

# peditst



pediatric plates  
proximal femur



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proximal femur

## Index

Introduction	1
Indications	2
Features of the Implants	2
Surgical Technique	3
Surgical Technique 1	3
Surgical Technique 2	3
Osteotomy Operations	7
Plate Applications	8
Exception Status in 120° Trauma Plate	9
Placement of the Proximal Screws	9
Placement of the Calcar Screw	10
Fixation of the Distal Fragment	10
Medialization Procedure	11
Rotation Osteotomy	12
Proximal Femur Fractures	12
Sample Cases	18
Analyses	20

# Introduction

Proximal femoral osteotomy is an important operation applied to children.

It may be applied as a surgical treatment option especially for pediatric cases such as Developmental Dysplasia of the Hip, Cerebral Palsy, Legg-Calve Perthes Disease, Slipped Capital Femoral Epiphysis.

Surgical applications in this context can be listed as:

- 1- Intertrochanteric osteotomy,
- 2- Varus osteotomies with excision of the trochanter minor,
- 3- Valgus and valgus rotation osteotomies for the femoral heads,
- 4- Rotation osteotomies above or below the trochanter minor as required.

Different fixation devices such as angled blade plates which their effectiveness have been accepted in order to stabilize osteotomies.

However, additional fixation or usage of additional implants is needed for the reason of that fixing inadequacies could be seen in the case of poor bone quality.

To reduce the negative points, these type of implants could need additional fixation materials like plaster from time to time, that surgical application techniques of Angled Blade Plates have some difficulties and dangers, the need for additional fixation or use of implants because of rotational instability in implants like pediatric sliding hip plates, time loss during surgery to adapt other different locking plates (Proximal Humerus, Distal Radius plates etc.) to the anatomy of this region, have brought up new implant needs.

To meet those requirements; Pediatric Locking Hip Plates that are easily applied over the guide Kirschner wires placed into the neck of the femur, through the guide holes on the proximal part of these plates specially designed and compatible with the anatomy of the region, having holes that supply different angles of varization and valgization with locking screws, providing the desired rigidity by locking especially in patients having cachectic-osteoporotic bone structure, having low-profile, having high rotational and angular stability and thus minimize the needs for additional post-operative fixation, have been developed.

LC Pediatric Hip Plates; it's a unique set for Pediatric Proximal Femoral Osteotomy applications that allows the application of medialization besides options for locking & non-locking, cortical and cancellous screws in various diameters and lengths, presented with the rich instruments support with the ease of use.

Also in the set; there are 120° Trauma Fracture Fixation Plates that are each designed for angular stability during fixation of proximal femoral fractures, allowing application of three screws pointed to the neck of the femur through special 120° angled holes on its proximal part. While making compression with one of these screws, angular stability is provided by the other two.

## Indications

Pediatric Locking Hip Plates can be used for fracture fixation and osteotomies of the proximal femur in children, adolescents and small statured adults.

Situations in which it's particularly used can be listed as;

Collum femoris and/or pertrochanteric fractures,

Intertrochanteric rotational and/or varus osteotomies

Intertrochanteric valgus and/or rotational osteotomies

## Features of the Implants

This set prepared for orthopedics those engaged in pediatric orthopedic surgery, with the aim of meeting their needs of implants and instruments in this field; is specifically designed for stable fixation of varus, valgus or rotational osteotomies and trauma applications.

Owing to this special designed Locking Screw-Plate Angular Fixation;

The risk of primary and secondary loss of correction has been reduced by this system. When compared with angled blade plates; it provides optimum fit with the screws designed according to the needs and ensuring fixation of the femoral neck at different angles, can be sent through the locking screw holes on the proximal part of the plate, and providing possibilities of flexible application and re-correction even in different situations during the operation, having various diameter and length options.

Owing to the guide hole between the two screw holes located on the proximal part of the plate and having the same angle with the screws to be sent to the neck and also guide K-wire sent through this hole, application errors of the screws pointed to the neck are minimized. Fixation will be even more strengthened through a calcar screw routed differently. Limited contact of the plate with the periosteum minimizes damage to the blood supply.

The plate design is intended compatible with right and left proximal femur.

Owing to the combined hole in the shaft of the plate, it allows fixation with locking fixed-angled screw applications or non-locking screw & axial compression applications through the same hole.

