

Concomitant Tibia Shaft and Distal Triplane Fractures

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ABSTRACT

Concomitant tibia shaft fracture and triplane fracture of the distal tibia are very rare in the pediatric orthopaedic traumatology. The very limited number of cases in the world literature has all been documented in older children or adolescent patients. Appropriate diagnostic evaluation and treatment is required to minimize the incidence of delayed or missed diagnosis of the ankle injury, prevent complications and optimize outcomes of both fractures. A new case as well as an extensive review of the literature is presented in this editorial.

Key words: Concomitant; Ipsilateral; Tibia shaft; Triplane; Fracture

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EDITORIAL

Pediatric tibia shaft fracture is the third most common diaphyseal long bone fracture, next to the clavicle and forearm bones. It is also the third most common diaphyseal fracture after the femur and humerus in polytrauma pediatric patients^[1-7].

Physeal injuries have been reported to occur in approximately 15-30% of children's long bone fractures. Injuries to the physis of the distal tibia are the second most common growth plate injuries (17.8%) following those of the distal radius (29.6%), if physeal fractures involving the phalanges are excluded. Randsborg et al. have found that fracture rates differ between various physical activities. They reported that the distal part of the radius was the commonest fracture site (31.1%) for the most common childhood sport and recreational activities, while tibial shaft (4.8%) and ankle (3.6%) fracture rates accounted less than distal radius, hand, foot, distal humerus, clavicle and forearm fractures^[8-13].

Pediatric ankle physeal fractures are most commonly described by the Salter-Harris classification types. Classification schemes for adult ankle fractures, such as the anatomically-based Weber system and the mechanism-based Lauge-Hansen system, are not particularly useful in children. The Dias-Tachdjian classification is a mechanism-based pediatric ankle fracture classification system that is a synthesis of the Salter-Harris and Lauge-Hansen classifications^[14-16]. The correlation of the frequency of distal tibial physeal fractures with the Salter-Harris classification in the world literature confirms that the most common radiographic injury patterns are type II injuries^[17-20]. The results of two studies are presented. In the former, 376 children and adolescents were included. A group of 181 patients with a clinically diagnosed epiphyseal separation, having a negative x-ray (Salter-Harris type I), was excluded from the results and analysis. Subsequently, without respect to type I injuries, 113 (58%) with type II, 66 (33.8%) with type III and 16 patients (8.2%) with type IV fractures were diagnosed^[21]. In the latter, 96 distal tibia physeal fractures were included. The average age was 12 years and 8 months (range 2-17 years), but 71 were 11-14 years old. Using the Salter-Harris classification 12 type I, 42 type II, 30 type III and 12 type IV

fractures were diagnosed. There were also 4 triplane fractures and 7 Tillaux fractures^[22].

The pediatric triplane ankle fracture represents a unique spectrum of injury that does not fit neatly into the Salter-Harris classification of physeal injuries. This fracture is particular to the pediatric population and it is often termed a transitional injury. Transitional period refers to the time of epiphysiodesis from adolescent to skeletally mature bone. It is the result of the characteristic asymmetric closure of the distal physeal plate of the tibia, over a period of approximately 18 months, in children aged 12 to 15 years. Classically, this fracture appears as a Salter-Harris type III injury in the anteroposterior x-ray and as a type II injury on the lateral view. The triplane ankle fracture is a multiplanar injury, since it may incorporate fracture lines in the sagittal, coronal, and axial anatomical planes (corresponding to Salter-Harris fracture types II, III, and IV, respectively). The incidence, classification, treatment and outcome of triplane fractures have been extensively studied in the English literature^[23-31].

The application of external rotation and plantar flexion force on the foot in relation to the leg in adolescents forces the talus against the fibula and places the anterior inferior tibiofibular ligament under tension resulting in an avulsion fracture of the anterolateral epiphysis. This isolated Salter-Harris type III injury is referred as the biplane fracture of Tillaux. Further forcing of the foot may result in a triplane fracture of the distal tibia. Subsequently, the juvenile Tillaux and the triplane fractures were both included in the classification scheme developed by Diaz-Giegerich, which was based on created increasing forces, as stage I and stage II injuries, respectively. Stage III injuries were due to the transmission of still further external rotation forces and included a stage II injury associated with an ipsilateral spiral or oblique fracture of the fibula. Morgan and Jimenez considered that continued external rotation transmitted through the tibia may finally result in a stage II injury associated with an oblique fracture of the tibia shaft. They classified it as a new stage injury^[32-35].

