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Research Article

Outcomes of Temporary Hemiepiphyseal Stapling for Correcting Genu Valgum in Children

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Abstract

Purpose: The purpose of this study was to assess femoral distal hemi-epiphysiodesis using staple in order to correct valgus angular deformities of the knee in pediatric.

Methods: This is a retrospective study longitudinal study in which our experience with 24 patients is described.

Results: There are 16 boys, and 8 girls, we evaluated 48 knees surgically managed for pathologic genu valgum over a 36 months period. The average age at surgery for boys and girls was 14 years and 7 months (range 12.7 - 15.1 years) and 12 years and 9 months (range 11.2 - 13.8 years), respectively. The presurgical tibiofemoral (T-F) angle was measured at between 14° and 34°, and the postoperative T-F was measured at between 6° and 12° (7.2° ± 0.65, mean ± standard deviation), for an average correction of 0.73 ± 0.45 per month). The average surgical timing was 28 min for each knee (range 20.2 - 36.8 min). Average bleeding was 10 ml. The mean follow-up after surgery was 3.6 years (range 2.4 - 5.9 years). There were no complications, such as vascular injuries, infection, chondrolysis or compartment syndrome. The mean follow-up after surgery was 3.6 years (range 2.4 - 5.9 years).

Conclusion: We demonstrate a simple, fast and reproducible surgical technique for staple epiphysiodesis with low morbidity, rapid rehabilitation and a rapid return to school and sports activities. We experienced no complications, such as overcorrection, undercorrection, postoperative hematoma or infection. And we conclude that staple epiphysiodesis is an excellent option for the treatment of genu valgum in children.

Keywords: *Cannulated Screw; Genu Valgus; Angular Deformity; Percutaneous; Epiphysiodesis; Transphyseal Screws*

INTRODUCTION

Idiopathic genu valgum, commonly known as “knock knees”, is observed frequently in adolescence, as a temporary finding, and rarely requires surgical correction [1]. Normal alignment of the lower extremities includes equal leg length, with the mechanical axis of the leg bisecting the knee when the patient stands upright with the patella facing forward. This position places relatively balanced forces on the medial and lateral compartments of the knee as well as on the collateral ligaments, while the patella remains stable and centered in the femoral groove. When we refer to the femur-tibia angle, we are describing the angle determined by the mechanical axis of the femur intersecting the mechanical axis of the tibia.

In 1993, Phemister [2] described the first method of epiphyseal surgery. He created a bony bridge across the body by removing a rectangular segment of bone medially and laterally, including a small asymmetrical portion of the metaphysis and epiphysis on either side of the body, then reattach the bone fragment in the opposite direction, resulting in formation. of a bone bridge. This epiphysectomy is permanent and requires accurate prediction of remaining growth. It requires medial and lateral exposure, protected postoperative loading, and postoperative rehabilitation.

In 1945, after studies in animals and then in children, Haas [3] proposed to prevent the growth of the body with nails. He could see that after removal of the nails, longitudinal growth was reestablished, suggesting new methods for treating dystonia and angular deformities of the limbs. Then, in 1949, Blount and Clarke [4] presented a method that included a 5 to 8 cm long longitudinal incision to place a surgical pin across the growth plate on the convex side of the deformity. The purpose of this procedure is to prevent the development of underpinning and to allow gradual correction of angular deformities. These authors concluded that three types of pins should be used secondary to the high rate of complications, including loss of fixation and metal failure due to pin fracture. In 1979, Zuege [5] reported that stapled epiphyseal fusion was an effective and safe technique for treating angular deformities in the lower extremity. He also noted the importance of complete clinical evaluation and radiographic imaging to accurately predict the timing of staple removal, as well as the phenomenon of "rebound". Stevens [6] created an implant consisting of a two-hole titanium plate with two canned screws used in a manner similar to pins to create partial treatment. This technique has the advantage of quickly correcting angular deformities, while avoiding compression of the body and permanent cessation of the body. Loss of fixation and implant failure are rare. However, pin placement has been used successfully, even in the treatment of genu valgum secondary to bone dysplasia, blood or endocrine disorders, or other pathologies where physiological changes are present.

In 1984, Bowen., *et al*. [7] proposed a percutaneous puncture site technique using fluorescence imaging and body curettage. Permanent physical retention is created using this technique. Since then, other percutaneous techniques have been described, including the use of other instruments, such as broaching knives, cannulated burs, and Steinmann pins. Among the complications that have been described, injury to the popliteal nerve has been associated with the use of heating devices near the proximal tibia.

Biological agents that influence physeal development, including stromal cell-derived growth factor 1 (SDF-1), may offer alternative therapeutic approaches to treat length differences and angular distortions [8]. Metaizeau., *et al*. in 1988 [8] and Khoury., *et al*. in 2007 [9] described a percutaneous technique to create a reversible epiphyseal fusion using transosseous screws. Advantages of this technique include shorter surgery time, rapid rehabilitation, improved recovery, and fewer complications, such as fractures or implant loosening.

PURPOSE of the STUDY

The purpose of this study is to evaluate the results of treatment of idiopathic genu valgum disease with Stapling created with Kirschner wires.

MATERIALS and METHODS

The basic understanding of epiphyseal plate

Anatomy of the growth plate, and histology

The growth plate consists of a fibrous component, a cartilaginous component, and a bony component. The fibrous component sur rounds the growth plate and is divided into an ossification groove called the groove of Ranvier and a perichondrial ring called the ring of LaCroix [10] (Figure 1). The function of the groove of Ranvier is to contribute chondrocytes for growth in diameter and length of the growth plate. The ring of LaCroix is located between the ossification groove and the periosteum of the metaphysis, which sheathes the growth plate, and provides mechanical support for the growth plate. The fibrous component protects growth cartilage against shear forces.

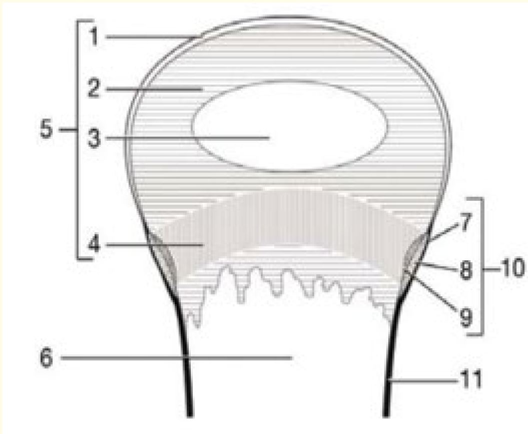


Figure 1: *Components of the epiphysis and metaphysis. (1) articular cartilage; (2) epiphyseal cartilage; (3) secondary center of ossification; (4) epiphyseal plate; (5) epiphysis; (6) metaphysis; (7) fibrous layer of the periosteum; (8) ring of LaCroix; (9) groove of ranvier; (10) fibrous components of the epiphyseal plate; (11) cortical bone.*

The cartilaginous component of the growth plate is divided into reserve, proliferative, and hypertrophic zones (Figure 2 and 3). The hyper trophic zone itself is divided into the zones of maturation, degeneration, and provisional calcification. Immediately adjacent to the cartilaginous component is the bony component of the growth plate. This is where cartilage cells are transformed into bone.

