

## Insertion of One-third Tubular Plate for Hemiepiphyodesis in Children: Surgical Technique

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### Abstract

*Limb length discrepancy and angular deformities are among the main issues in paediatric patients. There are various ways to manage these two problems which includes growth modulation with eight-Plate. For certain reasons, the use of the eight-Plate is limited, thus conventional plates have been selected for the guided growth, for example two-hole one-third tubular plate or reconstruction plate. Literatures reported good results on its use but none of them explained the surgical technique in details. Therefore, we proposed the surgical technique of inserting the two-hole one-third tubular plate in hemiepiphyodesis in children, which includes pre-skin incision preparation, placement of one-third tubular plate and screw insertion. The three steps are surgeon-friendly and less demanding, being suitable to apply to paediatric patients that require growth modulation.*

**Keywords:** Angular deformity, Hemiepiphyodesis, One-third tubular plate, Limb length discrepancy.

### Introduction

Limb length discrepancy and angular deformity are common in children. In cases when the physis is still open with the remaining growth of more than two years, the treatment of these two conditions with growth modulation is famous among paediatric surgeons [1-20]. Less invasive, immediate weight-bearing, avoiding or delaying more invasive surgeries, early rehabilitation and minor and fewer reported morbidities are the advantages of the guided growth compared to bone lengthening or corrective osteotomy for limb length discrepancy and angular deformity, respectively [1-10, 12-15, 18].

Historically, the epiphyodesis has been introduced to the medical field as early as 1933 by Phemister albiet with its own disadvantages [1, 6, 14, 19]. Since then, many others have refined it such as the first reversible technique using staples by Blount and Clarke, eight-Plate

by Stevens and drilling using a low-speed high torque drill by Bowen [1, 6, 8-11, 13, 14, 18]. The reversible technique is widely accepted as it does not destroy the physis of the bones but rather just halts its progression [1]. The use of guided growth has evolved from the treatment of angular deformity to treatment of limb length discrepancy, coronal deformity and joint dislocation [1, 4-5, 6, 8-10, 12, 15, 19].

The use of eight-Plate was popular among surgeons for growth modulation in children [1, 7, 18]. The implant design makes its surgery less demanding. In view of cost and availability issues, some authors alternatively used two-hole reconstruction plate or one-third tubular plate for the hemi epiphyodesis [16]. As the latter plates have a different design from the original eight-Plate, therefore the surgical technique in putting the plate would also be different. To date, there have been no reports on this technique in detail. Therefore, we would like to propose the surgical technique in

inserting one-third tubular plate for hemiepiphysiodesis of distal femur or proximal tibia in paediatric patients.

## Methods

Patient was positioned in supine under general or spinal anaesthesia. A thigh tourniquet applied and inflated. The three main steps are:

### Pre-skin Incision Preparation

Distal femur physis or proximal tibia physis were marked in both views (anteroposterior and lateral) with surgical marker under image intensifier (II) guidance. Another imaginary longitudinal line drawn on the skin that follows centre of the femoral or tibial shafts (midsagittal or lateral view), and intersected the distal femur or proximal tibia physis, respectively.

### Placement of One-third Tubular Plate

A 3 cm skin incision made centred at the intersection point between the physeal line and the imaginary longitudinal line. Soft tissue dissection made until periosteum visualized. A small Kirshner wire (guide wire) was inserted into the physis (under II guidance) in midsagittal plane or slightly posterior to this plane to prevent recurvatum. After the guide wire confirmed in place, preliminary Kirshner wire inserted about 1cm proximal and distal to the guide wire correspond to the plate hole (Figure. 1a, 1b). Then, the guide wire was removed, and a 2-hole one-third tubular plate was slid in as deep as possible through the two preliminary wires until the periosteum (Figure. 1c, 1d). An additional Kirshner wire was inserted posterior to the plate to further stabilize and prevent it from migrating posteriorly while putting the screws (Figure 1e).

### Screw Insertion

The epiphyseal screw was inserted first followed by the metaphyseal screw. A 2.5 mm drill used to create the entry point for the screw

at the near cortex. A 4.0 mm cancellous screw was then inserted (without tapping step) into the two holes before sequentially tightened until the plate well hold on the bone surface. Once satisfactory placement of the plate and screws were achieved, the posterior wire was removed, and the surgical wound washed and closed in layers.

