Scientific Research Publishing

Open Journal of Orthopedics, 2025, 15(2), 78-87
https://www.scirp.org/journal/ojo
ISSN Online: 2164-3016
ISSN Print: 2164-3008

Unusual Complication of Flexible Intramedullary Nail in Pediatric Femoral Shaft Fracture

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How to cite this paper: Arong, A., Legaspi, J.A. and Espiritu, W.P.A. (2025) Unusual Complication of Flexible Intramedullary Nail in Pediatric Femoral Shaft Fracture. *Open Journal of Orthopedics*, **15**, 78-87.
https://doi.org/10.4236/ojo.2025.152009

Received: January 20, 2025
Accepted: February 14, 2025
Published: February 17, 2025

Abstract

Background of the Study: Femoral shaft fracture is the most common pediatric injury requiring hospitalization. For children less than 5 years old, non-surgical approach is recommended. For pediatric patients 5 - 14 years old, the most common mode of treatment is flexible intramedullary nailing with a known complication of pain at post-op site, inflammatory reaction/bursitis at the entry site, superficial and deep infection, knee synovitis, knee stiffness, leg length discrepancy, proximal nail migration, angulation or malunion, delayed and non-union, implant breakage. This study aims to present a rare complication of a femoral fracture fixed with flexible intramedullary nail. **Methodology:** We report the outcome of a 12-year-old male with peri implant fracture of the left femur. He underwent removal of plates and screws and subsequently fixed with flexible intramedullary nails. Patient was followed up at 1, 3, 7, and 10 months post-operatively. Varus-valgus, sagittal angulation, and limb shortening were measured pre- and post-operatively. Complications were recorded on each visit. **Results:** Pre-operative varus angulation was 10˚, pro-curvatum of 55˚ with limb shortening of 4 cm. Postoperatively, varus was maintained to 10˚ but pro-curvatum was corrected to 4˚ and limb shortening was reduced to 1 cm. However, after 1 month the varus angulation increased to 30˚ while maintaining sagittal pro-curvatum. Limb shortening also increased to 2 cm. New bone formation started to appear along the mechanical axis of the left femur which is apparent at 3 months post-op and pro-curvatum increased to 20˚. At 7 and 10 months post-op no signs of union was noted at the fracture site but the callus formation along the mechanical axis gradually matured and appeared as a new femoral shaft. **Conclusion:** Formation of new bone in response to unstable flexible intramedullary fixation in pediatric femoral shaft fracture is a very rare complication.

Keywords

Elastic Stable Intramedullary Nail, Wolff's Law, Pediatric Femur Fracture, Pediatric Orthopaedic, Femoral Shaft Fracture

1. Introduction

In the past, majority of fractures of the femur in children were treated conservatively, and because of several unwanted complications, this led to the search for other mode of treatment and surgical interventions. Flexible intramedullary nailing has been the treatment of choice for pediatric femoral fracture especially in 5 - 14 years of age [1]. Three-point fixation should be achieved, in order to have a more stable construct. Such procedure has its own complications such as pain at post-op site, inflammatory reaction/bursitis at the entry site, superficial and deep infection, knee synovitis, proximal nail migration, implant failure, loss of fracture alignment or malunion, delayed and non-union, knee stiffness, and leg length discrepancy [2]. In the literature, loss of fracture alignment that would lead to malunion has been recognized in larger patients, patients with unstable fracture patterns, inappropraite nail size/curve, asymmetrical entry points and those who had no postoperative immobilization [3]. Whether fracture fixation is in acceptable aligment or malunited, good callus formation was always seen at the fracture site during the healing process of this type of fixation. Formation of new bone along the mechanical axis of the fractured femur fixed with flexible intramedullary nail is a rare occurrence and can give a positive effect on patient with this complication.

2. Case History

A Case of M.R. 12yo, male, student, admitted in our institution due to left thigh pain. He was hospitalized at 4 years of age due to a closed fracture of the left femur and tibia-fibula secondary to a vehicular accident. He underwent hip spica casting and the fracture healed uneventfully. He was able to ambulate well thereafter.

At 6 years of age, he accidentally slipped and fell while playing and landed on his left thigh which resulted to pain and swelling. He was again hospitalized because of refracture of his left femur. He underwent open reduction and fixation with plates and screw. The patient was discharged improved, and the fracture healed well. Patient was able to return to his usual activities.