In adults, distal tibia fractures associated with ipsilateral tibia shaft fractures, specifically distal one-third spiral type, are more prevalent than previously reported. The recognition of a distal one-third spiral pattern tibia shaft fracture had 88.6% sensitivity and 63.9% specificity for the presence of an ankle injury. The recognition of the associated ankle injury has been considered sufficiently important for proper preoperative planning and appropriate postoperative physical therapy. Recently, there has been increasing recognition and interest in the association of tibia shaft fractures and ipsilateral ankle injuries, although clinical studies have not sufficiently examined the clinical significance of this entity in adults^[36,37].

Unlike adults, the lesion is less reported in children and adolescents. Rapariz et al. found that 48% of triplane fractures were associated with a fractured fibula and 8.5% were associated with an ipsilateral tibia shaft fracture. Healy et al. reported a triplane fracture associated with a proximal fibula fracture and syndesmotic injury (Maisonneuve equivalent). Failure to detect this injury may lead to chronic instability^[38-41]. Recently a limited number of new cases suffering from ipsilateral tibia shaft and distal triplane fracture have been presented. They were all recorded in adolescents^[42-47].

We were also able to identify, from the hospital database, a single case with this rare concomitant injury. The patient was a 13-year-old boy that was referred for a left tibia fracture associated with an ankle fracture. The left leg twisting injury had occurred after stepping into a hole while running. No open lesions were noted. Neurovascular assessment revealed no abnormal findings. Plain radiographs showed an oblique fracture of the tibia shaft associated with an ipsilateral undisplaced Tillaux fragment and a posterior malleolar shear

fragment with an intact fibula (Figure 1A). The leg was immobilized in a long leg cast. A computed tomography (CT) scan was performed the next day. Both 2D-CT (Figure 1B) and 3D-CT (Figure 1C) scans were used in the imaging of the tibial and ankle fractures. There was no evidence of displacement bigger than 2 mm between the ankle fragments. The patient was then taken to theater and an above knee compression cast, with the tibia in valgus, was placed. The reduction of both the tibial and the triplane fracture was considered satisfactory. The patient was discharged on the seventh day post-injury after a satisfactory radiographic examination. He was then followed on an outpatient basis. Radiographs following a 2, 3 and 4 week-period post-injury showed satisfactory reduction of the tibial and ankle fractures. The plaster was removed 7 weeks post-injury, new radiographs were taken, and a below knee splint was applied for a further 2-week period. Radiographs at 3 months showed complete union of the fractured tibia. The triplane fracture was also well united with no disruption of the plafond of the tibia (Figure 1D).

The term complex triplane fracture has also been used to describe the ipsilateral triplane and diaphyseal shaft fracture in adolescents^[42]. This nomenclature is accurate, since it may be used to describe multiple fractures at several levels in a single bone. However, it may also be used to describe either an open/compound triplane fracture or a triplane fracture associated with comminution, cartilage injury, dislocation and bone loss. Therefore, the term concomitant or ipsilateral distal triplane and tibia shaft fracture was preferred in this report.

A high index of suspicion is required for diagnosis. Pediatric orthopaedic surgeons should be aware that tibia shaft fractures, especially oblique or spiral-type fractures, may occasionally be associated with ankle injuries, such as triplane fractures. Minimum appropriate imaging for tibia fractures should always include ankle radiographs. Computed tomography may be required to reveal the full extent of the ankle injury and the degree of displacement. Various reports have showed that CT has a definite impact on the triplane fracture classification, displacement measurement, and treatment planning. The primary goal in treatment is reduction of the joint surface. Growth disturbance is not a common issue, since the fracture occurs just prior to the closure of the physis. Closed reduction is successful if there is no more than 2 millimeters of displacement. Positive results following closed reduction of displaced triplane fractures with internal rotation and casting have been reported throughout the literature. Displaced transitional fractures with a fracture gap of more than 2 millimeters in the weight-bearing portion of the epiphysis require closed or open reduction^[39,48-52].