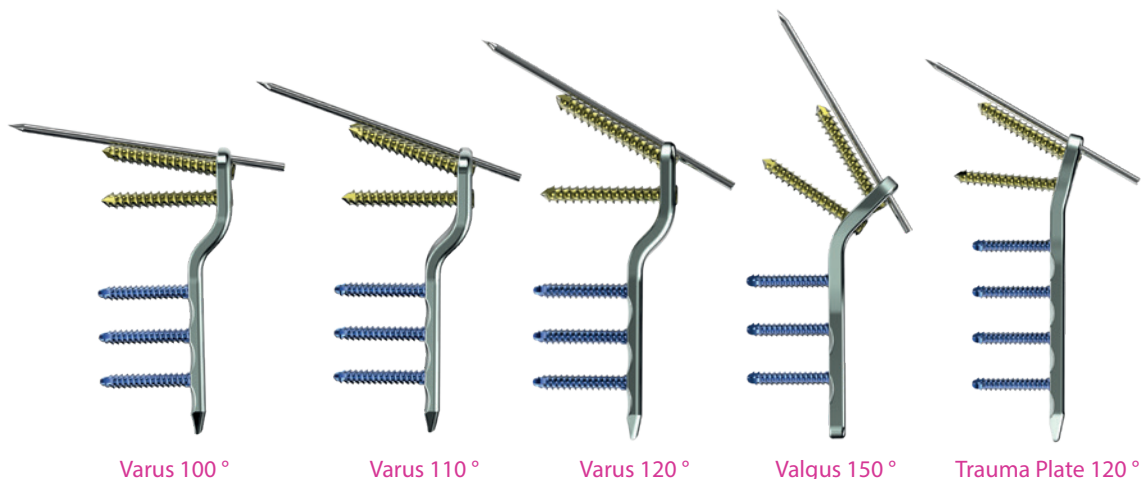
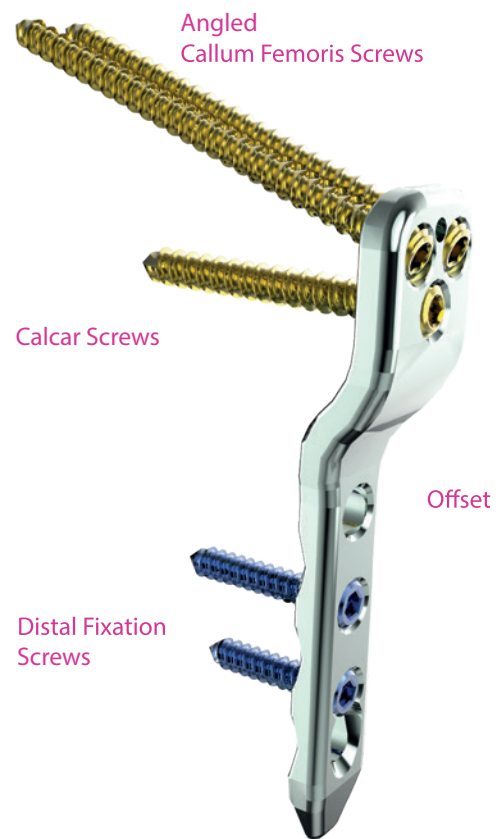
The proximal parts of the plates of 100°-110°-120° designed for varus osteotomies have offset structure.

The 3.5 mm small plate has an 8 mm offset and the 4.5 mm standard plate has a 10 mm offset.

Considering simultaneous bilateral application requirements, There are a couple of each types of plates in the set. 3.5 mm Small Plates are used with cortical screws of 2.7 mm, 3.5 mm and special spongy screws having diameter of 4 mm.

As for 4.5 mm Standard Plates, cortical screws of 5 mm and spongy screws of 5.5 mm are used.

Locking Pediatric Hip Plates of 100°-110°-120° for Varus osteotomies, 150° for Valgus osteotomies and anatomic 120° for fracture fixation are available in the set.