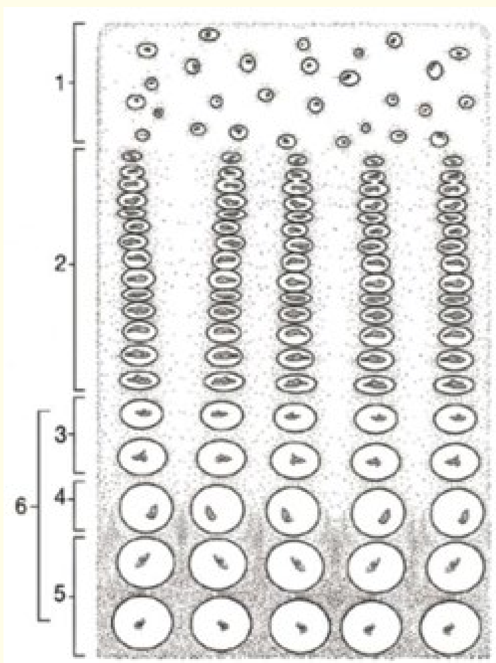


Figure 2: *Zones of the cartilaginous component of the epiphyseal plate. (1) reserve zone; (2) proliferative zone; (3) zone of maturation; (4) zone of degeneration; (5) zone of provisional calcification; (6) hypertrophic zone.*

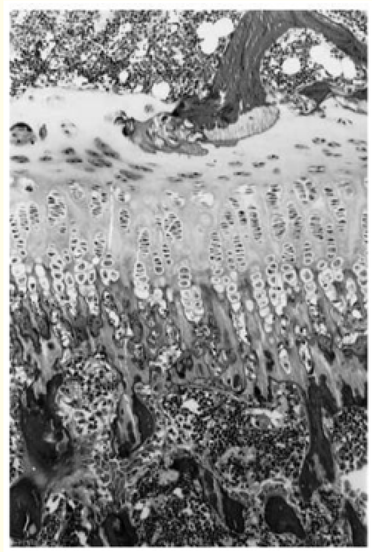


Figure 3: *Histology of the epiphyseal plate.*

Vascular supply

Several arteries supply the growth plate (Figure 4). The epiphyseal arteries supply blood to the epiphysis via multiple branches that arborize into the growth plate, providing vascularization into the proliferative zone to a depth of up to 10 cells. No vessels penetrate beyond the proliferative zone, making the hypertrophic zone avascular. Perichondrial arteries supply the fibrous structures of the growth plate.

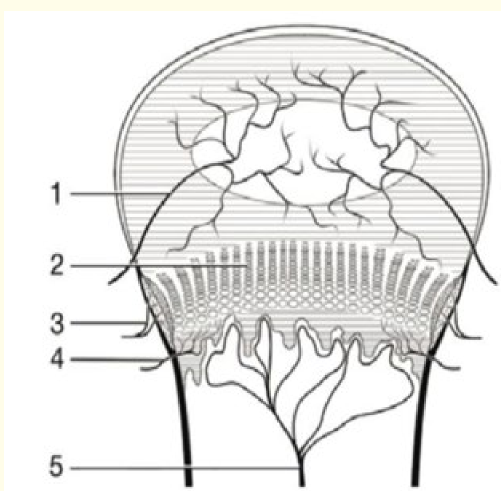


Figure 4: *Blood supply of the epiphyseal plate. (1) Epiphyseal artery; (2) epiphyseal plate; (3) perichondrial artery; (4) metaphyseal artery; (5) nutrient artery.*

The nutrient artery provides fourfifths of the metaphyseal blood supply and does not cross the open physis. Branches of the meta physeal arteries supply the remainder of the blood supply. The terminal branches of these vessels end in small vascular loops or capillary tufts below the last intact row of chondrocyte lacunae of the growth plate.

The chondrocytes at this level are dead, which is important in understanding the development of osteochondrosis dissecans. Venous drainage of the metaphysis occurs via the large central vein of the diaphysis.

In humans and cats, the femoral capital growth plate can be partially supplied with blood via branches of the artery of the ligament of the femoral head (epiphysis); however, no such blood supply exists in dogs.

Physiology of the growth plate

Cartilaginous component as blood supply varies in the different zones of the growth plate, so does cell metabolism. In the proliferative zone and the top half of the hypertrophic zone, it is aerobic, while in the lower half of the hypertrophic zone, it is anaerobic.

Chondrocytes in the reserve zone are spherical, not as numerous, and separated by more matrix compared with cells in other zones. The cells in the reserve zone contain many lipid vacuoles and abundant endoplasmic reticulum, which is indicative of protein production. The oxygen tension in this area is relatively low, consistent with low cellular activity. This may indicate that oxygen and nutrients reach this area only by diffusion, which in turn may be important for the etiology of osteochondrosis dissecans and hypertrophic osteodystrophy. The function of this zone is likely the endowment of chondrocytes to the proliferative zone.

In the proliferative zone, chondrocytes are flattened and aligned in columns parallel to the long axis of the bone (Figure 3). The oxygen tension is higher than in other zones, as is the cell metabolism, resulting in a high concentration of cell metabolites. The primary function of this zone is cellular proliferation; other functions include the formation of intracellular matrix, proteoglycan, and collagen. Collagen has great tensile strength and supports the mechanically weak proteoglycan gel within the cartilage of this zone.

The hypertrophic zone is divided into the zones of maturation, degeneration, and provisional calcification (Figure 4). The beginning of the maturation zone can be accurately determined based on cell shape. The chondrocytes become spherical and, at the base of the zone, are five times the size of chondrocytes in the proliferative zone. It has been found that insulin like growth factor stimulates the hypertrophy of the chondrocytes in this zone, thus promoting longitudinal growth. The cytoplasmic contents of the chondrocytes in the maturation zone, including glycogen, diminish rapidly in cells farther from the proliferative zone. The last cells, bordering on the degeneration zone, show evidence of cell destruction and cell death. The oxygen tension in this part of the hypertrophic zone is low, suggesting reduced metabolic activity. The chondrocytes in this area lack cytoplasmic glycerol phosphate dehydrogenase, which is important for the aerobic energy production of a cell. In the absence of glycerol phosphate dehydrogenase, anaerobic metabolism develops, and lactate accumulates. This environment may contribute to the death of chondrocytes in the degeneration zone.

The mitochondrial and cell wall calcium content of the chondrocytes decreases with cell destruction. The lost calcium accumulates in matrix vesicles, starting in the middle of the hypertrophic zone. This calcification process of the matrix is called initial or provisional calcification. It occurs mainly in the matrix vessels of the longitudinal septa of the cell columns.

Other structures such as collagen fibrils and proteoglycans also undergo calcification.

Growth plate closure and contribution to overall growth

In dogs, major growth occurs between 3 and 6 months of age. Most dogs achieve 90% of their adult size by the end of 9 months. Most growth plates close between 4 and 12 months of age, depending on the anatomic site and breed of dog. However, it is our clinical impression that the growth plates of some giant breed dogs may not close until 15 to 18 months of age. The time frame of growth plate closure in the front and hindlimbs of the average dog. Growth plates that contribute a large percentage to the total axial growth of the long bones remain open longer compared with smaller bones (e.g. carpus, tarsus). It is generally accepted that epiphyseal closure occurs earlier in smaller animals. Cats have similar patterns of growth plate closure. Physeal closure begins at 4 months of age and is usually complete at 7 to 9 months. However, final closure of the distal radial physis can occur in cats as late as 20 months of age. Studies have evaluated the amount that each epiphyseal plate contributes to total growth.

Distal femoral epiphysis provides 70% of the longitudinal growth of the femur, and 40% of the overall growth of the lower extremity. Skeletal growth at the distal femoral physis is the fastest of all physis. Distal femoral epiphysiolysis is a rarely seen injury with frequently seen complications. Among all of the most observed epiphysiolysis, it is the most common growth plate injury in children. It constitutes 5% of all epiphyseal fractures.

Distal femoral epiphysis is present at birth, and forms both femoral condyles. It fuses with metaphysis in girls at 14 to 16, and in boys at 16 to 18 years of age. Several studies have shown that incidence of growth disturbance after distal femoral physis disruption is high, and usually results in leg length discrepancy, angular deformity, or both. When the function of the growth plates is severely impaired, anatomic deformity may develop. Direct trauma, diet, and hormonal and genetic etiologies are clinically important to growth deformity.

Figure 5: *Patient girl, 9 years older with genu valgum.*

Between 2010 and 2015, a total of 28 patients were treated at the three Hospitals in Hanoi (General HongPhat, National Hospital for Pediatric, Saint Paul) by staple epiphysiodesis. The inclusion criteria for this study were children with at least 3 years of growth remaining; follow-up greater than 1 year; patients undergoing PETS as their primary corrective procedure; LLD of 2 to 5 cm; and progressive angular deformity. Of the 28 patients, 3 were lost to follow-up due to movement out of the hospital catchment area, and 1 patient was followed for less than 1 year, therefore 24 patients remained in this study.

All members have confirmed consensus. The study was approved by our Institute's Ethics Review Committee and was conducted in accordance with the tenets of the Declaration of Helsinki.

There were 16 boys and 8 girls. Average chronological age at surgery was 12.7 years for boys (range 7.2 - 15.5 years) and 12.7 years for girls (range 9 - 15.3 years).

The distal femur was the most common site for PETS because of its greater growth potential and therefore speed of correction. In addition, there is the risk of mechanical or thermal damage to the peroneal nerve with the use of power instruments.