The ipsilateral presence of an oblique tibia shaft fracture may complicate the attempts at closed reduction of distal tibia triplane fractures in children and adolescents. Moreover, tibia shaft fractures with an intact fibula show a higher rate of delayed, non- and mal-union, in varus, than those with an associated fibular fracture^[53-57]. We usually offer patients with isolated fractures of the tibia a chance at closed treatment provided that there will be a careful radiographic follow-up of the patient, especially after a 2-4 week-period. During this period, displacement of the tibia fracture in the plaster is most likely due to the decreased swelling of the leg. In such cases a new compression cast with the conventional 3-point molding or cast wedging in valgus may be required.

The concomitant tibia shaft and distal triplane fracture in our patient occurred with an intact fibula. Morgan and Himenez^[35] suggested the inclusion of the triplane ankle fracture associated with tibia fracture in the classification scheme suggested by Dias-Tachdjian^[16] and modified by Dias-Giegerich^[32] as a new last stage



Figure 1 A 13-year-old boy injured his leg and ankle after a fall. The initial anteroposterior and lateral radiographs of the leg and ankle indicated an oblique tibia shaft fracture and a distal tibia triplane fracture (A). A CT scan, in a two-dimensional (2D) form, showed 3-4 millimeters of shortening and a minimal recurvatum deformity of the tibia fracture as well as an undisplaced triplane ankle fracture (B). The three-dimensional (3D) CT reformation form provided better perception of the pattern of the fracture lines (C). Radiographs recorded uneventful healing of the tibia and ankle fractures, following conservative treatment, 3 months post-injury (D).

injury. However, it may be prudent to consider fractures of the fibula or tibia associated with a concomitant either Tillaux^[58-60] or triplane ankle fracture in adolescents as a subtype of the same last stage injury, which previously included only an ipsilateral distal tibia triplane and a fibula fracture.

REFERENCES

- Shannak AO. Tibial fractures in children: follow-up study. *J Pediatr Orthop.* 1988; **8**(3): 306-10. [PMID: 3366890]
- Mashru RP, Herman MJ, Pizzutillo PD. Tibial shaft fractures in children and adolescents. *J Am Acad Orthop Surg.* 2005; **13**(5): 345-52. [PMID: 16148360]
- Setter KJ, Palomino KE. Pediatric tibia fractures: current concepts. *Curr Opin Pediatr.* 2006; **18**(1): 30-5. [PMID: 16470159]; [DOI: 10.1097/01.mop.0000192520.48411.fa]
- Gougoulas N, Khanna A, Maffulli N. Open tibial fractures in the paediatric population: a systematic review of the literature. *Br Med Bull.* 2009; **91**: 75-85. [PMID: 19474055]; [DOI: 10.1093/bmb/ldp019]
- Hedström EM, Svensson O, Bergström U, Michno P. Epidemiology of fractures in children and adolescents. *Acta Orthop.* 2010; **81**(1): 148-53. [PMID: 20175744]; [PMCID: PMC2856220]; [DOI: 10.3109/17453671003628780]
- Joeris A, Lutz N, Blumenthal A, Slongo T, Audigé L. The AO pediatric comprehensive classification of long bone fractures (PCCF). *Acta Orthop.* 2017; **88**(2): 129-32. [PMID: 27882811]; [PMCID: PMC5385105]; [DOI: 10.1080/17453674.2016.1258533]
- Patel NK, Horstman J, Kuester V, Sambandam S, Mounasamy V. Pediatric tibial shaft fractures. *Indian J Orthop.* 2018; **52**(5): 522-

