Journal of Advances in Medicine and Medical Research

22(11): 1-10, 2017; Article no.JAMMR.32863
Previously known as British Journal of Medicine and Medical Research
ISSN: 2231-0614, NLM ID: 101570965

Corrective Osteotomy for Residual Lower Extremity Deformities Following Healed Rickets: A Retrospective Study in a Rural Hospital among Nigerian Children

D. D. Mue[1*], P. Denen-Akaa[1], M. N. Salihu[2], W. T. Yongu[1], J. N. Kortor[1], I. C. Elachi[1], I. T. Annongu[1], J. O. Donwa[2] and D. G. Mancha[3]

[1]Department of Surgery, Benue State University, Makurdi, Nigeria.
[2]Department of Clinical Services, National Orthopaedic Hospital Dala, Kano, Nigeria.
[3]Department of Orthopaedics and Trauma, University of Jos, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author DDM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PDA, MNS and WTY managed the analyses of the study and reviewed the intellectual content. Authors JNK and ICE managed the literature searches. Authors ITA, JOD and DGM reviewed the intellectual content. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2017/32863
Editor(s):
(1) Panagiotis Korovessis, Chief Orthopaedic Surgeon, Orthopaedic Department, General Hospital "Agios Andreas" Patras, Greece.
Reviewers:
(1) Shubhangi V. Agale, Grant Medical College, India.
(2) Danladi Sambo Amaza, Kaduna State University, Nigeria.
(3) Kenan Koca, Gulhane Military Medicine Academy, Turkey.
(4) Sainath K. Andola, M. R. Medical College, India.
Complete Peer review History: http://www.sciencedomain.org/review-history/20105

Original Research Article

Received 20th March 2017
Accepted 8th July 2017
Published 18th July 2017

ABSTRACT

Background: Rickets is the clinical manifestation of a failure of calcification of bone matrix in growing children. Although treatment of rickets is medical, residual deformities following healed/ burnt out rickets may exist requiring surgical correction.
Objective: To determine the pattern of presentation and outcome of corrective osteotomy in children with residual lower extremity deformities following healed rickets in a rural hospital.
Methods: Retrospective data was obtained over a 5 year period from January 2010 to December

**Corresponding author: E-mail: mue.daniel@yahoo.com;*

2015. All patients 0-18 years who presented in Nongu u Krestu u i ser u Sha Tar (NKST) rehabilitation hospital Mkar, North- Central Nigeria with residual lower extremity deformities following healed rickets who had corrective osteotomy were included. Thirty eight patients met the inclusion criteria. Data was analysed using SPSS version 21.

Results: The mean age was 8.5±3.1 years. There were 21(55.3%) males and 17(44.7%) females with a male to female ratio of 1.2:1. The commonest pattern of presentation of residual deformity following healed rickets was knock knee deformity occurring in 21 (55.3%) patients. Corrective osteotomy was the main form of treatment. Sixteen (41.0%) patients commenced full weight bearing at 9-12 weeks. The commonest post op complications encountered was recurrence in 2(5.3%) and delayed union in another 2(5.3%) patients.

Conclusion: Knock knee deformity was the commonest residual lower extremity angular deformities following healed rickets in our environment. Recurrence and delayed union were the commonest complications encountered following corrective osteotomy. It was therefore recommended that careful patient selection, proper preoperative planning and meticulous surgical technique are vital in order to achieve satisfactory lower limb alignment, restore lower extremity function and ameliorate morbidity.

Keywords: Healed rickets; residual lower extremity angular knee deformity; corrective osteotomy; outcome.

1. INTRODUCTION

Rickets is the clinical manifestation of failure of calcification of bone matrix in growing children due to deficiency or impaired metabolism of vitamin D, phosphorus or calcium [1,2]. This softens the bone and permits marked bending and distortion of bones leading to fractures and deformity [1-4].

The most dramatic presentation of rickets involves changes in the musculoskeletal system. Indeed, it represents an important cause of angular deformity of the knee in children. Previous studies [5,6] suggest it to be the commonest cause of angular knee deformity in children.