The placement of the 2 screws should be parallel to each other (Figure. 2a, 2b). The divergent of both screws always been expected as in the eight-Plate (Figure. 2c, 2d). Once the screws diverged maximally at about 30 degrees, the screw repositioned to be parallel if the effect of growth modulation still needed (Figure 3). The same surgical technique described above was used to do this revision surgery.

## Results

The authors have used this technique for eleven sites of two-hole one-third tubular plate insertion involving three limbs with limb length discrepancy and three limbs with angular deformity. The inclusion criteria for this technique similar to those that require eight-Plate for growth modulation. Any two-hole non-specialized plate can use these three steps in putting the plate for hemiepiphysiodesis. There have been no wound complications apart from one screw loosening in three sites before the maximum divergent of screw. All patients were able to weight-bear after surgery and continue routine activities about 2 weeks after operation.

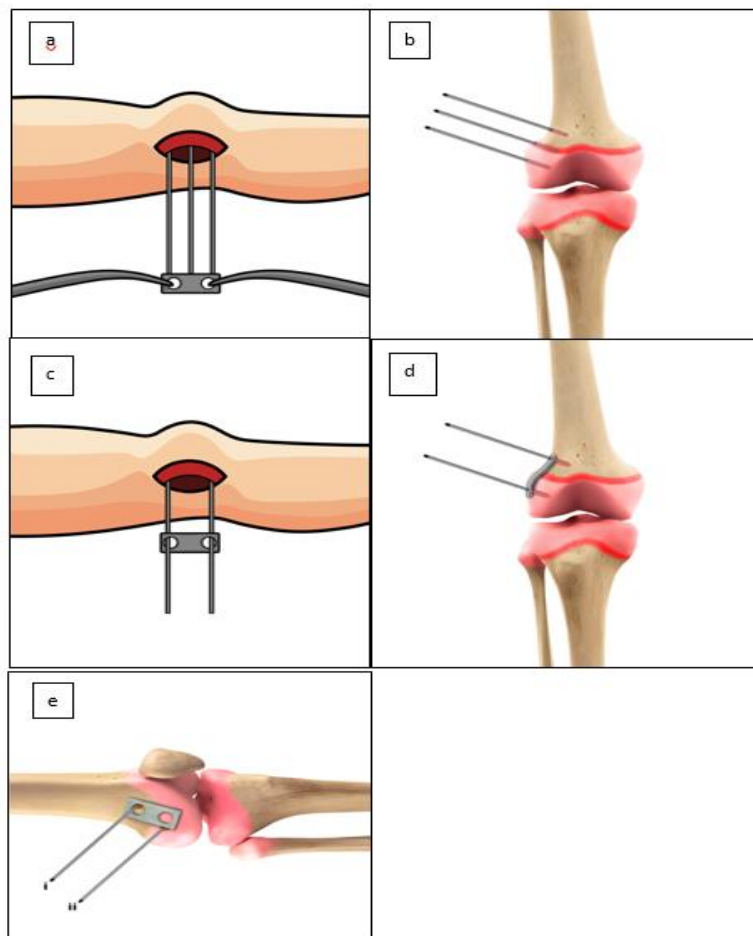
## Discussion

The principle of eight-Plate in growth modulation is by applying the tension band plate principle [1, 6, 8, 16, 19]. Unlike staples that use physeal compression principle, the eight-Plate with non-rigid screw fixation would avoid this compression to the growth plate as the screws could angulate progressively while correcting the deformity [6, 9, 10, 20]. The use of these plates is safe as the risk of physeal arrest is low [6, 20].