8. [PMID: 30237610]; [PMCID: PMC6142797]; [DOI: 10.4103/ortho.IJOrtho_486_17]
8. Peterson CA, Peterson HA. Analysis of the incidence of injuries to the epiphyseal growth plate. *J Trauma*. 1972; **12**(4): 275-81. [PMID: 5018408]
9. Mizuta T, Benson WM, Foster BK, Paterson DC, Morris LL. Statistical analysis of the incidence of physeal injuries. *J Pediatr Orthop*. 1987; **7**: 518-23. [PMID: 3497947]
10. Mann DC, Rajmaira S. Distribution of physeal and nonphyseal fractures in 2,650 long-bone fractures in children aged 0-16 years. *J Pediatr Orthop*. 1990; **10**(6): 713-6. [PMID: 2250054]
11. Kawamoto K, Kim WC, Tsuchida Y, Tsuji Y, Fujioka M, Horii M, Mikami Y, Tokunaga D, Kubo T. Incidence of physeal injuries in Japanese children. *J Pediatr Orthop B*. 2006; **15**(2): 126-30. [PMID: 16436948]; [DOI: 10.1097/01.bpb.0000191874.69258.0b]
12. Randsborg PH, Gulbrandsen P, Saltytè Benth J, Sivertsen EA, Hammer OL, Fuglesang HF, Aroen A. Fractures in children: epidemiology and activity-specific fracture rates. *J Bone Joint Surg Am*. 2013; **95**(7): e42. [PMID: 23553305]; [DOI: 10.2106/JBJS.L.00369]
13. Mencio GA, Swiontkowski MF. Green's skeletal trauma in children. 5th ed. Elsevier Saunders, Philadelphia, 2015.
14. Lauge-Hansen N. Ligamentous ankle fractures; diagnosis and treatment. *Acta Chir Scand*. 1949; **97**(6): 544-50. [PMID: 18129346]
15. Salter RB, Harris WR. Injuries involving the epiphyseal plate. *J Bone Joint Surg Am*. 1963; **45**(3): 587-622.
16. Dias LS, Tachdjian MO. Physeal injuries of the ankle in children: classification. *Clin Orthop Relat Res*. 1978; **136**: 230-3. [PMID: 103673]
17. Kraus R, Herbst U, Perler G, Schnettler R, Röder C. Traumatic physeal separations of the distal tibia. Occurrence, forms, treatment strategies. *Unfallchirurg*. 2011; **114**(5): 403-10. [PMID: 21528395]; [DOI: 10.1007/s00113-011-1966-1]
18. Blackburn EW, Aronsson DD, Rubright JH, Lisle JW. Ankle fractures in children. *J Bone Joint Surg Am*. 2012; **94**(13): 1234-44. [PMID: 22760393]; [DOI: 10.2106/JBJS.K.00682]
19. Su AW, Larson AN. Pediatric ankle fractures: Concepts and treatment principles. *Foot Ankle Clin*. 2015; **20**(4): 705-19. [PMID: 26589088]; [PMCID: PMC4912125]; [DOI: 10.1016/j.fcl.2015.07.004]
20. Herman MJ, B Horn BD. Contemporary surgical management of fractures and complications. Volume 3: Pediatrics. Jaypee Brothers Medical Publishers, New Delhi, 2014.
21. Schurz M, Binder H, Platzer P, Schulz M, Hajdu S, Vécsei V. Physeal injuries of the distal tibia: long-term results in 376 patients. *Int Orthop*. 2010; **34**(4): 547-52. [PMID: 19662414]; [PMCID: PMC2903140]; [DOI: 10.1007/s00264-009-0851-9]
22. Melchior B, Badelon O, Peraldi P, Bensahel H. Epiphyseal fractures-dislocations of the lower extremity of the tibia. *Chir Pediatr*. 1990; **31**(2): 113-8. [PMID: 2268949]
23. Lynn MD. The triplane distal tibial epiphyseal fracture. *Clin Orthop Relat Res*. 1972; **86**: 187-90. [PMID: 4625879]
24. Spiegel PG, Mast JW, Cooperman DR, Laros GS. Triplane fractures of the distal tibial epiphysis. *Clin Orthop Relat Res*. 1984; **188**: 74-89. [PMID: 6467731]
25. Ertl JP, Barrack RL, Alexander AH, VanBuecken K. Triplane fracture of the distal tibial epiphysis. Long-term follow-up. *J Bone Joint Surg Am*. 1988; **70**(7): 967-76. [PMID: 3403587]
26. Dailiana ZH, Malizos KN, Zacharis K, Mavrodontidis AN, Shiamishis GA, Soucacos PN. Distal tibial epiphyseal fractures in adolescents. *Am J Orthop (Belle Mead NJ)*. 1999; **28**(5): 309-12. [PMID: 10333879]
27. El-Karef E, Sadek HI, Nairn DS, Aldam CH, Allen PW. Triplane fracture of the distal tibia. *Injury*. 2000; **31**(9): 729-36. [PMID: 11084162]