It is generally not known which type of deformity represents the most usual form of presentation of residual angular knee deformity following healed or burnt out rickets. Current literature suggests that the age of onset of rickets usually determine the nature of deformity at presentation [5-7].

Treatment of rickets is medical, however, residual deformities following healed rickets may exist requiring surgical correction. Although guided growth or growth modulation is emerging as the treatment of choice in the growing child [7,8], corrective osteotomy is still the mainstay for severe residual angular deformities for healed rickets in our environment [9,10]. It is however a major surgical intervention with operative site morbidity and prolonged therapy that requires internal or external fixation and restricted weight-bearing which are the main drawbacks of this surgery. Osteotomies, especially of the proximal tibia, are high-risk surgeries, with a small but significant incidence of compartment syndrome, neurovascular injury, and overcorrection or under correction, delayed union or nonunion [9-11].

There is paucity of data upon which to base guidelines on the management of residual lower extremity angular deformities in healed rickets in our environment. This retrospective study determined the most common form of presentation of healed rickets and the outcome of corrective osteotomy of residual lower extremity angular deformities in a rural hospital.

2. MATERIALS AND METHODS

This is a 5 year retrospective descriptive study conducted in u Krestu u i ser u Sha Tar (NKST) rehabilitation hospital Mkar, Middle Belt Region-Nigeria from January, 2010 to December, 2015. All records of children 0- 18 years old with clinically, biochemical and radiographic diagnosis of residual lower extremity angular deformities following healed rickets that had surgical correction were reviewed. Thirty eight children met the required criteria for the study. Patients with active or florid rickets, lower extremity angular deformity from other causes such as (Blount's disease, trauma, infection, physiological and idiopathic), those greater than 18 years and those with incomplete data were excluded from the study.

Fig. 1. Florid rickets- indistinctness of the metaphyseal margin, progressing to widening and irregularity of the growth plate ("fraying") Weight bearing & stress on uncalcified bone gives rise to widening of the metaphyseal end of the bone ("splaying"), concavity of the metaphysis ("cupping") and bilateral genu valgus deformity

Pre operatively, supplemental Calcium 2 g daily, vitamin D 1000IU daily, cod liver oil 10 mls twice daily and nutritional rehabilitation were used in the treatment of florid rickets for 4-6 months according to hospital protocol until progressive reversion towards normality of the biochemical and radiological pattern was noted. Radiological criteria for the diagnosis of healed or burnt out rickets was according to Lovette's Radiological Staging. In Stage I: Acute Stage (Early) Epiphysis shows cloudy appearance, poorly defined margin, ≥1 indistinct ossification centre. Metaphysis reveal Splaying and osteopenia. Periosteum is thickened and there may be Fracture of long bones. In Stage II: (Established Stage) Epiphysis shows Mottled, irregular, ill-defined margins. Metaphysis reveal *Splaying & Cupping*, Widening; Margin irregular & ragged-*Fraying* Periosteum- is Normal but if bowing of bone then it is thickened on concave side. In Stage III: Stage of Repair (Healing stage) Epiphysis becomes well defined and denser with distinct ossification center. Bending deformity gradually subsides with continued growth. In Stage IV (Completely Repaired) metaphyseal margins become distinct; growth plate becomes narrow and regular Signifying completely healed & Burnt -out Rickets.

Fig. 2. Healed rickets 6 months after treatment with calcium and vitamin D supplement- metaphyseal margins become distinct; growth plate becomes narrow and regular with residual valgus deformity