The average surgical timing was 28 minutes for each knee (range 20.2 - 36.8 min). Average bleeding was 10 ml. Length of hospital stay was 2.5 days. Postoperatively, patients were allowed immediate weight bearing as tolerated.

Follow-up was every 3 - 6 months, at which time changes in LLD and AD were measured using clinical and radiologic criteria. Angular correction was referenced from a femorotibial angle of 6 degrees valgus. Where possible, the mechanical axis was also recorded. Average follow-up was 2.4 (range 1 - 3.5 years). Follow-up continued until skeletal maturity (observed in eight patients) or until the desired correction was achieved and the screws were removed (six patients). The remaining three patients continued to show improvement at the latest review.

Clinical

Data collection

Clinical and radiological (AP full-length weight-bearing) evaluation was performed pre-surgery, immediately postsurgery, before and immediately after operation. In order to decrease unnecessary exposure of the children to radiation, only clinical evaluation was performed during follow-up visits, which included measuring of the intercondylar or intermalleolar distance.

Clinical tibiofemoral angles and inter malleolar distances were noted in all patients initially and after 3 months interval as described below. On standing position with patella facing outwards, anterior superior iliac spine (ASIS), center of patella and center of ankle (point between midpoint of medial and lateral malleoli) were marked. Anterior superior iliac spine and center of patella were joined and center of patella and center of ankle were joined by 2 lines. By using goniometer, tibiofemoral angle was measured using the above lines.

This valgus deformity is maximal at around age 3 - 4 years with an average lateral tibiofemoral angle of 12 degrees. Finally the genu valgum spontaneously correct by the age of 7 years to that of the adult alignment of the lower limbs of 8 degrees of valgus in the female and 7 degrees in the male (Figure 6). The greater degree of valgus in females may be due to their wider pelvis.

Extrinsic and intrinsic factors may interfere with this normal angular alignment of the lower limbs.

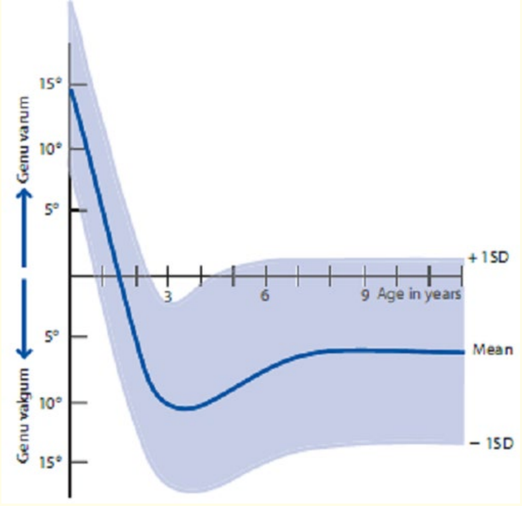


Figure 6: *The tibiofemoral angle changes as the child grows; the alignment of the knee passes from genu varum in early childhood to some degree of genu valgum before assuming the normal adult alignment around six years of age.*

During early childhood development, the alignment of the knee should follow a predictable change from varus to valgus as described by Salenius and Vankka [11]. At approximately 6 years of age, this transition stabilizes at approximately 5 - 7º of tibiofemoral valgus. By 10 years of age, a 10º valgus deformity cannot be expected to improve spontaneously. The presence of deformity leads to abnormal joint overload, which can result in future degenerative joint disease. In addition, the deformity can lead to cosmetic concerns, functional limitations, and abnormal gait mechanics.

Intercondylar and intermalleolar distance

In bow legs, we measure intercondylar distance, which indicates the degree of genu varum and is the distance between the medial femoral condyles when the lower extremities are positioned with the medial malleoli touching (Figure 6).

In knock knees, we measure intermalleolar distance that indicates the degree of genu valgum and is the distance between the medial malleoli with the medial femoral condyles touching (Figure 7).

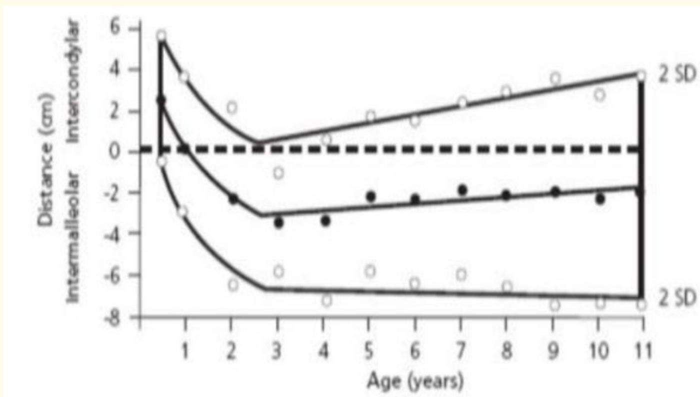
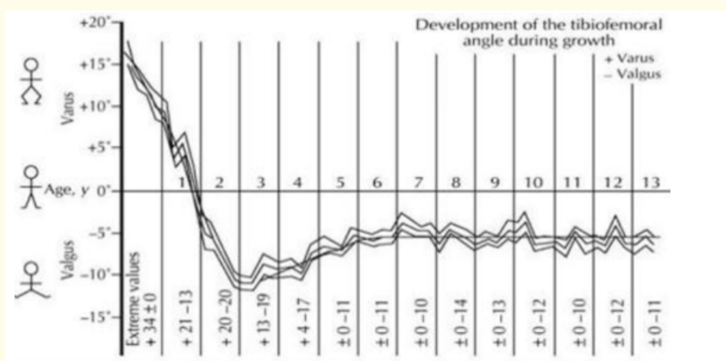


Figure 7: *Standard values of intercondylar and intermalleolar distances in a study of 196 white children. Standard values are solid dots; circles are two standard deviations.*

Tibio femoral angle [12]

Tibio femoral (TFA) angle or knee angle is the angle formed by the mechanical axis of the femur intersecting the mechanical axis of the tibia. When there is a reduction of this angle, it leads to genu varum (bow legs) and an exaggeration of this angle results in genu valgum (knock knees). The physiological development of the TFA from bow legs (varus) in infants to knock knees (valgus) in early childhood is well known (Figure 8).



(A)

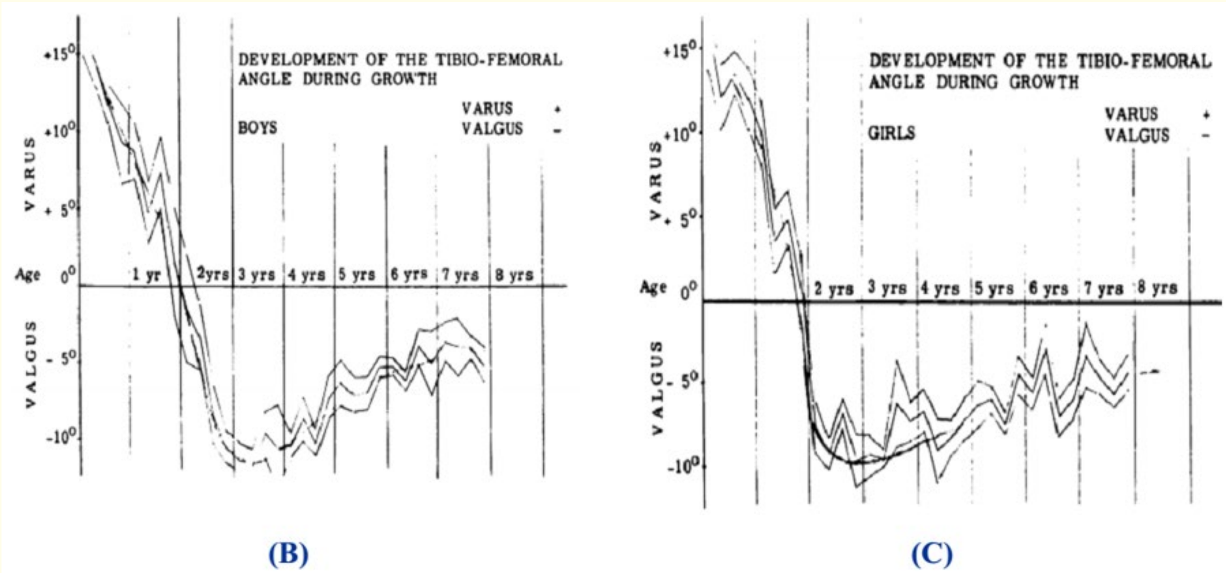


Figure 8A-8C: *Development of the tibiofemoral angle during growth (0 - 13 years) [13]. A. The development of the tibiofemoral angle during growth. B. The development of the tibiofemoral angle C. The development of the tibiofemoral angle in boys in girls.*

There are many studies in the literature have shown that physiological bow legs may be present up to 1 ½ to 2 years. They have studied age group ranging from 0 to 18 years, by using clinical, photographic, radiological methods in different racial population (Figure 9 and 10).