Few hours prior to admission, he accidentally fell again while running and landed on his left thigh. This resulted to severe pain and swelling on the affected part. He was immediately brought to our institution and eventually admitted. On physical examination, his left thigh was swollen with pain and tenderness. His left lower extremity was externally rotated and shorter, with leg length discrepancy of 4 cm. There was equal palpable peripheral pulses with no motor and sensory loss.

Laboratory tests which include complete blood count, PT, APTT and serum electrolyte did not yield any abnormalities. Standard left thigh orthogonal x-rays were taken (**Figure 1**) which showed peri-implant fracture with varus angulation of 10 degrees and procurvatum of 55 degrees. Application of splint was done and he was scheduled for surgery after his parents provided the necessary consent.

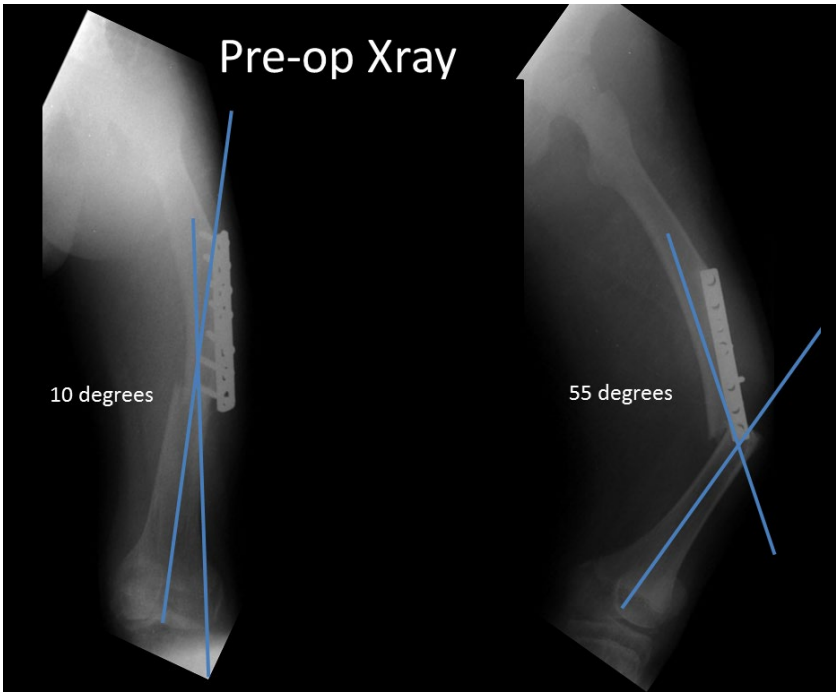

Figure 1. Peri-implant fracture with varus angulation of 10 degrees and procurvatum of 55 degrees.

The patient underwent removal of broken plate and screws, and femur was subsequently fixed with 3.5 mm elastic IM nails. He was kept on knee immobilizer immediately post-op and was advised non-weight bearing on the affected extremity for at least 4 weeks. Acceptable alignment was achieved immediately post-op. However, a corkscrew configuration between the two nails was observed on x-ray. There was noted asymmetrical level of nail insertion hence, three-point fixation at the fracture site was not achieved (**Figure 2** and **Figure 3**). Measurements were acceptable but risk of nonunion and malunion is likely of we accept this configuration pf fixation. Revision surgery was discussed but parents declined.

1 month after, he began to have partial weight bearing. Varus angulation of 30 degrees was noted on repeat x-ray though sagittal angulation was maintained , at this time, a silhouette of a shaft along the axis can be appreciated with no signs of significant mineralization or callus formation. (**Figure 4** and **Figure 5**). Weight bearing gradually progressed to full and the patient was ambulating well. New bone formation along the mechanical axis of the left femur was noted at 3 months follow up with no signs of bone healing at the fracture site (**Figure 6**). Callus formation gradually progressed and became more calcified on succeeding follow up

x-rays (Figure 7 and Figure 8), and the nails were removed at 11 months post-op. (Figure 9) Latest follow up showed good outcome with no pain and limitation in the range of motion of the affected extremity with no limitation to activities of daily living.