Corrective osteotomy was carried out in Lovette's stage III (stage of repair) and stage IV (stage of complete repair) (Fig. 2). All affected limbs were operated under general anesthesia using standard procedures.Medial based closing wedge osteotomy of the distal femur in case of genu valgum and lateral based closing wedge osteotomy of proximal tibia in case of genu varus deformity. In all cases appropriate size wedge (1 cm for every degree of correction) was removed and attempts at slight over correction achieved.Those with bilateral affectation had correction at the same sitting. Post-operatively, correction was maintained by an above knee plaster of Parie cast in case of tibia osteotomy and long above knee cast in case of distal femoral osteotomy with an attempt at slight overcorrection was achieved. Additional stabilization with smooth crossed K- wires was required for older children to prevent

displacement when the hinge of intact cortex and periosteum at the apex of the wedge is inadvertently compromised. Where deformity was severe greater than 20°, full correction was achieved after 2 weeks when stitches were removed as a 2nd stage procedure. Limbs were elevated and physiotherapy was commenced early; active range of motion exercises of the toes to the limit of pain tolerance within 24 hours. Over a variable period of 6-8 weeks, graded mobilization was commenced with bilateral axillary crutches with plaster of Paris cast insitu. Plaster of Paris cast was removed and full weight bearing was commenced when there was clinical and radiological evidence of union. The patients were followed up and all complications were recorded.

The variables studied included; Age at presentation, sex, type of angular knee deformity, limbs affected, surgical treatment and complications. The data were analyzed using Microsoft excel and Statistical Programme for Social Sciences (SPSS) version 21.

3. RESULTS

Complete records were available for thirty eight children with burnt out rickets out of 107 children with lower extremity angular deformities during the study period with a prevalence rate of 35.5%. The mean age was 8.5±3.1 years. There were 21(55.3%) males and 17(44.7%) female with a male to female ratio of 1.2:1. Nineteen (50.0%) patients were below 5 years of age, 5(13.2%) patients were 6-10 years, 10(26.4%) patients were between 11-15 years and 4(10.5%) patients were between 16-18 years of age (Table 1).

Table 1. Showing age distribution of residual deformity following burnt out / healed rickets

Age grade (years)	Frequency	Percentage (%)
0-5	19	50.0
6-10	5	13.2
11-15	10	26.4
16-18	4	10.5

Twenty nine (76.3%) patients had bilateral limb affectation while 9(23.7%) had unilateral pathology of whom 8(21.1%) were right limb and 1(2.6%) was left (Table 2).

The commonest residual deformity was knock knee in 21(55.3%) patients followed by windswept deformity in 15(39.5%) patients, genu recurvatum in 1(2.2%) patient and genu varus deformity with anterior tibia bowing in 1(2.2%) patient (Table 3 and Fig. 3).

Table 2. Showing laterality of residual deformity following burnt out / healed rickets

Laterality	Frequency	Percentage (%)
Left side	1	2.6
Right side	8	21.1
Bilateral	29	76.3

Table 3. Showing pattern of presentation of residual deformity following burnt out / healed rickets

Deformity	Frequency	Percentage (%)
Knock knees	21	55
Varus	15	39
Windswept	1	3
Genu recurvatum	1	3

All patients had corrective osteotomy. Postoperatively, all limbs were immobilized with plaster of Paris and 22(59.5%) patients required additional stabilization with crossed smooth K-wires (Figs. 4 and 5). Removal of cast and commencement of full weight bearing was began at 6-8 weeks in 10(26.3%) patients, 9-12 weeks in 16(41.0%) patients, 13-14 weeks in 9(23.7%) patients and greater than 14 weeks in 3(7.7%) patients.

Complication rate was 15.8% of which recurrence occurred in 2(5.3%) patients, delayed union in 2 (5.3%) patients, surgical site infection in one (2.6%) patient and inadequate correction 1(2.6%) patient (Fig. 6).

4. DISCUSSION

Multiplanar bone deformities due to healed rickets may develop in young age and indications for surgical intervention appear early [11-14]. Deformities of lower limbs should be surgically corrected for biomechanical conditions, and to prevent early osteoarthritis of hip and knee joints [15-18].

There was a male preponderance of healed rickets in this study with a male: female ratio of 1.2:1. This is in similar to previous studies by Bafor et al. [5] with male:female ratio of 1.8:1 and Solagberu [19] with male:female ratio of 1.1:1. The significance of gender in the etiology of rickets remains yet to be ascertained, more so with variation in results from different studies [5,6,12-15].