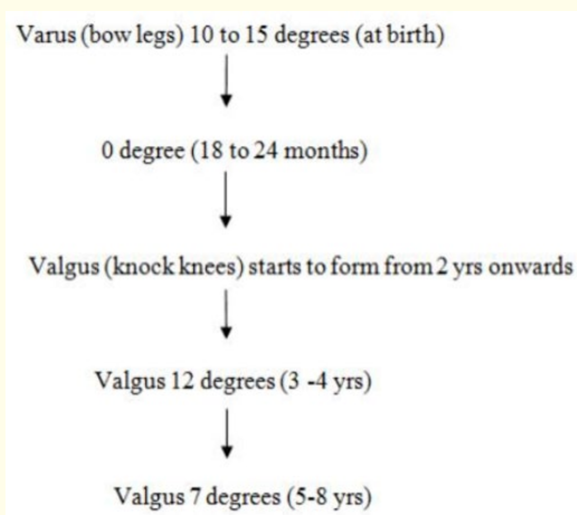


Figure 9: *Flow chart of sequential changes.*

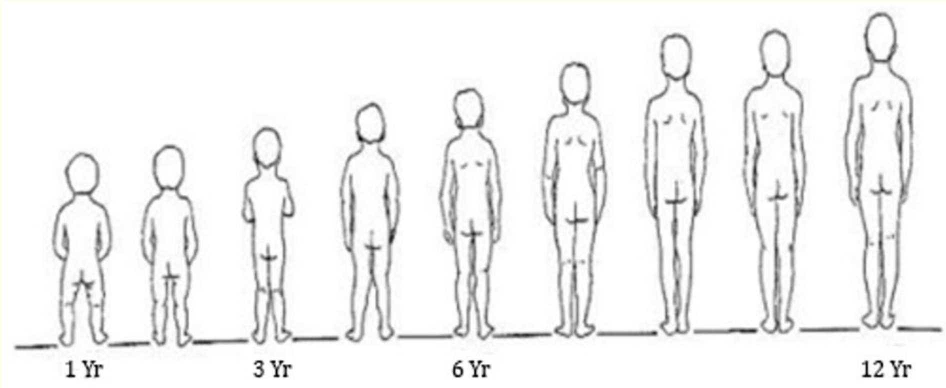


Figure 10: *Progression of TFA [14].*

When a child is born, it has 10 - 15 degrees of physiological genu varum, 5 degree internal tibial torsion and external rotation contracture of the hip. It reaches the maximum by about 9 - 12 months. This usually gets corrected to neutral by the age of 18 - 24 months then the limb develops a valgus angulation, which reaches the maximum of about 12 degrees by the age of 3 - 4 years. This physiologic valgus usually gets corrected to the adult value of 7 degrees of valgus by the age of 8 years. Physiologic valgus is bilateral and symmetrical; less than 15 degrees and the inter-malleolar distance doesn't exceed 8 centimetres.

Detailed history is taken from the parents, regarding the onset, when did they notice, since how long is the problem, when it began. Antenatal, natal and post natal history is taken along with detailed developmental history. Information regarding similar history among the family members, history of trauma, any pain, limping, tripping, falling and also about sitting habits of the baby like "W" sitting is also enquired.

The clinical TFA was measured using a goniometer, while the ICD and IMD were measured using a measuring tape. The lower limbs were carefully positioned during the assessment. The children were made to stand ensuring full extension and neutral rotation at the hips and knees, with the knees or ankles touching each other closely (Figure 11), intermalleolar distance (Figure 12).

Figure 11: *The teleradiograph of the lower extremity. The radiographs were obtained in standing position, if the subject is compliant, including hip, knee, and ankle joints in a single exposure. The anatomical tibiofemoral angle (aTFA) was defined as the angle (α) between the anatomical axes of femur and tibia [15].*

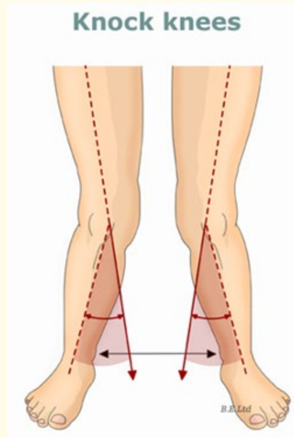


Figure 12: *Tibiofemoral angle and Intermalleolar distance were measured.*

Radiographic analyses

Standard, standing full-leg radiographs (patella pointing forward) were performed regularly, every 3 to 6 months. Radiologic analyses included measurements of mechanical lateral distal femoral angle (mLDFA) and medial proximal tibial angle (MPTA) as described by Paley and Tetsworth [21]. The measurements were taken immediately before surgery and at treatment completion (defined as hardware removal). All radiologic measurements were performed by 2 orthopaedic residents who were blinded to the study. The residents performed measurements independently, twice for each radiograph with at least 1 month between measurements. We converted the measured mLDFA and MPTA to valgus angle (the deviation angle from its normal value) for analyses, assuming a normal value of 88 degrees for mLDFA and 87 degrees for MPTA [16].

The following variables were also calculated: amount of correction, duration of correction, and rate of correction. The duration of correction refers to the time between surgery and implant removal. The rate of correction was defined as the amount of angular correction divided by the time in months that lapsed from surgery to hardware removal.

Pairwise comparisons were made to see if there was a significant difference in the rate of correction between the 2 groups. Several demographic and surgical variables were considered as possible factors that could be related to rate of correction. These factors included (1) age, (2) sex, (3) BMI, (4) surgical site, (5) implant type, and (6) valgus angle. A correlation analysis was performed to determine if the rate of correction significantly correlated with all possible factors mentioned above.

Operative procedure

Indications

- Tibiofemoral angle > 15 degrees.
- Intramalleolar distance of 10 cm after age 10 years.
- Rapidly progressive deformity after age of 7.
- If line drawn from center of femoral head to center of ankle falls in lateral quadrant of tibial plateau in patient > 10 yrs of age.

A decision to offer surgical correction was based on symptoms and absence of spontaneous improvement after observation for at least 12 months. The deformity was assessed using a standing scanogram which enabled femorotibial angles and the position of the mechanical axis to be measured. We considered the mechanical axis of the limb to be abnormal if it crossed the knee joint outside the inner two quadrants of a six quadrant zone (Figure 2) [17]. In order to determine if there was sufficient growth remaining for correction by guided growth, a bone age was obtained in all patients [18]. Those who were within six months of skeletal maturity (14 years of bone age for females and 16 years for males), were considered unsuitable for this technique [19].

Surgical technique

A Staple was created by Kirschner wire (diameter of 1.7) was applied per physis. Under general anesthesia, tourniquet was applied and a 5 cm incision taken centering over the physis located under a C-arm. A 1.2 mm K wire now passed into the physis under fluoroscopic guidance. Care should be taken to avoid any damage to the physis. Staple was created by Kirschner wire now placed extra periosteally and 1.6 mm guide wires introduced into the metaphyseal and the epiphyseal region with care to avoid damaging the periosteum. The Staple placed flush to the bone and fixed with 4.5 mm fully threaded self-tapping over the guide wires into the metaphysis and the epiphysis after drilling with a 1.6 mm drill bit. Stapling Kirschner wire was placed medial distal femur only (Figure 13).

The final placement of the staple and the staple is confirmed under the C-arm in AP and lateral views with the staple being in the center on the lateral view to avoid any iatrogenic sagittal plane deformities. Skin was sutured with nonabsorbable sutures.

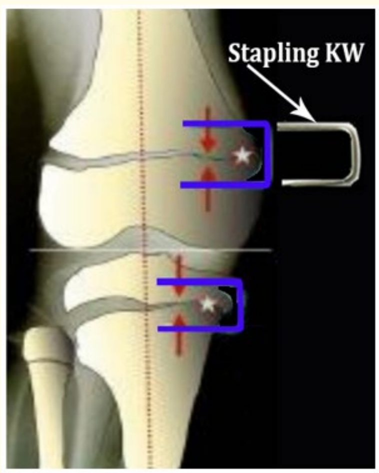


Figure 13: *Operative procedure was illustrated with Stapling Kirschner wire.*

Patients were discharged on the following day having safely mobilised partially weight-bearing on crutches. The compression bandage was reduced after three or four days and knee motion encouraged. Full weight-bearing was usually achieved in the second week.