28. Rang M, Pring ME, Wenger DR. Rang's children's fractures. 3rd ed. Lippincott Williams & Wilkins, Philadelphia, 2005.
29. Nenopoulos SP, Papavasiliou VA, Papavasiliou AV. Outcome of physeal and epiphyseal injuries of the distal tibia with intra-articular involvement. *J Pediatr Orthop*. 2005; **25**: 518-22. [PMID: 15958907]
30. Schnetzler KA, Hoernschemeyer D. The pediatric triplane ankle fracture. *J Am Acad Orthop Surg*. 2007; **15**(12): 738-47. [PMID: 18063714]
31. Wuerz TH, Gurd DP. Pediatric physeal ankle fracture. *J Am Acad Orthop Surg*. 2013; **21**(4): 234-44. [PMID: 23545729]; [DOI: 10.5435/JAAOS-21-04-234]
32. Dias LS, Giegerich CR. Fractures of the distal tibial epiphysis in adolescence. *J Bone Joint Surg Am*. 1983; **65**(4): 438-44. [PMID: 6833316]
33. von Laer L. Classification, diagnosis, and treatment of transitional fractures of the distal part of the tibia. *J Bone Joint Surg Am*. 1985; **67**(5): 687-98. [PMID: 3997921]
34. Hoeffel JC, Lascombes P, Poncelet T, Najid A, Bretagne MC, Galloy MA, Bernard C. Biplane fracture of Tillaux. *Eur J Radiol*. 1989; **9**(4): 250-3. [PMID: 2512161]
35. Morgan JH Jr, Jimenez AL. Triplane fracture of the distal tibia with ipsilateral tibial shaft fracture: A case report. Chapter 56, 309-15, http://www.podiatryinstitute.com/pdfs/Update_2003/2003_56.pdf
36. Schottel PC, Berkes MB, Little MT, Lazaro LE, Nguyen JT, Helfet DL, Lorch DG. Predictive radiographic markers for concomitant ipsilateral ankle injuries in tibial shaft fractures. *J Orthop Trauma*. 2014; **28**(2): 103-7. [PMID: 23760178]; [PMCID: PMC4378526]; [DOI: 10.1097/BOT.0b013e31829e71ef]
37. Jung KJ, Chung CY, Park MS, Chung MK, Lee DY, Koo S, Lee KM. Concomitant ankle injuries associated with tibial shaft fractures. *Foot Ankle Int*. 2015; **36**(10): 1209-14. [PMID: 26041543]; [DOI: 10.1177/1071100715588381]
38. Peiró A, Aracil J, Martos F, Mut T. Triplane distal tibial epiphyseal fracture. *Clin Orthop Relat Res*. 1981; **160**: 196-200. [PMID: 7285424]
39. Rapariz JM, Ocete G, González-Herranz P, López-Mondejar JA, Domenech J, Burgos J, Amaya S. Distal tibial triplane fractures: long-term follow-up. *J Pediatr Orthop*. 1996; **16**(1): 113-8. [PMID: 8747367]
40. Healy WA 3rd, Starkweather KD, Meyer J, Teplitz GA. Triplane fracture associated with a proximal third fibula fracture. *Am J Orthop (Belle Mead NJ)*. 1996; **25**(6): 449-51. [PMID: 8798988]
41. Beatty JH, Kasser JR. Rockwood and Wilkins' fractures in children. 7th ed. Volume 3, Lippincott Williams & Wilkins, Philadelphia, 2010.
42. Jarvis JG, Miyanji F. The complex triplane fracture: ipsilateral tibial shaft and distal triplane fracture. *J Trauma*. 2001; **51**(4): 714-6. [PMID: 11586164]
43. Rico-Pecero J, Dwyer A. Triplane fracture of the ankle associated with homolateral tibial fracture in a teenager. A case report. *Revista Española de Cirugía Ortopédica y Traumatología (English Edition)*. 2009; **53**(4): 254-6. [https://doi.org/10.1016/S1988-8856\(09\)70174-9](https://doi.org/10.1016/S1988-8856(09)70174-9)
44. Sprenger De Rover WB, Alazzawi S, Hallam PJ, Walton NP. Ipsilateral tibial shaft fracture and distal tibial triplane fracture with an intact fibula: a case report. *J Orthop Surg (Hong Kong)*. 2011; **19**(3): 364-6. [PMID: 22184172]; [DOI: 10.1177/230949901101900321]
45. Strelzow J, Aarvold A, Reilly CW. Triplane Fracture of the proximal tibia: A case report and literature review. *Hindawi Case Reports in Orthopedics*. 2017; Article ID 6490728, 4 pages.; [DOI: 10.1155/2017/6490728]
46. Kasture S, Azurza K. Triplane ankle fracture with concomitant ipsilateral shaft of tibia fracture: Case report and review of