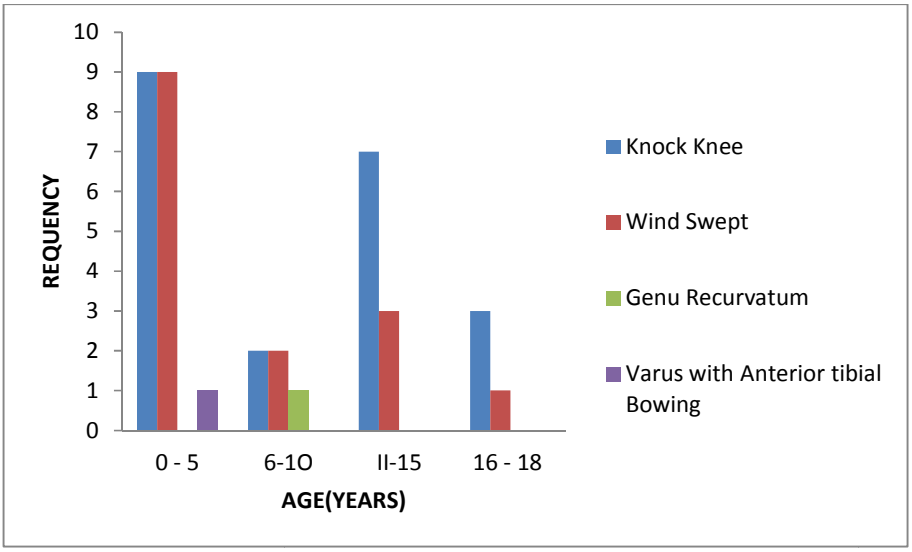

Fig. 3. Bar chart showing age versus pattern of presentation of residual deformity following healed rickets

Fig. 4A. Anteroposterior view of immediate post-operative radiograph demonstrating distal femoral medial based closing wedge osteotomy with slight overcorrection for bilateral genu valgus deformity stabilized by percutanous crossed K wires and Plaster of Paris external support

Fig. 4B. Anteroposterior view at 6weeks follow up demonstrating complete healing of distal femoral medial based closing wedge osteotomy (Right)

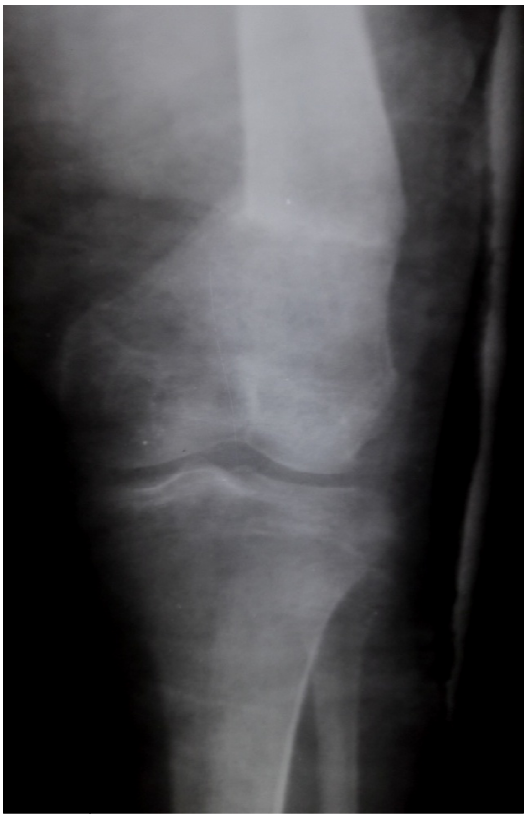

Fig. 4C. Anteroposterior view at 6 weeks follow up demonstrating complete healing of distal femoral medial based closing wedge osteotomy (Left)

