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Management of a Severe Case of Osteogenesis Imperfecta in Ghana: Evaluation of Outcome

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Abstract

Introduction: Osteogenesis imperfecta is the most common genetic disorder of bone and is characterised by growth retardation, bone fragility, deformity and joint hyperlaxity. Severe disease causes pain and limitation of function.

Case Report: An 8-year old male with multiple lower limb deformities, growth retardation and inability to stand upright and walk since birth.

Conclusion: Surgery in a child with severe osteogenesis imperfecta with multiple lower limb deformities could be safe, effective and improves function. At 3 years following surgery, the child's lower limbs remain well aligned, he is a community ambulator and is able to perform self-care: toileting, dressing and grooming.

Keywords: Osteogenesis Imperfecta; Osteotomies; Genetic Mutation; Intramedullary Nail

Introduction

Osteogenesis imperfecta (OI) is a genetic connective tissue disorder that commonly results from mutation in type I collagen genes and is typically inherited as an autosomal dominant trait [1]. It is the most common genetic disorder of bone and is characterised by growth retardation, bone fragility, deformity and joint hyperlaxity [2]. The point prevalence of OI is approximately 5-6.7/100,000 live births. The condition varies broadly in severity with a wide range of clinical manifestation from mild symptoms to perinatal lethality. The outcomes following treatment of OI depends on the type or grade of the disease [2].

Genetic basis and classification of osteogenesis imperfecta

The disease is classified into four sub-types, ranging from mild to lethal, on the basis of clinical severity (Sillence, 1979). Osteogenesis imperfecta type I is mild, type II is lethal in the neonatal period, type III is the most severe type and type IV is intermediate in severity, between type I and II. Long-bone deformities are common in children with types III and IV disease and corrective surgery is indicted [3,4]. Recently new genes for OI have been discovered prompting a modification of Sillence' classification system into sub-types. In the modified classification system the sub-types of the disease are based on the underlying genetic abnormality. The majority of patients with OI fall into group A sub-types which result from abnormalities in collagen synthesis, processing and structure. However, the new subtypes of OI are extremely rare. Between 85 and 90% of patients with OI have mutations in COLIA1 and COLIA 2 genes that encode alpha1 and alpha 2

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Konadu-Yeboah D, et al., Arch Clin Med Case Rep 2024
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chains of type 1 collagen [5]. Additionally, mutations in the BMP1 gene underline a recessive form of OI that falls under group A OI. The group B sub-types are caused by mutations in genes that modulate post- translational modification of collagen and are recessively inherited. They present in early infancy and underlie severe disease. Group C subtypes of OI are moderate to severe in clinical manifestation and have dominant or recessive inheritance [6,7]. Sub-types of group C are caused by mutations in genes responsible for collagen folding and crosslinking. A mild OI phenotypic expression, may result from heterozygous mutations in P4HB gene [1,5,8]. The mutations in the P4HB gene are responsible for the Cole-Carpenter syndrome in which craniosynostosis, hydrocephalus and proptosis may be associated with the disease [8]. Patients with group D sub-types of OI have abnormalities of mineralization. Mutations in IFTM5 produce an autosomal dominant form of the disease characterized by increased mineralization of bone whilst SERPINF1 mutations cause a recessive form of OI with reduced bone mineralization. Group E sub-types of the disease are caused by mutations in osteoblast differentiation genes SP7, WNT1 and CREB3L1 and exhibits recessive inheritance [5].

Orthopaedic management of deformities of osteogenesis imperfecta

The limb deformities of OI are multiplanar and their management is complex, and challenging. The principle of management is to reduce pain and improve function in patients affected by the disease. The management is multidisciplinary and includes orthotists, physiotherapists, endocrinologists and rheumatologists. Treatment commences in early childhood. Maximising function is the primary indication of deformity correction in OI. In 1950, Sofield described multiple long bone osteotomies with intramedullary nail fixation, which still applies in current orthopaedic practice [5,9]. In Sofield procedure, all the deformities in a long bone are corrected at a single surgical sitting with intramedullary nail fixation of the osteotomies, as a method of choice. Telescopic rods: Fassier-Duval and Sheffield systems may be used in the stabilisation of osteotomies in skeletally immature patients. They are however, associated with high rates of re-operation for delayed or nonunion [9-15]. There is limited literature on outcomes of surgical treatment of OI, particularly in Low- and Middle-income countries [16].