- literature. *Journal of Orthopaedic Case Reports*. 2017; **7(3)**: 84-7.
47. Holland TS, Prior CP, Walton RD. Distal tibial triplane fracture with ipsilateral tibial shaft fracture: A case series. *Surgeon*. 2018; pii: S1479-666X(18)30038-6. [PMID: 29666001]; [DOI: 10.1016/j.surge.2018.03.004]
 48. Kärholm J. The triplane fracture: four years of follow-up of 21 cases and review of the literature. *J Pediatr Orthop B*. 1997; **6(2)**: 91-102. [PMID: 9165437]
 49. Crawford AH. Triplane and Tillaux fractures: is a 2 mm residual gap acceptable? *J Pediatr Orthop*. 2012; **32 Suppl 1**: S69-73. [PMID: 22588107]; [DOI: 10.1097/BPO.0b013e31824b25a1]
 50. Tan AC, Chong RW, Mahadev A. Triplane fractures of the distal tibia in children. *J Orthop Surg (Hong Kong)*. 2013; **21(1)**: 55-9. [PMID: 23629989]; [DOI: 10.1177/230949901302100115]
 51. Nenopoulos A, Beslikas T, Gigis I, Sayegh F, Christoforidis I, Hatzokos I. The role of CT in diagnosis and treatment of distal tibial fractures with intra-articular involvement in children. *Injury*. 2015; **46(11)**: 2177-80. [PMID: 26250713]; [DOI: 10.1016/j.injury.2015.07.017]
 52. Eismann EA, Stephan ZA, Mehlman CT, Denning J, Mehlman T, Parikh SN, Tamai J, Zbojniec A. Pediatric triplane ankle fractures: Impact of radiographs and computed tomography on fracture classification and treatment planning. *J Bone Joint Surg Am*. 2015; **97(12)**: 995-1002. [PMID: 26085533]; [DOI: 10.2106/JBJS.N.01208]
 53. Teitz CC, Carter DR, Frankel VH. Problems associated with tibial fractures with intact fibulae. *J Bone Joint Surg Am*. 1980; **62(5)**: 770-6. [PMID: 7391100]
 54. Yang JP, Letts RM. Isolated fractures of the tibia with intact fibula in children: a review of 95 patients. *J Pediatr Orthop*. 1997; **17(3)**: 347-51. [PMID: 9150024]
 55. Gordon JE, O'Donnell JC. Tibia fractures: what should be fixed? *J Pediatr Orthop*. 2012; **32 Suppl 1**: S52-61. [PMID: 22588105]; [DOI: 10.1097/BPO.0b013e318254c7be]
 56. Canavese F, Botnari A, Andreacchio A, Marengo L, Samba A, Dimeglio A, Pereira B, Mansour M, Rousset M. Displaced tibial shaft fractures with intact fibula in children: Nonoperative management versus operative treatment with elastic stable intramedullary nailing. *J Pediatr Orthop*. 2016; **36(7)**: 667-72. [PMID: 26151246]; [DOI: 10.1097/BPO.0000000000000528]
 57. Stenroos A, Laaksonen T, Nietosvaara N, Jalkanen J, Nietosvaara Y. One in three of pediatric tibia shaft fractures is currently treated operatively: A 6-year epidemiological study in two university hospitals in Finland Treatment of pediatric tibia shaft fractures. *Scand J Surg*. 2018; **107(3)**: 269-74. [PMID: 29291697]; [DOI: 10.1177/1457496917748227]
 58. Kump WL. Vertical fractures of the distal tibial epiphysis. *Am J Roentgenol Radium Ther Nucl Med*. 1966; **97(3)**: 676-81. [PMID: 5927611]
 59. Cox PJ, Clarke NM. Juvenile Tillaux fracture of the ankle associated with a tibial shaft fracture: a unique combination. *Injury*. 1996; **27(3)**: 221-2. [PMID: 8736303]
 60. Peterson HA. Epiphyseal growth plate fractures. Springer-Verlag, Berlin Heidelberg, 2007.

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