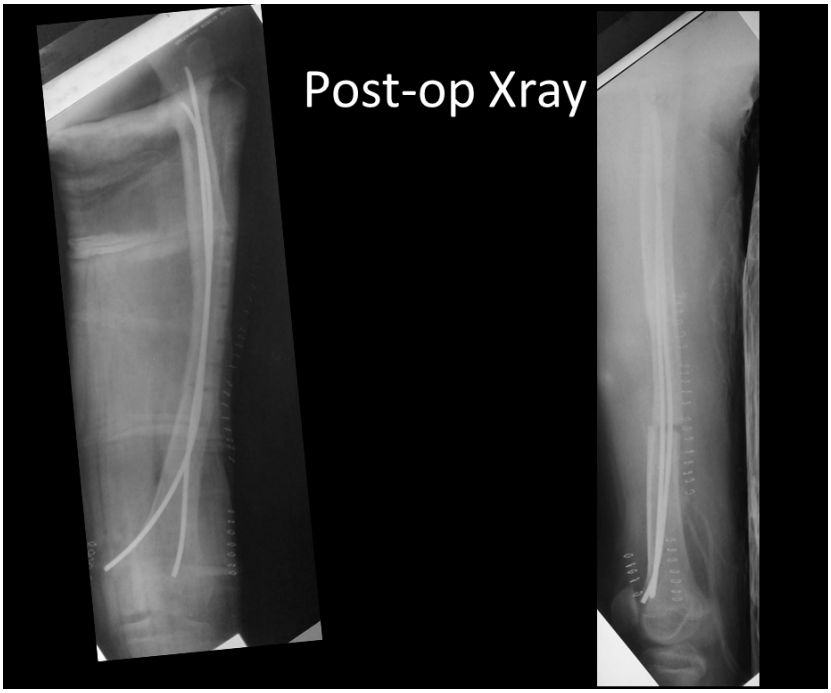

Figure 2. Failure to achieve a 3 point fixation seen at post op radiograph.

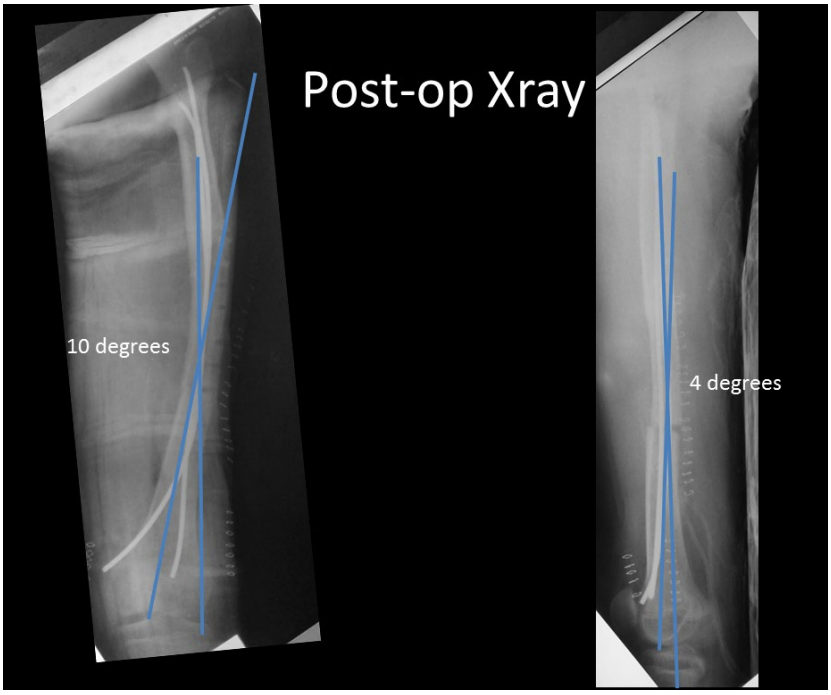

Figure 3. Asymmetrical level of nail insertion hence, three-point fixation at the fracture site was not achieved.