Patients were monitored clinically and radiologically at four-monthly intervals. When clinical correction of the deformity was deemed satisfactory, a standing scanogram was obtained to confirm the clinical impression. The desired correction was restoration of the mechanical axis to within the inner two zones of a six-zone division of an anteroposterior radiograph of the knee; when this occurs, there is improvement [20] in the position of the ground reaction forces. Staple removal was undertaken as day surgery and the patients followed up until skeletal maturity to check for rebound deformity, limb-length discrepancy or premature physeal closure.

Post-surgical recommendations

Standing and ambulation was encouraged 2h after surgery without the need for formal physical therapy. We recommend avoidance of activities resulting in excess axial loads to the lower limbs, including jumping and running for 2 weeks from the date of surgery.

Postoperative evaluation was performed 3 months, 6 months, and 36 months after surgery, and then every 6 months with long leg radiographs of the lower extremities and clinical assessment, including intermalleolar distance.

Statistical analysis

Data were summarised using means and ranges. A tibiofemoral angle of 6° was used as the normal from which the size of deformity was measured. The patients were divided into two groups; those aged < 11 years and those older. This was thought to represent a mean threshold between those pre-pubertal and those postpubertal. Further analysis was performed using linear regression methods to assess the relationship between age and rate of correction. Statistical significance was set at 5% (p-value of 0.05).

RESULT

A total of 16 boys and 8 girls comprised the study population, and 48 knees were surgically treated for genu valgum. The average age of the boys and girls at surgery was 12 years and 7 months (range 11.7 - 14.8 years) and 12 years and 6 months (range 12.9 - 13.6 years), respectively.

Mean follow-up after surgery was 3.4 years (range 2.2 - 5.6 years). None of the patients required physical therapy, and full functional recovery was achieved within 3 months post-surgery in 24 patients (100%), which was considered to be a satisfactory success rate.

The clinical preoperative evaluation was carried out with the patient in the standing position, during which time the IMD was measured in order to assess the degree of genu valgum. The patients with genu valgum had an average IMD of 25.6 cm [range 14 - 53 cm, standard deviation (SD) ± 1.35 cm] with a T-F angle of 27.1 (range 15.1 - 34.2, SD ± 2.24 cm), resulting in a T-F angle of 7.2 ± 0.55 (range 6.4 - 15.7) and average angular correction of 7.6 (range 7.4 - 10.8, SD ± 5.15) or 0.83 per month (SD ± 0.46 per month). The average surgical timing was 28 min for each knee (range 20.2 - 36.8 min). Average bleeding was 10 ml.

Group	Age	Boys number	Girl number	Average initial measurements	Postoperative at 3 months	Postoperative at 6 months	Postoperative at 36 months
				F-T (SD)	F-T (SD)	F-T (SD)	F-T (SD)
I	7 - 11	10	5	20 - 34° (2.80) (P < 0.02)	8 - 12° (1.32) (P < 0.04)	7 - 12° (0.45) (P < 0.02)	6 - 12° (1.26) (P < 0.03)
II	12 - 16	6	3	14 - 32° (0.80) (P < 0.02)	12 - 15° (6.32) (P < 0.03)	8 - 12° (5.18) (P < 0.03)	6 - 12° (3.12) (P < 0.02)

Table 1: *Salient preoperative radiological indices versus the postoperative indices (Femoraltibio angle).*

All data were analyzed using univariate and multivariate analysis of variance CI: Confidence Interval, SD: Standard Deviation, PO: Postoperative, IMD: Intermalleolar Distances.

There are 16 boys and 8 girls; average initial/postoperative measurements F-T 14°-34°/6° - 12°.

Group	Age	Average initial measurements	Postoperative at 3 months	Postoperative at 6 months	Postoperative at 36 months
		IMD (SD)	IMD (SD)	IMD (SD)	IMD (SD)
I	7 - 11	14 - 55 cm (1.23) (P < 0.02)	6 - 16 cm (0.26) (P < 0.02)	6 - 12 cm (0.26) (P < 0.02)	5 - 9 cm (0.26) (P < 0.02)
II	12 - 16	22 - 43 cm (0.26) (P < 0.02)	9 - 20 cm (8.23) (P < 0.02)	7 - 16 cm (5.51) (P < 0.02)	5 - 10 cm (3.12) (P < 0.02)

Table 2: *Salient preoperative radiological indices versus the postoperative indices (intermalleolar distances).*

All data were analyzed using univariate and multivariate analysis of variance. CI: Confidence Interval, SD: Standard Deviation, PO: Postoperative, IMD: Intermalleolar Distances.

Average initial/Postoperative intermalleolar distances 14 - 43 cm/5 - 10 cm.

During the follow-up period, none of the patients complained of pain or discomfort while walking or during school physical activities. The average surgical timing was 28 min for each knee (range 20.2 - 36.8 min). Average bleeding was 10 ml. There were no complications, such as vascular injuries, infection, chondrolysis or compartment syndrome.

The mean follow-up after surgery was 3.6 years (range 2.4 - 5.9 years) (Figure 14).

Satisfactory results were defined as an IMD/6 cm, and 97.2% of the treated physes were considered to be satisfactory in this study.

Figure 14A and 14B: *Male patient 11 years older with F-T Angle. A. Pre-Operation: 22.2°. B. Post-operation 36 Months: 5.0°.*

When the IMD was 6 cm, the result was considered to be unsatisfactory. An unsatisfactory result was seen in one patient (two physes) in a girl who was 13.4 years of age at surgery. The radiographic results were considered satisfactory when the T-F angle of the knee was 7 in the adolescent male patients and 9 in the adolescent female patients. Four patients were evaluated at the end of growth, after a radiographic physeal closure was observed. The staple were removed after an average of 23.2 months (range 18.2 - 26 months). In all cases, the staple were removed after angular correction. The Staple were removed during normal growth in 24 patients and prior to the end of growth in eleven patients. The others had not reached complete angular correction at the end of the follow-up.

We don't see: Peroneal nerve injury, limb length discrepancy, undercorrection, overcorrection, rebound phenomenon, physeal closure in this study.

DISCUSSION

Guide growth basic science

Basic science Heuter [21] first provided a scientific explanation for the phenomenon of mechanical manipulation of bone growth in 1862, when he reported that pressure increases parallel to the axis of the head bone will inhibit growth, while reduced pressure will accelerate the process. Seven years later, Volkmann [22] noted that changes in compression force caused asymmetric development of the joint. These observations, made nearly 150 years ago, laid the foundation for the concept of epiphyseal pinning and have influenced other aspects of pediatric orthopedic practice.

The relationship between loading and epiphyseal pattern is more complex than the Heuter-Volkmann law suggests. Frost's 'cartilage model' theory [23] suggests that the relationship between loading and cartilage growth resembles an inverted U shape. Physiological loads stimulate growth, while loads outside this range, whether higher or lower, inhibit it. Therefore, small degrees of joint misalignment, where the pressure remains within physiological limits, will generate negative feedback to restore the joint to normal. The increasing heterogeneity results in the body being subjected to loads outside the normal physiological range, triggering a positive feedback mechanism that leads to progressive deformation.

This complex, nonlinear relationship has many implications for deformation control, including a window outside which physical manipulation can fail. Most importantly, it suggests that any intervention should be carried out at an early stage when negative feedback correction can be exploited. Early restoration of the mechanical axis is desirable to avoid permanent deformity of the adjacent joint surfaces, which would otherwise lead to long-term morbidity.

Longitudinal growth results from the proliferation and expansion of organic chondrocytes, with differences in the degree of cell hypertrophy between different cells accounting for up to 50% of the difference in velocities. their growth [24]. Cell expansion is controlled by membrane transport, which can be regulated by hormones. The relationship between mechanical loading and these processes has not yet been fully elucidated. enough. Given the complex interaction between mechanical forces and physical responses, it is not surprising that attempts to manipulate bone growth produce mixed results.

Surgical physeal arrest (epiphysiodesis)

Permanent: The advent of percutaneous techniques performed under fluoroscopic guidance [25] has made the treatment of the epiphysis much simpler and more reliable than the Phemister epiphysis fusion technique. came up [2].