# Surgical Technique

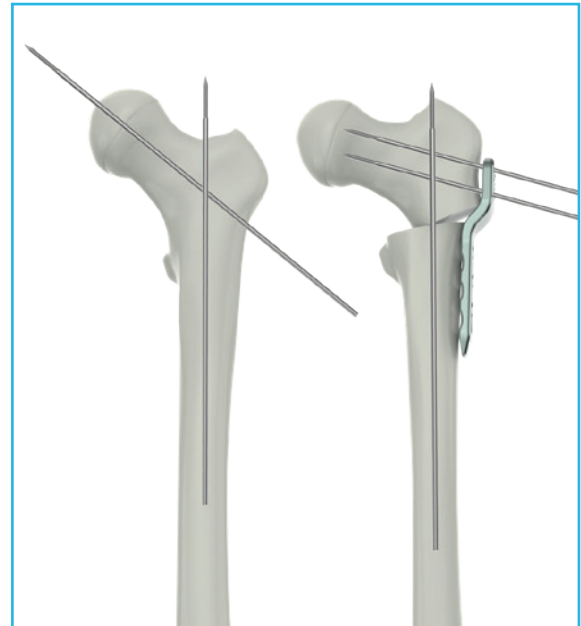
## Surgical Technique 1

Surgical technique applied with the determination of collo-diaphyseal angle; the proximal screws are placed parallel to the axis of the femoral neck by determining the final collo-diaphyseal angle through the plate/screw angle existing.

In pre-operative preparation; collo-diaphyseal angle is identified and the amount of the planned correction is simulated with templating on AP radiographs.

Plate selection is made according to the patient's age, weight and anatomy, by means of evaluation of the AP and lateral radiographs.

In general; For the patients of 2-9 years of age and average under 40 kg, 3.5 mm Small Plates can be used; As for the patients between the ages of 9-17 and up to 60 kg in weight, 4.5 mm Standard Plates can be used.

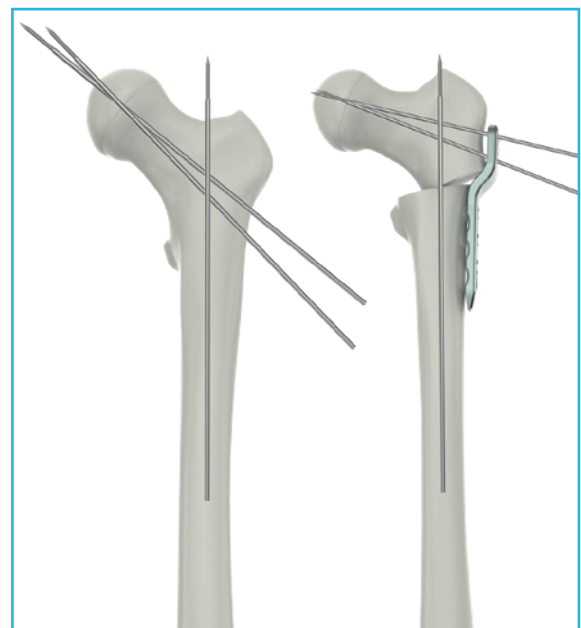


## Surgical Technique 2

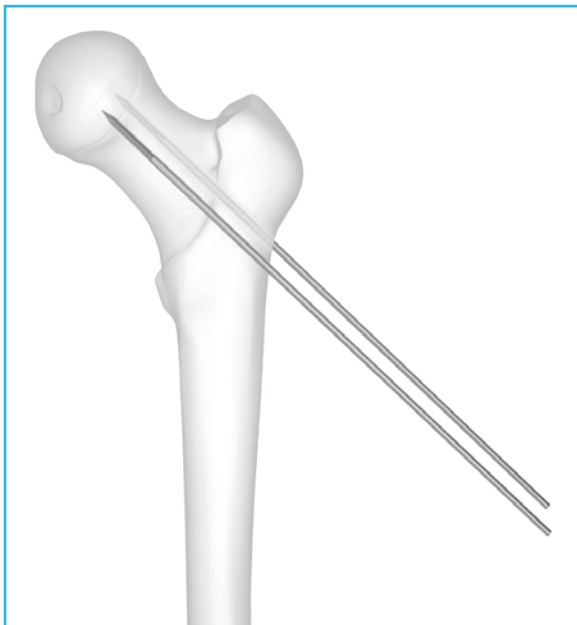
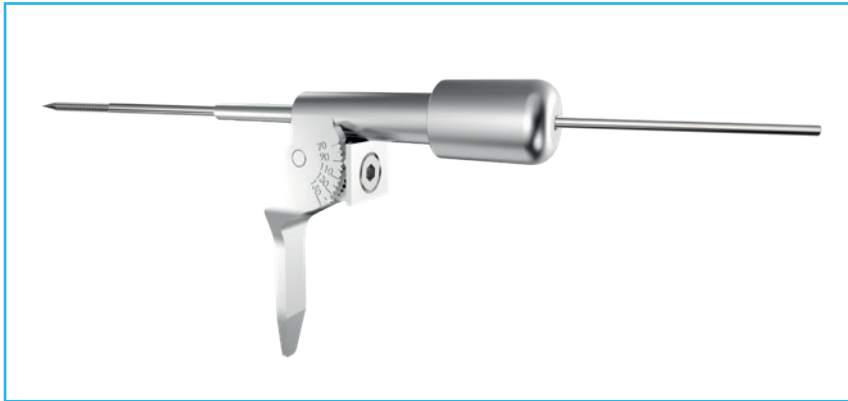
This technique applied by calculation of Collo-Diaphyseal angle is a technique developed on the basis of Muller1 intertrochanteric osteotomy technique. It may be preferred if the correction desired final Collo-Diaphyseal angle and the existing plate-screw angle are different from each other.