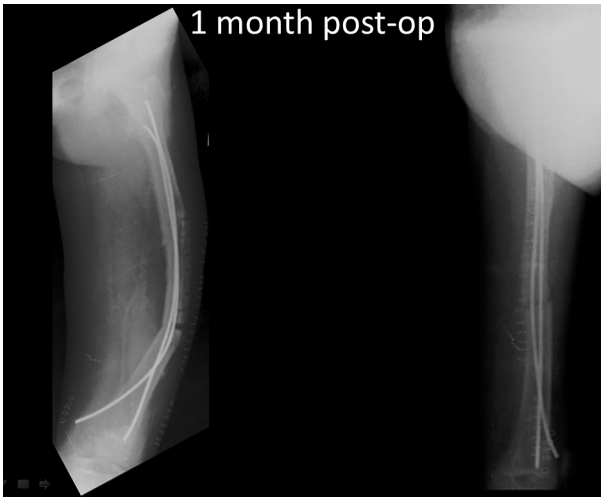

Figure 4. No callus formation can be seen at the fracture site.

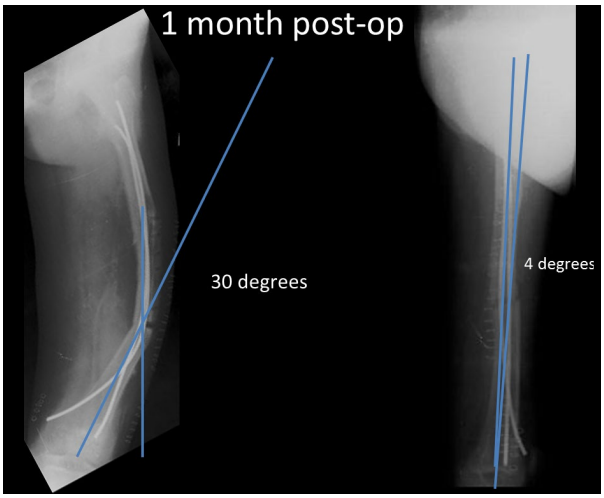

Figure 5. Silhouette of a shaft along the axis can be appreciated with no signs of significant mineralization or callus formation.

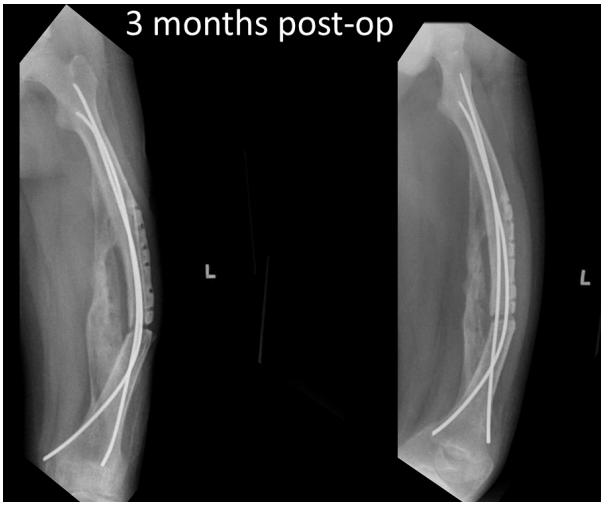

Figure 6. New bone formation along the mechanical axis of the left femur.

Figure 7. Callus formation gradually progressed and became more calcified.

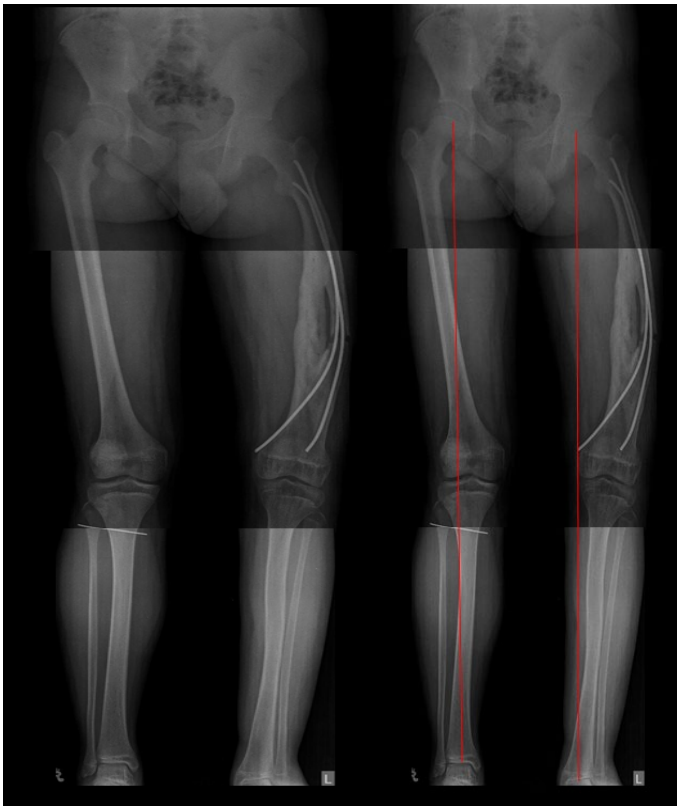

Figure 8. Progression of calcification in the newly formed shaft.