A longitudinal MRI study of the knee after epiphyseal surgery demonstrated that growth stopped immediately, although evidence of early bony fusion was not seen until four months after the procedure [26].

Satisfactory correction of leg length discrepancies has been reported in 82% of cases, with asymmetric fusion or overcorrection complicating 12% of cases [27]. The main problem with epiphysiodesis is its duration. Several prediction methods have been developed, all based on the data of Anderson, Green, and Messner [28]. Accuracy was mostly similar, with a significant proportion of poor results ranging from 10% to 27% > 2 cm compared to the predicted result [29].

Using bone age instead of chronological age did not improve prediction accuracy. However, epiphyseal resection remains the treatment of choice for leg length discrepancies < 5 cm, although the family must be aware of the possibility of a poor outcome.

Temporary: Reversible, intracorporeal differential arrest is an intuitive, simple, and attractive means of correcting angular deformities of long bones. Implant-mediated guided growth allows for this reversibility, provided that neither the implant nor the surgery involved permanently disrupts the body. Recent developments in transplantation have revived interest in the concept of guided growth and expanded the indications for this form of management.

Indications for temporary hemiepiphysiodesis

Physically 'sick' or pathological. Historically, partial therapy has been avoided in conditions associated with pathologic pathology, such as rickets, Blount's disease or postmeningococcal sepsis, due to the belief that that the physical 'disease' cannot withstand direct surgical manipulation and may stop functioning completely. Modern studies show that this is not the case [30].

Deformities secondary to rickets can be difficult to control. The first line of treatment should be alternative medical therapy but there is often a delay between initiation of treatment and response. During this time, a small deformity may become more severe, leading to more complex multifocal bulbar and diaphyseal abnormalities, which are less likely to correct spontaneously and may be difficult to correct. corrected by osteotomy. Early restoration of the mechanical axis will reduce pathological loading and improve the chances of spontaneous reconstruction of the deformity.

Recent evidence suggests that hemiepipsyodesis can successfully normalize the mechanical axis, leading to improved radiographic appearance of the hip and ankle as well as in the knee (Figure 15) [30].

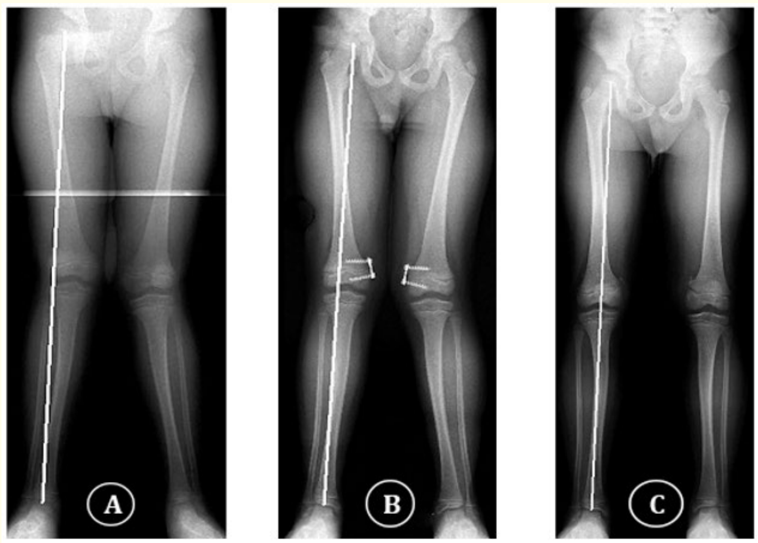


Figure 15A-15C: *Radiographs showing A. bilateral genu valgum secondary to hypophosphataemic rickets. Both mechanical axes (illustrated only on the right) pass through the lateral compartment of the knee, B. improvement in the mechanical axis is noted four months after insertion of the 8-plates (illustrated only in the right leg) and C. implants were removed ten months after insertion and correction of the mechanical axis has been maintained 12 months following removal (illustrated only in the right leg).*

Instead of physeal closure, implant failure has been reported to be a significant problem in patients with physeal pathology, with metal fracture rates up to 44% in Blount disease [31,32].

Good correction has been achieved in those in whom the metal part has not failed but factors predicting failure have not been identified. In Blount's disease, the bulbar screw fails and it is thought that this may be due to a significant increase in screw movement as a consequence of the disorganized cellular structure and cystic degeneration that often occurs in the condition. this [28]. Using screws that are less susceptible to fatigue can overcome this problem.

For more than 70 years, epipsyodesis has been a widely accepted method for correcting limb length discrepancy (LLD). This technique is increasingly used to correct angular deformity (AD).

In 1933, Phemister [2] first described a surgical procedure for growth plate fusion. It involves removing a rectangular portion of bone containing the interposed bulb, epiphysis, and shaft and reinserting it with the ends reversed, resulting in the creation of a bony bridge. Irreversible, this approach requires accurate prediction of subsequent growth to determine the timing of surgery. Additionally, Phemister's technique requires exposure of both the medial and lateral aspects of the limb. This is associated with significant pain, prolonged post-operative recovery time, and a significant scar [33]. Other complications include angular deformity [34] exostosis and saphenous nerve damage [20] have been reported.

It has long been known that continuous mechanical compression of the growth plate results in growth retardation. Based on this observation and the work done by Haas [35] Blount and Clarke in 1949, invented a method in which stiff pins were inserted through the body to slow growth [4]. The theoretical advantage of this technique is that unlike Phemister's procedure, the procedure is reversible, making surgical time less critical. However, this cannot always be predicted, as full regrowth after staple removal depends on good surgical technique with preservation of the perichondral ring and epiphyseal vessels [4]. Pinning errors and loosening are other unforeseen problems.

With the advent of fluoroscopy in the operating room and the trend toward minimally invasive surgery, new methods have been developed. One such technique, popularized by Bowen in 1984 [3] involves percutaneous excision of the periphery of the growth plate with a curette, resulting in closure of the perichondrium and permanent growth arrest. Similar procedures using electric drills and dental drills have also been described [37].

In 1998, Metaizeau and colleagues described a new technique for performing epiphyseal registration with screws [8]. The science of this procedure is based on the work of Green and Haas in 1950 [36], who observed in a rabbit model that transcorporeal pins passing through the body prevented growth. Screws can be placed percutaneously under image enhancement on the proximal or distal tibial shaft of the femur unilaterally or bilaterally diagonally or longitudinally to achieve the desired effect. We present our initial experience with this technique in a prospective study.

From birth through adolescence, there is a continuous change in tibiotalar angle at the knee as part of the physiological evolution of limb alignment. Newborns have a knee axis of up to 15°, followed by a neutral mechanical axis by 12 - 18 months of age. At 3 - 4 years of age, the maximum valgum knee develops up to 12°, gradually stabilizing at 4 - 7° during adolescence corresponding to adult values [37].

However, throughout childhood, the mechanical axis remains in the medial half of the knee joint (zones +1 and −1 around the midline) in normal individuals despite the above-mentioned variations [39]. This progression in limb alignment must always be kept in mind, especially when treating deformities in younger age groups to prevent any inadvertent surgery for physiological deformities. Therefore, patient selection must be done carefully during the physiological reconstruction phase and physiological deformity should be ruled out before making a surgical decision. However, the possibility of overlapping deformities due to underlying pathology and normal physiological processes should be kept in mind.

As deformities around the knee progress, gait disorders will appear as soon as the child begins to walk. Head flexion > 10°, leading to a circling gait and anterior knee pain [39]. Knee flexion causes sideways propulsion, ligament laxity, and a waddling gait.

These deformities around the knee are known to cause early osteoarthritis and often require surgery. In addition to clinical signs and symptoms, it is important to note the effects of these deformities on the malleable body. Heuter and Volkmann independently studied the effects of compression and tension on the body and consequent bone regeneration and growth.

Excessive and prolonged forces on the epiphysis will put pressure on the mechanotransducing chondrocytes, inhibiting the growth of the epiphysis. Consequently, the deformity will progress until eccentric weight persists on the body, exacerbating gait disturbances, pain, and eventually leading to functional disability. According to the Heuter-Volkmann principle, people will soon be able to correct these distortions.

However, traditionally, most authors have advocated delaying surgery, i.e. temporary amputation of half of the body until age 8 - 10 years due to concerns about permanent body damage [40].