Case Report

We report our findings in the operative management of an 8-year old male, who was seen at our clinic with complaints, by his parents, of multiple lower limb deformities, growth retardation and inability to stand upright. The child was delivered via spontaneous vaginal delivery at term to a 28-year old nulliparous mother and a 34-year old father and weighed 1.8kg at birth. The mother of the child had no known history of exposure to teratogenic agents such as x-rays or hormonal contraceptives and had no family history of congenital anomalies nor birth defects in her community. The mother had an up-to-date immunization status, did not smoke cigarette in pregnancy, was a regular attendant at the antenatal clinic and had no illness during pregnancy. Physical examination revealed a small for age child with blue sclerae and severe multiplanar deformities involving the lower limbs. There was no dental or cardiovascular abnormalities and no hearing impairment.

The child mobilized by crawling and could not stand erect. Physical examination of the chest and abdomen was uneventful and there was no cognitive impairment found. A diagnosis of osteogenesis imperfecta, type III, was made. Figure 1, shows the child in the crawling position and the nature of the lower limb deformities before surgery was performed. Chest x-ray and abdominal ultrasound scan showed normal findings. Multiple osteotomies of both femora and tibiae were performed at the apex of the deformities, under general anaesthesia and fluoroscopic guidance. The osteotomies were closing wedge at the convex surfaces of the deformities of the left femur, right femur, left tibia and the right tibia. Oblique proximal osteotomy of the fibulae was performed to allow for correction of the tibia. The osteotomies were stabilized with 3.0mm flexible titanium intramedullary nails. The nails were introduced after recanalization of the both femora and tibiae as their intramedullary canals were obliterated. The femoral nails were passed retrograde and those of the tibiae, antegrade. The surgical incisional sites were closed in layers. The post-operative radiographs of the lower limbs are shown in Figure 2. The construct was buttressed with an above knee circular Plaster-of-Paris cast, on both lower limbs, shown in Figure 3. The surgery was performed at a tertiary hospital on 12th April, 2021.

Figure 1: An 8-year-old child with osteogenesis imperfecta, type III: unable to stand upright (left), severe deformities of both lower limbs (right).

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The above knee circular casts were removed 6 weeks following surgery, shown in Figure 3. A repeat x-ray showed healed osteotomies. The patient commenced weight bearing at 8 weeks and underwent an active rehabilitation programme after cast removal. This included gradual weight bearing, practicing self-care skills, gait training, periodic assessment of function and parental education on handling.

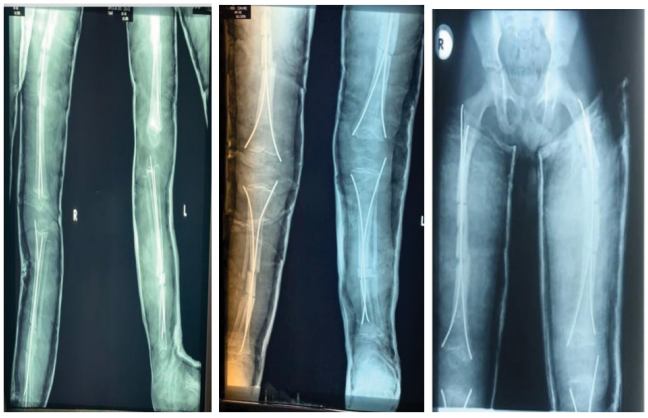

Figure 2: Post-operative x-rays of both femora and tibiae (left) and middle and the knee joints, femora and pelvis (right).

Figure 3: Post-operative day 1, showing the patient in a bilateral above knee circular cast (left), the appearance of the lower limbs after removal of the cast at 6 weeks (middle) and the child standing upright at 3 years following surgery (left).