The patient's current Collo-Diaphyseal angle before the operation and the desired Collo-Diaphyseal angle are determined, and the correction angle is calculated before surgery.

**Correction angle = Collo Diaphyseal angle before surgery - Collo Diaphyseal angle after surgery**



This correction angle calculation will be required in subsequent operations for positioning the K-wire 2 mm in diameter with Adjustable K-wire Guide.



The Adjustable K-wire Guide is prepared by using a screwdriver according to the angle determined during pre-operative planning. This angle is calculated according to the correction (varus or valgus) determined prior to the operation, and the angle of plate to be used.

A Threaded Tip K-wire of 2 mm is sent to the neck of the femur through the Adjustable K-wire Guide, so that access point will be 5 mm distal to trochanteric physis on AP view, and in a position centering the neck on the lateral view.

For Correction of Varus; Positioning  
K-wire Angle = Plate angle + Correction angle

Example: If 110° varus plate is wanted to be used for varus correction angle of 25°, the angle of The Adjustable K-wire Guide is set at 135°  
(135°=110°+25°)

For Correction of Valgus; Positioning  
K-wire Angle = Plate angle - Correction angle

Example: If 150° valgus plate is wanted to be used for valgus correction angle of 20°, the angle of The Adjustable K-wire Guide is set at 130° (130°=150°-20°)



The patient is positioned “supine” or lateral position on the table. From the lower abdominal region to the fingers are prepared in sterile and covered in the way that both lower extremities will allow rotation control during surgery.

Skin, subcutaneous and fascia lata are passed by and reached to vastus lateralis muscle with a longitudinal incision of 8-10 cm in the way that the greater trochanter will be in the middle, in accordance with the standard lateral approach technique. The lateral side of the proximal femur is reached by lifting vastus lateralis in inverted L-shaped.

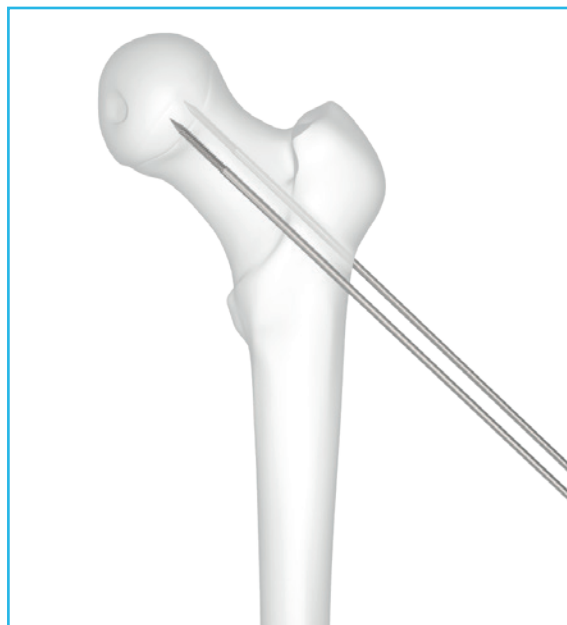
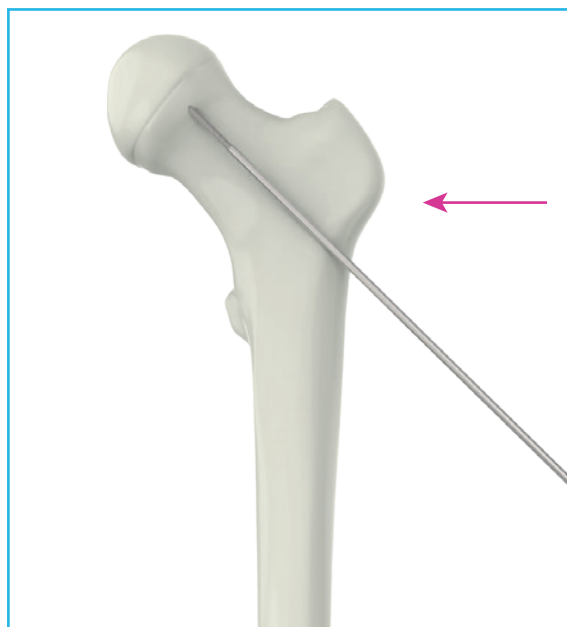
In this section, the first surgical technique and the proximal femoral varus osteotomy is described by using a 3.5 mm Small Plate of 110°.