Figure 9. Nail removal and solidification of the newly formed shaft.

3. Operative Technique

The patient was positioned supine on a fracture table. General anesthesia was inducted and the surgical site was prep with povidone iodine solution. Lateral approach was done over the previous surgical scar. Careful dissection was made passing thru the inter-nervous plane, gaining access to the intermuscular septum which was incised to expose the bone. The periosteum was incised and dissected over the bone to expose and remove the broken implant. The fracture was reduced directly and was held in place using a bone clamp. Pre-bent 3.5 mm Titanium elastic nails were inserted 2 cm proximal to the distal physis using a T-handle and rotatory movement of the wrist. They were carefully pushed up and crossing the fracture site one at a time. However, there was difficulty pushing the lateral nail further because it was exiting out thru the screw holes of the previous implant. With the use of the T-handle, the lateral nail was probably twisted more than 90 degrees to avoid passing thru the screw holes and subsequently anchored to the proximal metaphysis pointing to the greater trochanter. The medial nail was carefully pushed up with ease and was anchored in the proximal metaphysis pointing to the lesser trochanter. The nails were cut and the tip was left slightly protruding to the bone for ease of removal. Knee immobilizer was used on the affected lower extremity post-operatively.

4. Discussion

Femoral shaft fractures are among the most common pediatric bony injuries that requires hospitalization. When subtrochanteric and supracondylar fractures are

included the femoral shaft fractures represents about 1.6% of all bony injuries in children [4]. Most femoral fractures in children are closed injuries and traditionally have been treated by conservative methods. The management of pediatric femoral fractures as noted by Galpin evolved gradually in the past decade toward operative approaches because of the desire for more rapid recovery and reintegration of patients, with recognition that prolonged immobilization can have negative effects on children [5].

Surgical options include internal fixation with a plate and screws via a traditional open or a minimally invasive approach, external fixation, elastic nail and even rigid nails for intramedullary fixation [6]. The fact that ESIN is a load sharing device that allows rapid mobilization, no risk for osteonecrosis, low risk for physical injury, reduced risk for refracture and prevents complications of prolonged immobilization, it has been used for most pediatric femoral fracture especially of aged 5 - 14 years old [5]. Careful adherence to the basic principle of ESIN must be followed in order to have a more stable construct. Three-point fixation must be achieved, that is: apex of the nail curvature must be at the fracture site, and both ends must be opposite to each other and well anchored in the proximal and distal metaphysis [7]. Because of the elastic properties of the nails, this system supports the biology of children's fracture healing by stimulating both periosteal and endosteal callus formation. Cutting or stripping the periosteum, which usually occurs with any open procedure, disrupts fracture biology and has a deleterious effect on healing, it slows down both the callus formation and rate of healing. This slow reparative processes, can in turn affect the length of the extremity by delaying the stimulation of growth associated with the healing process [7].

Over the past two decades the advantage of fixation of pediatric femoral shaft fractures by elastic stable intramedullary nails have been increasingly accepted. However, complications like pain at the nail entry site, inflammatory reaction, superficial/deep infection, proximal migration of nail, acute reactive synovitis, malunion/nonunion, post operative breakage of nail, have been well documented [2]. Radiographic malunion seen in our case is not a new complication, it was documented as one of a possible complication if the 3 point fixation is not achieved [8] Some patients may lead to re operation just to achieve union highlighting the importance of adherence to the ESIN fixation principle [8]. Integrity of the fracture site surrounding tissues including periosteum is necessary in order to provide the resources for bone regeneration. [9] Periosteum is a tough thin membranous fibrous tissue that covers the external surface of the bone. Their presence allows the bone to heal either by formation of new bone or cartilage and is greatly influenced by strain [10] Future studies looking if there is other possible alternative explanation for this unusual phenomena will be of great help in understanding the complexity and beauty of bone biology.

