.

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