Genu valgus was the commonest 25(55.6%) residual deformity following healed rickets (Table 3). This is in keeping with Solagberu [19] who found valgus deformity in 32(44%) of patients but at variance with Bafor et al. [5] who found windswept deformity to be the commonest type of angular knee deformity. Bone softening conditions such as rickets affect the entire epiphyseal plate and can cause varus or valgus knee deformities. Usually the direction of the deformity is dependent on the child's alignment at the onset of the condition suggesting a contribution by weight bearing to the pattern of deformity. The age at the onset of the pathology may also be a major determining factor in the type of deformity that results. Onset of vitamin D deficiency or vitamin D resistant rickets during the "bow-leg phase" will lead to more pathologic bowing. Genu valgus is typically associated with renal osteodystrophy because the onset of chronic renal disease generally occurs while children are in the valgus phase. Patients with windswept deformity usually have only one of the bone diseased (usually the valgoid limb) the other appear to be compensating for the ensuing reduction in height of the patient [7].

All patients had surgical correction - high tibial osteotomy for genu varus and supracondylar osteotomy in the femur for genu valgus (Figs. 4 and 5). Operative correction is indicated if tibiofemoral angle is more than 15 degrees, persistent or worsening deformity despite adequate brace treatment and development of ligament laxity [20,21]. Genu valgus in children younger than seven years of age may be safely ignored unless the tibiofemoral angle is greater than 15°, the valgus is progressive, unilateral, and symptomatic or accompanied by shortened stature [19-21].

Complication rate following corrective osteotomy was 15.8%. This is at variance with Spahn et al. [22] who reported complication rate of 43.6% following his review of 85 corrective osteotomies. Majority of their complications were from hard ware failure and from lateral cortex fractures. Miller et al. [23] reported a complication rate of

36.9%. Majority of which were from loss of correction (15.2%) and hardware failure (10.5%) following opening wedge osteotomy. Closing wedge osteotomy as observed in this study offers better stability and the use of percutanous crossed K wires obviates the need for a second surgical procedure for implant removal (Figs. 4 and 5). Stability is further augmented by Paris external support. The broad surface contact and stability offered by this technique prevent excessive movement and displacement at the osteotomy site and allows for early unions and consolidations therefore, decreasing the duration of postoperative immobilization and chances of hard ware failure.

Recurrence of deformity which occurred in 2(5.3%) patients. Hae-Ryong et al. [24] had recorded higher (10-15%) recurrence rate in their study and advocated that intramedullary nail method can prevent progressive recurrent deformity at the diaphysis. Wilson et al. [25] reported that recurrence is higher in younger age group and Ferris et al. [26] emphasized that it is more beneficial to perform a metaphyseal osteotomy near maturity. Recurrence of skeletal deformity is common in patients with continued metabolic pathology, so medical treatment should be adjusted before and continued after corrective osteotomy in the growing child. Slight over-correction is also recommended to minimize this problem (Figs. 4 and 5).

Surgical site infection occurred in 1(2.6%). This is at variance to previous studies by Wilson et al. [25] and Spahn et al. [22] who reported surgical site infection rate of 4.4% and 4.7% respectively. This was superficial surgical site infection and

Fig. 5A. Anteroposterior view of immediate post-operative radiograph demonstrating proximal tibial lateral based closing wedge osteotomy with slight overcorrection for genu varus deformity stabilized by percutanous crossed K wires and Plaster of Paris external support

Fig. 5B. Anteroposterior view at 6 months followup demonstrating complete healing of proximal tibial lateral based closing wedge osteotomy