Factors supporting this thinking are the malleability of the child's body, the pathologic damage of the body, and the implantable devices used in partial pathologic treatments. Patients with pathological bodies (also known as diseased bodies) including conditions such as Rickets, bone dysplasia, etc., were until recently also excluded from the scope of treatment of physiological disorders temporary sale. The dominant ideology is that an already compromised physical body may not tolerate direct surgical manipulation with its potential to cause permanent physical cessation and irreversible damage.

In 2008, Stevens and Klatt published a retrospective review of 14 patients with atopic disease who were undergoing temporary treatment of a hemibody condition [20].

They showed improvement not only in the alignment of the limbs but also in the physical condition of the body. The explanation is that by eliminating eccentric loading on an already damaged body, recovery will occur more quickly. They believe that over time, knee and limb misalignment will affect the hips and ankles. These patients also subsequently require surgery to correct ankle and hip deformities.

When the mechanical axis is adjusted, there is an improvement in shape and width not only in the knee but also in the hip and ankle. Therefore, the current trend is to perform temporary hemiarthroplasty at an early age to prevent deterioration of not only the knee but also the surrounding joints. Research by Novais and Stevens and Boero., *et al*. showed the safe implementation of temporary partial treatment in pathophysiology with the preferred implant being a tension band plate and screw construct.

However, the rate of adjustment seen in pathological organisms will be slower than in idiopathic deformities due to the slower growth rate in this organism. Our cases adjusted at an average of 1.53°/month. Staples have become a popular implant for performing temporary hemiarthroplasty around the knee since their introduction by Blount and Clarke in 1949 [41].

Staples works by creating a solid fulcrum within the body. This rigid support causes compression of the body and slows growth in that part of the body. The prolonged presence of such a rigid implant around the body raises concerns about permanent physical closure [37].

In order to avoid such a permanent damage to the physis, temporary hemiepiphysiodesis was not advocated in preadolescent children. Studies regarding the mechanical and biological responses of the physis to compression, have shown chondrogenesis and provisional calcification to come to a standstill following staple insertion [35].

Biopsy specimens have shown disorganized cell columns and metaphyseal tongues of disorganized cartilage and biochemical alteration by radioimmunoassay in presence of staples [33]. However, all these changes caused by stapling seem to be reversible in nature [36]. And most studies advocate removal of these staples within 24 months to resume growth of the physis [35]. Prolonged retention of these staples beyond the prescribed time will increase the chances of physeal damage.

In an article in 1996, Mielke and Stevens have reported a series of 25 patients younger than 10 years who underwent temporary hemiepiphysiodesis [42]. The mean age at the time of surgery was 6 years and 4 months (ranging from 3 years 6 months to 9 years 11 months). They showed improvement in every case with no instances of a permanent physeal closure or a limb length discrepancy. One staple backed out and one broke during implant removal. However, staples though effective have a number of complications including breakage, extrusion, migration and malposition.

There have been reports of inadvertent permanent hemiepiphysiodesis. Migration of these staples increases the frequency of repeat surgery especially in younger patients.

The prongs of the staples being smooth allow easy extrusion and migration in a predominantly unossified bone in younger patients. In 1998, Métaizeau., *et al.* [8] introduced transphyseal screws to retard growth on one side of the physis. This method however has concern of irreversible and complete growth arrest as the transphyseal screws traverse the physis.

The concept of the tension band plate with two nonlocking screws to bring about temporary hemiepiphysiodesis was introduced by Stevens in 2007 in lieu of the complications of staples. These plates have their center of rotation outside the physis and as the physis grows the screws toggle in the plate and pivot in the bone bringing about gradual correction [20].

Thus, unlike the staples which bracket the physis this system of plate and screws does not compress the physis reduces the concern of permanent physeal damage. Stevens stated that this system brought about a more rapid correction than staples.

Stevens and Klatt in 2008 reported a lower complication rate than with staples [20] Several studies have shown a favorable result with the use of this technique [20].

In contrast, several comparative studies between hemiepiphyseal stapling and tension band plate hemiepiphysiodesis have shown no significant difference in the rate of deformity correction [43].

The complication rates too have been reported to be the same [43]. A recent randomized clinical trial by Gottliebsen., *et al*. also found no difference in treatment times in patients inserted with either the tension band plate or the staple.

Regarding surgical time, Jelinek., *et al*. note that the time required to insert or remove a tension strip plate is significantly shorter than with staples. Furthermore, the installation of the tension strip plate is more precise and controlled, preventing any accidental screw insertion [43].

This situation is important in cases of skeletal dysplasia due to anatomical changes in the epiphyseal area. Several current studies support the safe use of this system in younger patients with underlying pathologies. In our study, we applied the tension plate to patients as young as 2 years old without permanent osteochondral closure or limb length discrepancy with improvement in all cases. We had a success rate of 91.66%, similar to other studies [43].

One concern with these plates is fracture of the bulbar screw. Burghardt., *et al*. reviewed 65 patients with mechanical failure of this system.

In all of these cases, it was the screws that broke, not the base plate. Nearly 93% of these patients are obese, overweight or obese (according to NIH). Schroerlucke., *et al*. in their study reported fracture of bulbar screws in 8 of 31 operated patients, all of whom had Blounts' disease [41].

To date, implant failure has only been reported in Blount patients, which is rare in India [44].

None of the patients we operated on were obese, and none of them had screw breakage or implant failure. We suggest that this system is very suitable for Indian children. In the case of obesity, two such parallel tensioning plates with strong screws should be used to minimize breakage.

Cases of pin migration had been reported previously, but none had occurred with a tension plate until Oda and Thacker reported in 2011 a case in which the tension plate applied to the distal tibia. anterior has been pulled across the body resulting in the creation of the anterior segment. physical symptoms in 9-year-old girls [45]. However, this is an isolated case and no other cases have been reported. Physically spacing the screws will prevent that from happening.

Ambiguity still exists regarding the timing of implant removal. Premature removal will result in undercorrection while delaying it will result in overcorrection. One should also keep in mind the rebound phenomenon after removing the plate. Therefore, most studies favor an overcorrection of 5° to account for rebound phenomena. Two of our patients experienced recurrence after an average of 16.33 months and required reoperation.

Therefore, the body's response can sometimes be unpredictable and with the possibility of recovery and under-correction occurring, one may have to repeat this process multiple times to maintain the muscle axis Neutral learning in growing children. Temporary partial treatment is minimally invasive, is the least morbid option for correcting angular deformities around the knee, and can be repeated as needed. Therefore, growth guidance in young adolescent patients became safer with the advent of tension wire plates.

Finally, an important aspect is parent counseling. Compliance can be an issue because results are not obtained immediately after surgery. Parents should be counseled about the gradual nature of deformity correction and that it may take up to 1.5 - 2 years for the deformity to be corrected. Regular follow-up is recommended, preferably every 3 months, to prevent overcorrection and detect any complications early.

Treatment - Surgical

Age at time operation

Boero., *et al*. [46] applied a different approach to treat according to the cause; Patients with pathological malformations were treated earlier (2 - 13 years) than patients with idiopathic malformations (8 - 14 years). Patients with idiopathic deformities are treated only after it is clear that physiologic recovery has failed. Surgical treatment is not recommended before age 8 years. After age 8, angular deformity less than 10° can be considered cosmetic and does not require surgery. However, surgical intervention should be considered for deformities greater than 10° with an anticipated remaining growth period of at least 12 months. The timing of surgery should take into account the fact that the rate of correction appears to decrease with age and that as the patient reaches skeletal maturity, the body will grow at a slower rate. In some cases, plates are applied to both the femur and tibia, to speed up correction before physical closure.

Burghardt., *et al*. found tension band plating to be effective for various deformities around the knee and ankle [47]. They reported their results on changes in mechanical axial deviation and, similar to the study by Ballal., *et al*. had a younger mean age of the patients. It appears that multiple factors, including age, diagnosis, growth rate, and body size, are involved in the observed differences in adjustment speed. Our study is the first to report the revision rate for the application of a tension wire plate to the distal femur for idiopathic valgum knee disease.

It is important to understand the rate of correction in order to make accurate decisions about the timing of surgery in patients. Theoretically, bone age is preferable in this case because it provides a more objective criterion for determining the end point of growth. However, no method for predicting the optimal timing of surgery has been shown to be consistently accurate. Age has been identified as another factor that may independently influence the rate of correction using tension band plating. In our study, patients were grouped based on their chronological age relative to the onset of their peak growth rate. Bone age will be more appropriate. However, not all patients had their bone age recorded at the time of the index procedure. Younger patients in this study tended to have a faster rate of adjustment than the older age group. Unfortunately, there were not enough patients in the two groups to give significance. Differences between age groups were not influenced by the number of placards as there was a similar distribution between one and two placards within each group.