Assessment of treatment Outcome

At three (3) years following surgery, we assessed functional outcome using the Paediatric Evaluation of Disability Inventory (PEDI) instrument. The PEDI has been shown to be valid and reliable in evaluating function in children with OI and can be administered to patients from 6 months to 21 years of age [17]. The assessment was performed with the aid of a physiotherapist through parent interview and an observation of the child's performance. Each item was scored 1 or 0, indicating able (1) or unable (0), to perform a task, including dressing, grooming and toileting, and the raw score was translated into scaled scores and summed up [16]. A score of 100 indicates full function and 0, no function. Since social and cognitive impairment are not known features of OI, the social function domain of PEDI was not tested in our patient. The modified Bleck scale (non-ambulator = 0, therapeutic ambulator = 1, household ambulator = 2, limited community ambulator = 3, full community ambulator = 4), was used to measure the level of ambulation of the patient at 3 years [6,18]. Our patient was a limited community ambulator at three years, and had a PEDI score of 70.

Discussion

The child of our report had severe osteogenesis imperfecta with multiple lower limb deformities and inability to stand upright and walk at 8 years. Following multiple osteotomies involving the lower limbs, the child's lower limb deformities were corrected and was able to stand erect and walk 8 weeks after surgery. In addition, at 3 years after surgery, the child's lower limbs remain well aligned, he is a community ambulator and is able to perform self- care such as toileting and tasks such as dressing and grooming. Our findings corroborate those of several other authors who have reported that in osteogenesis imperfecta with lower limb deformities, surgery has a role of correcting the deformities, relieving pain and improving function for independent living [2,18,19]. A study by Montpetit and colleagues, reported significant improvement in function in a cohort of children with severe osteogenesis imperfecta compared to a control group of children that were matched for age and OI type [19]. Furthermore, we observed in the patient of this report that in spite of the disease severity, the osteotomies healed sufficiently to permit weight bearing at 8 weeks. Similarly, a number of authors have reported, that despite the bone fragility and the increased fracture risk, fractures and osteotomies tend to heal in osteogenesis imperfecta [2,10,18] In our case, we performed multidirectional, closing wedge osteotomies at the apices of the deformities of the affected long bones and stabilized the osteotomies with intramedullary nails. Similarly, in a study of a roadmap to surgery in osteogenesis imperfecta, Sakkers and others, recommended multilevel osteotomies at the apices of long bone deformities with intramedullary nail stabilization and bony shortening [20]. In the patient of our study, immobilisation of the limbs in plaster cast was performed to provide further support to the long bone osteotomies, and weight bearing was delayed until after adequate healing of the osteotomies. This supports the observation by other authors that following osteotomies in patients with osteogenesis imperfecta weight bearing should be delayed until healing of osteotomies [20,21]. Bisphophonates have been used by some authors as an adjunct to operative treatment and have been observed to improve bone mineralisation and healing [22]. In our patient, however, bisphosphates were not used and union of the osteotomies was achieved. Since, recurrent fractures are a feature of the disease, our patient will be followed up regularly, at least, until skeletal maturity.

Konadu-Yeboah D, et al., Arch Clin Med Case Rep 2024
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Conclusion

In a patient with severe osteogenesis imperfecta with multiplanar lower limb deformities, improvement in function and self-care could be achieved after lower limb reconstruction. Surgery, performed in a low-resource setting, could be safe and effective in a child with severe osteogenesis imperfecta.

Clinical Message

Surgical correction of lower limb deformities, could improve function in a patient with severe osteogenesis imperfecta.

Declaration of Patient Consent

Informed consent of the parents of the patient was duly sought and obtained for the images and clinical information to be reported. The parents of the patient understand that their names nor the name of their child will not be published and measures will be taken to conceal their identity.