In our case, we had to strip off the periosteum during the removal of the broken plate and screws. After fixing this fracture with flexible intramedullary nail, varus angulation developed due to instability of our fixation. The periosteum remained

in its native position along the mechanical axis, while the bone progressed into varus angulation. This led to formation of new bone within the stripped periosteum away from the femoral shaft. The strain encountered within the periosteum resulted in formation of this new bone, uniting the proximal and distal fragments. This phenomenon is probably explained by Wolff's law wherein bone adapts its external shape and internal structure in response to the mechanical stress it is required to support [11].

5. Conclusion

The treatment of choice for pediatric femoral shaft fracture in children aged 5 - 14 years old is flexible intramedullary nail. Adherence to the three-point fixation technique is mandatory to achieve a stable construct and avoid complication like angulation or malunion. Several other complications have been well documented but formation of new bone in response to an unstable fixation with an elastic intramedullary nail is a rare occurrence and to our knowledge, the only reported case of such complication. However, this may also be the only complication that can give a positive effect on a pediatric patient with femoral shaft fracture fixed with an unstable construct.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Barry, M. and Paterson, J.M.H. (2004) Flexible Intramedullary Nails for Fractures in Children. *The Journal of Bone and Joint Surgery. British Volume*, **86**, 947-953. https://doi.org/10.1302/0301-620x.86b7.15273

[2] Sarkar, S., Bandyopadhyay, R. and Mukherjee, A. (2013) Titanium Elastic Nail—Complications in the Treatment of Paediatric Diaphyseal Fracture of Femur. *The Open Orthopaedics Journal*, **7**, 12-17. https://doi.org/10.2174/1874325001307010012

[3] Nisar, A., Bhosale, A., Madan, S.S., Flowers, M.J., Fernandes, J.A. and Jones, S. (2013) Complications of Elastic Stable Intramedullary Nailing for Treating Paediatric Long Bone Fractures. *Journal of Orthopaedics*, **10**, 17-24. https://doi.org/10.1016/j.jor.2013.01.003

[4] Lascombes, P., Nespola, A., Poircuitte, J.M., Popkov, D., de Gheldere, A., Haumont, T., *et al.* (2012) Early Complications with Flexible Intramedullary Nailing in Childhood Fracture: 100 Cases Managed with Precurved Tip and Shaft Nails. *Orthopaedics & Traumatology: Surgery & Research*, **98**, 369-375. https://doi.org/10.1016/j.otsr.2011.11.011

[5] Singh, P. and Kumar, R. (2012) Pediatric Femoral Shaft Fracture Management by Titanium Elastic Nailing; A Prospective Study of 112 Patients. *The Internet Journal of Orthopedic Surgery*, **19**. https://ispub.com/IJOS/19/3/14336

[6] Volpon, J.B., Perina, M.M., Okubo, R. and Maranho, D.A.C. (2012) Biomechanical Performance of Flexible Intramedullary Nails with End Caps Tested in Distal Segmental Defects of Pediatric Femur Models. *Journal of Pediatric Orthopaedics*, **32**, 461-466. https://doi.org/10.1097/bpo.0b013e318259fe31

[7] Dietz, H. and Schmittenbecher, P. (2006) AO Manual of Fracture Management.

Elastic Stable Intramedullary Nailing (ESIN) in Children. AO Publishing.

[8] Narayanan, U.G., Hyman, J.E., Wainwright, A.M., Rang, M. and Alman, B.A. (2004) Complications of Elastic Stable Intramedullary Nail Fixation of Pediatric Femoral Fractures, and How to Avoid Them. *Journal of Pediatric Orthopaedics*, **24**, 363-369. https://doi.org/10.1097/01241398-200407000-00004

[9] Neagu, T.P., Ţigliş, M., Cocoloş, I. and Jecan, C.R. (2016) The Relationship between Periosteum and Fracture Healing. *Romanian Journal of Morphology and Embryology*, **57**, 1215-1220.

[10] Prendergast, P.J. and Huiskes, R. (1995) The Biomechanics of Wolff's Law: Recent Advances. *Irish Journal of Medical Science*, **164**, 152-154. https://doi.org/10.1007/bf02973285

[11] Weinstein, S. and Buckwalter, J. (2005) Turek's Orthopaedics, Principles and Their Application. 6th Edition, Lippincott Williams & Wilkins, 19.