Inclusion criteria: children aged 6 - 15 years with angular deformity of the lower extremity according to genu valgum (or genua valga), estimated residual growth of at least 6 months (usually assessed based on patient's age individual and based on preoperative status). X-ray and preoperative intermural distance (IMD) of 10 cm or more.

Pathological angular deformities may be idiopathic or due to congenital syndromes such as skeletal dysplasia. In contrast to physiological deformities, pathological deformities manifest when the underlying pathology progresses and impacts bone growth, leading to a gradual shift of the mechanical axis. Valgus deformity exceeding 10° can cause anterior knee pain, circumferential gait, and occasionally patellar instability [48]. A varus deformity can lead to sideways thrusting, ligament laxity, and a waddling gait. Regardless of whether the cause is idiopathic, dysplastic, or endocrine-related, the general goal of surgical treatment is to restore and maintain the neutral mechanical axis [49].

Some procedures [50] (Figure 16)

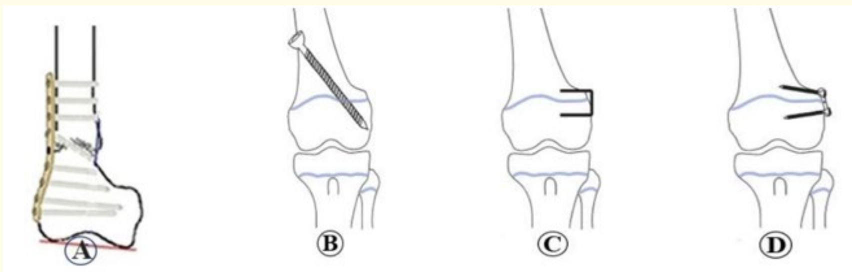


Figure 16A-16D: *A. Distal femoral osteotomy; B. Transphyseal cannulated screws; C. Hemiepiphyseal stapling for angular deformity; D. Eight-plate for angular correction of knee deformities.*

Wedge distal femoral osteotomy (Figure 17)

Figure 17: *Intraoperative fluoroscopy images showing a guide pin insertion in the designated trajectory of the osteotomy, the osteotomy performed by microsagittal saw, and laminar spreaders used to create an opening wedge at the osteotomy site based on preoperative planning.*

Hemiepiphyseal stapling for angular deformity (Figure 18)

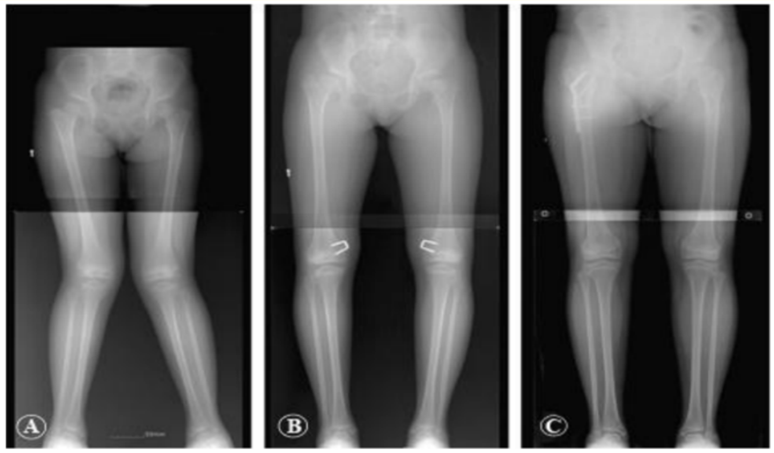


Figure 18A-18C: *An illustrative case. Hemiepiphyseal stapling was performed at age 10.9 ears (A). Staples were removed 17 months later when the deformities were slightly overcorrected (B). Two years after staple removal, the lower extremities remained in physiological alignment with some rebound phenomenon. Right proximal femoral valgization osteotomy also contributed to lateralization of the mechanical axis (C).*

Use of the eight-Plate for angular correction of knee deformities (Figure 19)

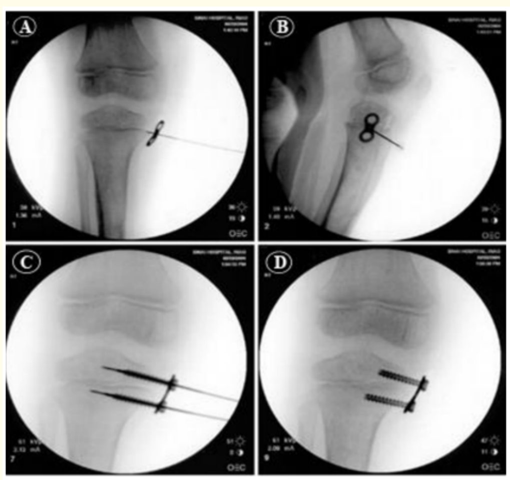


Figure 19A-19D: *Application of the eight plate. A: Anteroposterior view radiograph shows a 1.5-mm Kirschner wire being used to position the eight-Plate so that it straddles the physis. B: Lateral view radiograph shows that the position of the eight-Plate is monitored so that it is not positioned too anterior or posterior in the sagittal plane. C: Anteroposterior view radiograph shows two guide wires with threaded tips inserted in the two holes of the eight plate. Cannulated screws are then inserted over the guide wires. D: Anteroposterior view radiograph shows the final position of the eight-Plate and screws. The longer 32-mm screws depicted here are preferred over the shorter screws, especially when inserted in the metaphysic.*

Percutaneous hemi-epiphysiodesis using transphyseal cannulated screws (Figure 20)

Figure 20A-20C: *Under fluoroscopic control, the elastic nail guide is placed (A) directing the tunnel from cephalic to caudal and towards the lateral part of the condyle (B, C).*

Prognosis

- Idiopathic genu valgum has a better prognosis than pathological etiology with hemiepiphysiodesis.
- Higher rate of complete correction.
- Faster correction rate.
- Fewer complications.
- Physiologic genu valgum resolves spontaneous in vast majority by age of 7.
- Deformity after a proximal metaphyseal tibia fracture (Cozen) should be observed as most remodel.
- Maximum magnitude of deformity reached approximately 12 - 18 mo after injury.
- Resolve spontaneously within 2 - 4 years.
- Threshold of deformity that leads to future degenerative changes is unknown.

Complications

Other complications in this study include superficial and deep infection, compartment syndrome, peroneal nerve injury are not commonly reported.

The tension band design is a reasonable choice for treating partial pathology because it is temporary, easy to place and remove, and retains the adjusting fulcrum distally.

The combination of heavier loads on a physis that may have in creased motion with weight bearing secondary to its abnormal pathologic condition likely caused excess stress on the distal screw causing it to fail in fatigue. For these reasons, we believe that the eight-Plate (Orthofix) system should not be used in obese patients with Blount disease. Future tension plate designs should include larger non cannulated screws made of metal with high fatigue strength.

The combination of heavier loads on the body that can increase motion along with weight bearing secondary to its abnormal medical condition can cause excessive stress on the distal Staple causing it to damaged due to fatigue. For these reasons, we believe that Staple should not be used in patients with obesity or Blount disease.

CONCLUSION

Temporary partial treatment through the use of tension plates is an effective method to correct coronal plane deformities around the knee without complications. Its easy and precise insertion has expanded the indication for the treatment of temporary partial pathology to patients under 16 years of age and across a range of diagnoses including pathophysiology that has traditionally been beyond the purview of the medical profession. guided development. It reduces the risk of physical damage when compared to other implants, and the procedure can be safely repeated in recovery cases with minimal complications.

Genu valgum is usually a clinical diagnosis. Patients with this condition are often asymptomatic but may experience medial knee and/or ankle pain. Although the medical history and physical examination are sufficient for diagnosis, there are certain signs that require further evaluation of the condition. Although the primary care provider is often the first clinician involved in the care of these patients, it is important to consult with a multidisciplinary team of specialists including orthopedics, geneticist and pediatric endocrinologist depending on the underlying cause. Radiologists also play an important role in determining the cause. Without providing a proper medical history, the radiologist may not be sure what to look for or what additional radiological tests may be needed.

Limitations of the Study

The results of this study have some limitations. The study is a retrospective study. There are no some procedures for genu valgum to compare results.

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