Conflict of Interest: Nil

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References

1. Lindahl K, Åström E, Rubin CJ, Grigelioniene G, Malmgren B, et al. Genetic epidemiology, prevalence, and genotype–phenotype correlations in the Swedish population with osteogenesis imperfecta. European Journal of Human Genetics 23 (2015): 1042-1050.
2. Dar S, Khalily N, Khan S, et al. Management of osteogenesis imperfecta in adulthood a single centre experience. Endocrine Abstracts. Epub ahead of print (2018).
3. Forlino A, Marini JC. Osteogenesis imperfecta. The Lancet 387 (2016): 1657-1671.
4. Sillence DO, Senn A, Danks DM. Genetic heterogeneity in osteogenesis imperfecta. Journal of Medical Genetics 16 (1979): 101-116.
5. Li L, Zhao D, Zheng W, et al. A novel missense mutation in P4HB causes mild osteogenesis imperfecta. Biosci Rep 39 (2019): BSR20182118.
6. Montpetit K, Palomo T, Glorieux FH, et al. Multidisciplinary Treatment of Severe Osteogenesis Imperfecta: Functional Outcomes at Skeletal Maturity. Arch Phys Med Rehabil 96 (2015): 1834-1839.
7. Montpetit K, Palomo T, Glorieux FH, et al. Multidisciplinary Treatment of Severe Osteogenesis Imperfecta: Functional Outcomes at Skeletal Maturity. Arch Phys Med Rehabil 96 (2015): 1834-1839.
8. Rauch F, Fahiminiya S, Majewski J, et al. Cole-Carpenter Syndrome Is Caused by a Heterozygous Missense Mutation in P4HB. The American Journal of Human Genetics 96 (2015): 425-431.
9. Ralston SH, Gaston MS. Management of Osteogenesis Imperfecta. Front Endocrinol (Lausanne) 10 (2020): 506873.
10. Lee K, Park MS, Yoo WJ, et al. Proximal migration of femoral telescopic rod in children with osteogenesis imperfecta. Journal of Pediatric Orthopaedics 35 (2015): 178-184.
11. Fralinger DJ, Kraft DB, Rogers KJ, et al. The Fate of the Bent Rod in Children with Osteogenesis Imperfecta. Journal of Pediatric Orthopaedics 43 (2023): E465-E470.
12. Alonso-Hernández J, Galán-Olleros M, Miranda-Gorozarri C, et al. Two-stage Bone Lengthening With Reuse of a Single Intramedullary Telescopic Nail in Patients With Achondroplasia. Journal of Pediatric Orthopaedics 42 (2022): E616-E622.
13. Oliver B, Neville D, Mark L, et al. Experience with the Fassier-Duval Telescopic Rod First 24 Consecutive Cases With a Minimum of 1-Year Follow-up. Journal of Pediatric Orthopaedics 31 (2011): 458-464.
14. Wright J, Kazzaz S, Hill RA. Developments in the Orthopaedic Management of Children with Stüve-Wiedemann Syndrome: Use of the Fassier-Duval Telescopic Rod to Maintain Correction of Deformity. Journal of Pediatric Orthopaedics 37 (2017): e459-e463.
15. Birke O, Davies N, Latimer M, et al. Experience with the fassier-duval telescopic rod: First 24 consecutive cases with a minimum of 1-year follow-up. Journal of Pediatric Orthopaedics 31 (2011): 458-464.
16. Feldman AB, Haley SM, Coryell J. Concurrent and Construct Validity of the Pediatric Evaluation of Disability Inventory. Phys Ther 70 (1990): 602-610.
17. Fratzl-Zelman N, Barnes AM, Weis MA, et al. Non-Lethal Type VIII Osteogenesis Imperfecta Has Elevated Bone Matrix Mineralization. J Clin Endocrinol Metab 101 (2016): 3516-3525.
18. Montpetit K, Palomo T, Glorieux FH, et al. Multidisciplinary Treatment of Severe Osteogenesis Imperfecta: Functional Outcomes at Skeletal Maturity. Arch Phys Med Rehabil 96 (2015): 1834-1839.
19. Sakkers RJ, Montpetit K, Tsimicalis A, et al. A roadmap to surgery in osteogenesis imperfecta: results of an international collaboration of patient organizations and interdisciplinary care teams. Acta Orthop 92(2021): 608-614.

Konadu-Yeboah D, et al., Arch Clin Med Case Rep 2024
DOI:10.26502/acmcr.96550673

20. Laron D, Pandya NK. Advances in the orthopedic management of osteogenesis imperfecta. Orthopedic Clinics of North America 44 (2013): 565-573.

21. Biggin A, Munns CF. Osteogenesis imperfecta: Diagnosis and treatment. Curr Osteoporos Rep 12 (2014): 279-288.