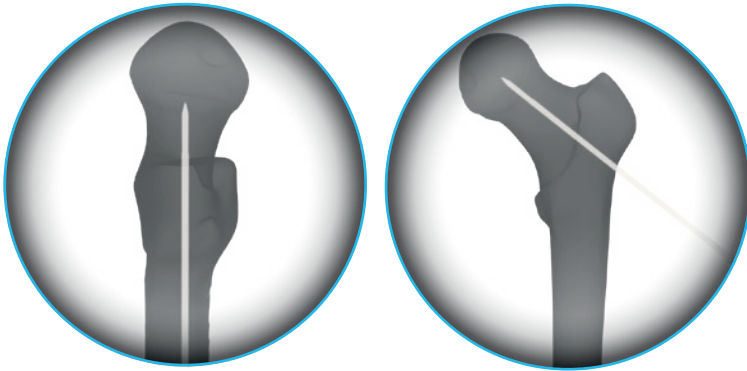
*Differences in application of 4.5mm Standard Plate are described with red letters in the catalogue.*

Firstly, the greater trochanter physis is determined by a marker. A Ø 2 mm Threaded Point K-wire is placed to the femoral head by being checked with fluoroscopy by sliding from the anterior of the femur parallel to the neck axis. This process will facilitate placement of the other Ø 2mm Threaded Point K-wire (positioning wire) which will then be applied to exactly parallel to the center line of the femoral neck and will be a guide for the correct anteversion angle.

At this step, the positioning K-wire which will be sent to the femoral neck through the guide hole on the proximal part of the plate, and having function as a guide for the screws must be sent in parallel to the axis of the femoral neck in the way that it will be parallel to the anteversion K-wire sent in first. Entry point must be 5 mm distal to the trochanteric physis on AP view, and the K-wire must be directed to the head in the way to be in the center of the femoral neck on lateral view. This K-wire placement by sending it in the correct position is very important for a successful surgical application. So the placement of two screws which are inserted from the proximal part of the plate is provided as parallel to the neck of the femur.

“Incorrect orientation of the blade to the posterior cortex of the femoral neck” that could be seen during angled blade plate applications may increase the risk of femoral neck fracture. In this technique, by inserting locking screws instead of a blade to the proximal fragment; “the orientation errors” in very low probabilities are then resolved with the use of shorter screws in the direction of the incorrect orientation.





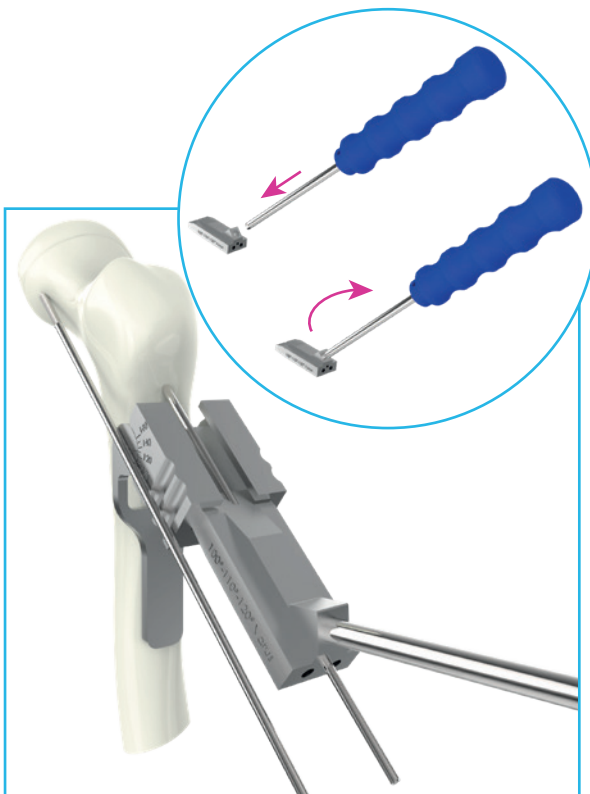
After this second K-wire is placed appropriately, the first K-wire on anterior of the femur can be removed and taken away.