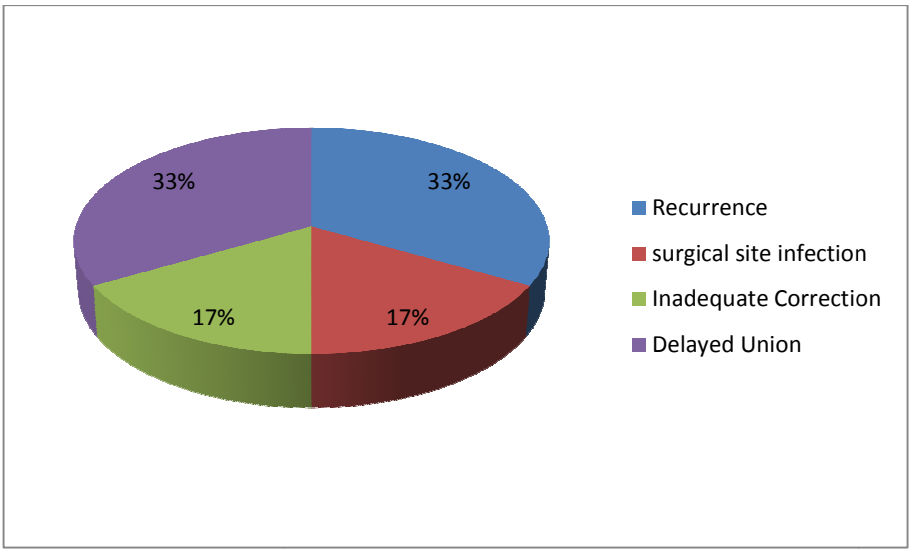

Fig. 6. Pie chart illustrating complications following corrective osteotomy for residual deformity following burnt out rickets

was treated by removal of alternate stitches, daily wound dressing and antibiotics therapy according to sensitivity pattern. Infection is kept low by proper preoperative preparation, proper hemostasis and adequate drainage of wound, avoidance of tension along the suture line during full correction and general measures for keeping operation room clean- by use of impervious drapes, routine use of prophylactic antibiotic and keeping such patients in the ward away from the infected patients.

Inadequate correction was encountered in 1 (2.6%) patient. Appropriate size wedge (1cm for every degree of correction) was removed and an attempt at slight over correction was achieved. Siffert et al. [27] in their study advocated that intraoperative image guide may be helpful in ensuring satisfactory correction internal tibial torsion must also be corrected with the osteotomy. The advent of computer navigation [28] in surgery has helped to address this where facilities exist. Despite the numerous conventional techniques available there is no single technique that can reliably determine the value of the intraoperative correction achieved. This complication is kept low by accurate and meticulous preoperative planning and judicious reproduction of the preoperative plan intraoperatively [27].

5. CONCLUSION

Residual Lower extremity angular deformity is the most dramatic presentation of healed rickets in our environment. Bilateral affectation was found in majority of patients and Knock knee deformity was the commonest pattern of presentation. Recurrence and delayed union were the commonest complications encountered following corrective osteotomy.

6. RECOMMENDATIONS

Medical treatment should be adjusted before and continued after corrective osteotomy in the growing child. Careful patient selection, proper preoperative planning and meticulous surgical technique are vital in order to achieve satisfactory lower limb alignment, improve lower extremity function and ameliorate morbidity.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENT

We wish to appreciate Dr. James Ior and the management of NKST rehabilitation hospital Mkar, Benue state-Nigeria for their substantial support towards data acquisition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ann Prentice, et al. Vitamin D deficiency and its health consequences in Africa. Clin Rev Bone Miner Metab. 2009;7(1):94–106.
2. Rajakumar Kumaravel. Vitamin D, cod-liver oil, sunlight, and rickets: A historical perspective. Pediatrics. 2003;112(2):132–135.
3. Vieth R. Vitamin D supplementation, 25-hydroxyvitamin D concentrations, and safety. The American Journal of Clinical Nutrition. 1999;69(5):842–56.
4. Gartner LM, Greer FR. Prevention of rickets and vitamin D deficiency: New guidelines for vitamin D intake. Pediatrics. 2003;111(41):908–10.
5. Bafor A, Ogbemudia AO, Umebese PFA. Epidemiology of angular deformities of the knee in children in Benin. Sahel Medical Journal. 2008;11(4):114-117.
6. Salawu SAI. Knock knees and bow legs in Zaria. Orient Journal of Medicine. 2009;4: 69- 72.
7. Jae HY, In HC, Tae-Joon C, et al. Development of tibiofemoral angle in Korean children. J Korean Med Sci. 2008; 23(4):714–717.
8. Pretkiewicz AE. Knock knee and the gait of six-year-old children. J Sports Med Phys Fitness. 2003;43:156–164.
9. Metcalf MH, Barrett GR. Prospective evaluation of 1485 meniscal tear patterns in patients with stable knees. Am J Sports Med. 2004;32:675–680.
10. Tanamas S, Hanna FS, Cicuttini FM. Does knee malalignment increase the risk of development and progression of knee osteoarthritis? A systematic review, Arthritis Rheum. 2009;61:459–467.
11. Pinkowski JL, Weiner DS, Complications in proximal tibial osteotomies in children with presentation of technique. J Pediatr Orthop. 1995;15:307–312.
12. Omololu B, Tella A, Ogunlade SO, Adeyemo AA, Adebisi A, Alonge TO, Salawu SA, Akinpelu AO. Normal values of knee angle, intercondylar and intermalleolar distances in Nigerian children. West African Journal of Medicine. 2003;22:4:301.
13. Akpede GO, Omotara BA, Ambe JP. Rickets and deprivation: A Nigerian study. J R Soc Promotion Health. 1999;119:216-222.
14. Keller Kathy A, Barnes Patrick D. Rickets vs. abuse: A national and international epidemic. Pediatric Radiology. 2008; 38(11):1210–1216.
15. Thacher TD, Fischer PR, Tebben PJ, et al. Increasing incidence of nutritional rickets: A population based study in Olmsted County, Minnesota. Mayo Clin Proc. 2013;88:176–183.
16. Brandi L, et al. 1alpha(OH)D3 One-alpha-hydroxy-cholecalciferol--an active vitamin D analog. Clinical studies on prophylaxis and treatment of secondary hyperparathyroidism in uremic patients on chronic dialysis. Dan Med Bull. 2008;55(4): 186-210.
17. Okonofua F, Gill DS, Alabi ZO, Thomas M, Bell JL, Dandona P. Rickets in Nigerian children: A consequence of calcium malnutrition, Metabolism. 1991;40:209-213.
18. Oginni LM, Sharp CA, Badru OS, Risteli J, Davie MW, Worsfold M. Radiological and biochemical resolution of nutritional rickets with calcium, Arch Dis Child. 2003;88:812-817.
19. Solagberu BA. Angular deformities of the knee in children. Nigerian Journal of Surgical Research. 2000;2:62-67.
20. Hanson LI, Zayer M. Physiological Genu Varum. Acta. Orthop. Scand. 1975;46:221-229.
21. Smith SL, Beckish ML, Winters SC, et al. Treatment of late-onset Tibia Vara using afghan percutaneous osteotomy and orthofix external fixation. Journal of Pediatric Orthopaedics. 2000;20(5):606-610
22. Spahn G. Complications in high tibial (medial opening wedge) osteotomy. Arch Orthop Trauma Surg. 2003;124(10):649–653.
23. Miller BS, Downie B, McDonough B, Wojtys EM. Complications after medial opening wedge high tibial osteotomy. Arthroscopy. 2009;25(6):639–646.
24. Hae-Ryong S, Soma RV, Satish K, Soek-Hyun L. Deformity correction by external fixation and/or intramedullary nailing in hypophophataemic rickets. Acta Rthopaedica. 2006;77(2):307-314.

25. Wilson AD, Luciano RP, André MC, Rodrigo PS, Márcio AC, Márcio RS. Complications following medial opening wedge osteotomy of the knee: Retrospective study. Rev Bras Ortop. 2011;46(1):64–68.
26. Ferris B, Walker C, Jackson A, Kuwan E. The orthopaedic management of hypophosphataemic rickets. J Pediatric Orthop. 1991;11:367-73.
27. Siffert RS, Katz JF. The intra-articular deformity in osteochondrosis deformans tibiae. J. Bone and Joint Surg. 1970;52: 800-804.
28. Pape D, Seil R, Adam F, Rupp S, Kohn D, Lobenhoffer P. Imaging and preoperative planning of osteotomy of tibial head osteotomy. Orthopade. 2004;33: 122–134.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20105