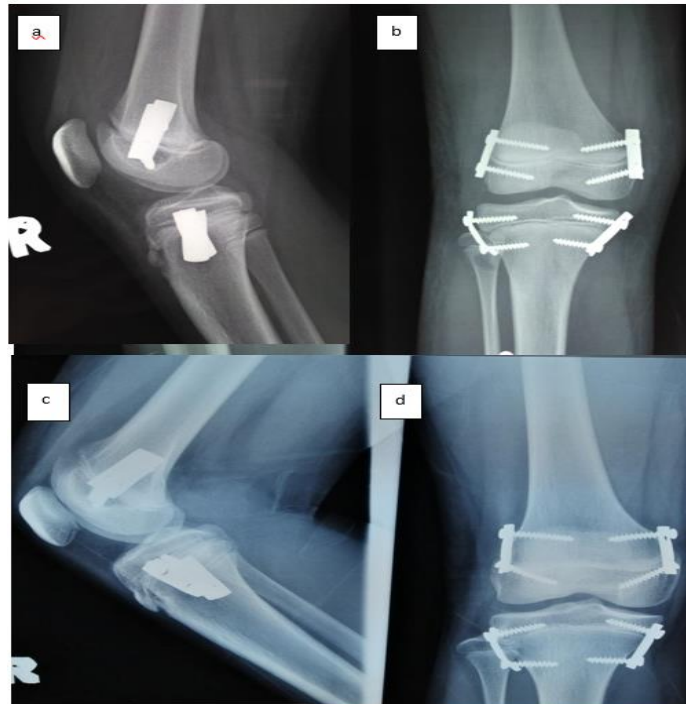
The design of implant between eight-Plate and one-third tubular plate would be the main reason for difference in their surgical technique. The eight-Plate has feature of contoured waist and a centre hole for a temporary guide wire during plate insertion. The guide wire will be at the level of physis and putting this wire is very essential to ensure accurate placement of the eight-Plate. As for one-third tubular plate, it is a non-specialised plate with no hole at the centre. Its two-hole plate may mimic the eight-Plate and could be used for hemiepiphysiodesis in children as reported by Stephanie et. Al [8]. However, as there is no centre hole, the surgical step would be different from the usual eight-Plate insertion.

We proposed three surgical steps in putting one-third tubular plate for hemiepiphysiodesis (as described above). The pre-skin incision preparation is similar to the eight-Plate as well

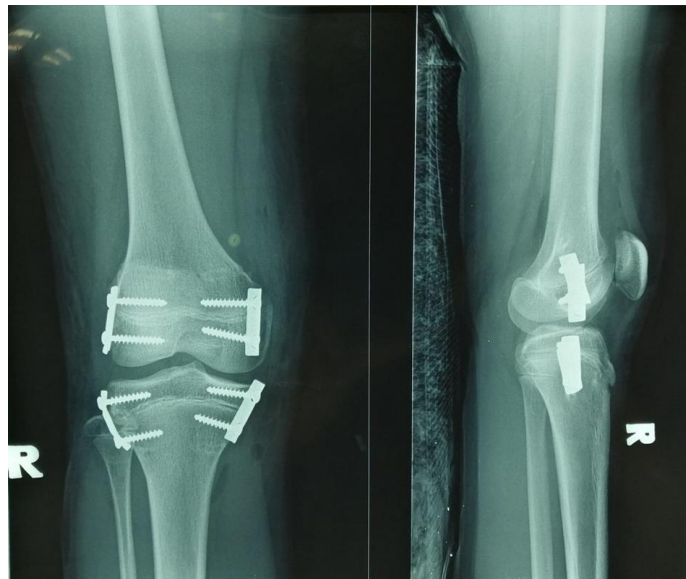
as for the screw insertion. After inserting the guide wire at the level of physis, this tubular plate could not slide on the wire as there is no centre hole unlike in eight-Plate. Therefore, another preliminary wire should be placed above and below to the guide wire (about 1cm distance) where the hole of the one-third tubular plate can slide and subsequently advanced to the bone surface [Figure. 1a]. The preliminary wires should be at the correct mid-sagittal plane as well as coronal plane in order to ensure the screws are at the appropriate level [Figure.1b]. After advancing the tubular plate on the bone, another temporary wire is necessary to stabilize the plate posteriorly before putting the first screw (epiphyseal screw) at the epiphyseal hole. This temporary wire should only be removed after the second screw (metaphyseal screw) have been inserted [Figure. 1c,1d and 1e].



**Figure 1.** Steps of one-Third Tubular Plate Insertion Starting from K-Wire Positioning until Plate Placement



**Figure 2.** Day-1 Post-operative Radiograph and Post-operative Radiograph after One Year



**Figure 3.** Radiograph Shows Parallel Screws after Readjustment

## Conclusion

The specialized eight-Plate is relatively a straight forward surgery. The non-specialized plate (e.g one-third tubular plate & reconstruction plate) needs additional surgical steps before the plate can be nicely put on the bone surface. We believe the above proposed surgical technique is surgeon-friendly and less demanding, therefore we would like to recommend this technique to those who are

planning to use non-specialized plate (e.g one-third tubular plate & reconstruction plate) for hemiepiphysiodesis in paediatric patients. It is not only for patients with limb length discrepancy but could also be used for those with angular deformity of limbs.

## Conflict of Interest

The authors declare there is no conflict of interest.

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