The appropriate placement is approved by controlling the position of the K-wire with the radiographs in AP and frog-leg positions.



The Position Device is placed in the way to center this position-approved K-wire, to ensure the placement of the Plate Guide Block and to determine flexion-extension.

Being loosened of the installation screw of this instrument should be checked. Otherwise its placement will be very difficult.



These Position Device and Plate Guide Block which their installation has been completed must be aligned with the femoral shaft in neutral position, and in contact with the lateral side of the femur.

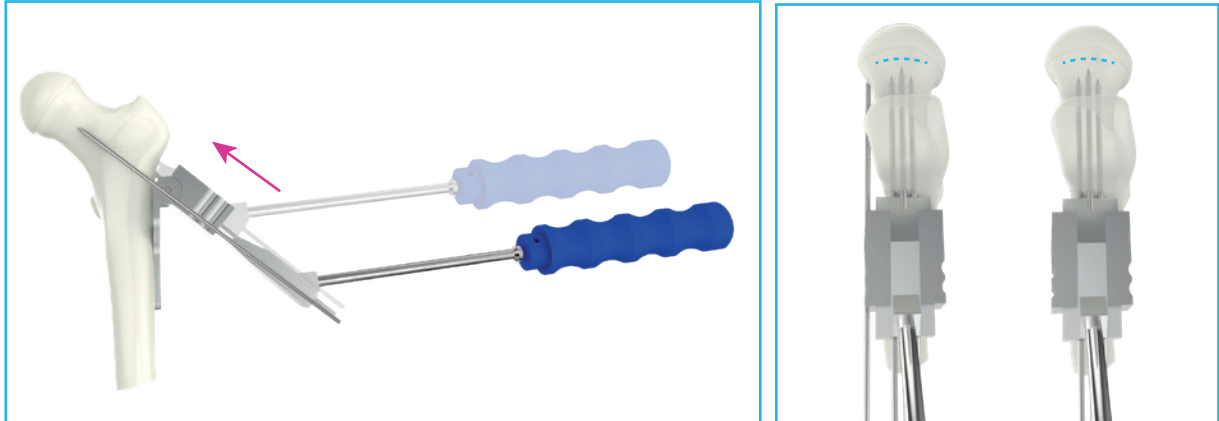
The Plate Guide Block can be used with or without the Position Device. But if necessity of determining flexion and extension during osteotomy exists, it allows that.

2.7 mm K-wire is placed by sending it through the Plate Guide Block and until the average distance of 5mm to the proximal femoral physis.

After appropriate placement of the other second 2.7 mm K-wire also by following the same steps, the Position Device and the Plate Guide Block are removed and taken away.



The appropriate placements of the K-wires and not damaging the physis must be approved on AP and lateral views with fluoroscopy.



## Osteotomy Operations

Proper osteotomy position when 3.5 mm Small Plates are used; must be average 10-15 mm distal to the entry point of the K-wires oriented to the femoral head (When 4.5 mm Standard Plates are used, this distance must be 15-20 mm).

This distance is measured by using an Osteotomy Ruler and marked.



After the correct distance is marked; In order to make rotation control, a sign is put with the Chisel in the way to appear on the anterolateral edge of the femur along both 20 mm proximal and distal to the osteotomy line.

Note: For planned rotational osteotomy; Rotation control can be done by placing K-wires in the trochanter major and the distal fragment. Even if rotation hasn't been planned, fixation of the bone fragments in the correct position is achieved by using the methods of two K-wire placement or marking.





Osteotomy is performed with an Oscillating Saw or the Chisel in the set, in the way to be perpendicular to the axis of the femoral shaft and by taking care of the medial cortex. Intertrochanteric osteotomy must be carried out transversely, slightly above the trochanter minor by protecting it.

The most distal lateral edge of the proximal femoral fragment can be straightened with a bone cutting instrument (Bone rongeur), to provide a better fit of the bone to the plate and to prevent disturbing protrusion of the plate under the skin especially in cachectic children.



## Plate Application

2.7 mm Threaded Drill Sleeve Guides are placed through the two holes in the proximal part of the plate, and tightened firmly (*4.2 mm Drill Sleeve Guides are attached to 4.5 mm Standard Plates, and Reduction Sleeves are placed into them*).

The prepared plate are positioned by sliding it over the K-wires which are oriented to the femoral head

Reduction Forceps can be used for stability and rotational control of the proximal fragment. In this way, the plate position can be maintained unchanged.

Fixation of the proximal fragment is always carried out by using locking screws.

## Exception Status in 120° Trauma Plate

For femoral neck and trochanteric fractures, when compression between fragments is necessary; while needed compression is performed with one Partial Threaded Cancellous Screw of 4 mm through any one of three parallel holes in the proximal part of the plate angular stability is provided with the locking screws inserted through the remaining two holes. (Implants and instruments required for this application: Partial Threaded Cancellous Screw of 4 mm, 3.2 mm Bone Drill and compatible 3.2 mm Drill Sleeve Guide are available separately from the contents of the set).

*(For 4.5 mm Standard Plates; Partial Threaded Cancellous Screw of 5.5 mm, 4.2 mm Bone Drill and compatible 4.2 mm Drill Sleeve are used for this process)*

## Placement of the Proximal Screws

Measuring Device for 2.7 mm Guide Wire 100 mm is used over K-wires to determine the lengths of the screws.

The cannulated part of the Measuring Device are placed properly over the K-wire by sliding it until the Drill Guide, and so measurement is performed.

*(For 4.5 mm Standard Plates; the Reduction Sleeve in the Drill Sleeve Guide of 4.2 mm is removed and then measuring process is carried out, then the K-wire is removed and for 5.5mm cancellous screws this hole must be enlarged with the 4.2 mm drill bit).*



After determining the appropriate screw length, one of the K-wires in the proximal part and the Drill Sleeve belonging to it are removed and then a Locking Cancellous Screw in appropriate length is inserted.

The same process is repeated by removing the other K-wire in the proximal part and the Drill Sleeve belonging to it.

2 mm Treaded Point K-wire is removed from the guide hole of the plate.



## Placement of the Calcar Screw

2.7 mm Treaded Drill Sleeve Guide is inserted into third hole in the proximal part and then both cortices are drilled with the 2.7 mm drill bit.

*(For 4.5 mm Standard Plates, drilling is performed by using 4.2 mm Drill Sleeve Guide and 4.2 mm Drill Bit.)*

Then the Drill Sleeve Guide is removed, and the length of the screw to be used is determined with the Depth Gauge and the Locking Cancellous Screw in appropriate length is inserted in this hole.



## Fixation of the Distal Fragment

The plate must be aligned parallel to the axis of the femoral shaft, otherwise it may lead to differentiation of pre-planned neck/shaft angle. The plate can be kept in place and in correct alignment with the Bone Holder Forceps.

Temporary fixation, together with the Drill Sleeve to be attached to the last threaded hole in the distal part of the plate and the Forceps placed over it and/or with the K-wire compatible with the Sleeve, can be performed for the error-free completion of this osteotomy process.

Distal fixation can be achieved with locking and/or non-locking 3.5 mm Self-Tapping Cortical Screws.

For special cases, 2.7 mm Self-Tapping Cortical Screws are available in the set.

Drilling is performed through the 1st hole in the plate shaft, by aid of the Drill Sleeve and with the 2.7 mm drill bit. *(For 4.5 mm Standard Plates; 5mm Cortex Screw and compatible 4.2 mm Drill Sleeve and 4.2 mm Drill are used for this process.)*



Then the Drill Sleeve is removed, and the length of the screw to be used is determined with the Depth Gauge; and the Cortical Screw in appropriate length is placed into this hole.

Motion, rotation and stability controls are made, and the process of closing the incision is begun.

Bleeding is controlled and a hemovac drain is placed under the fascia, and the layers are closed properly.

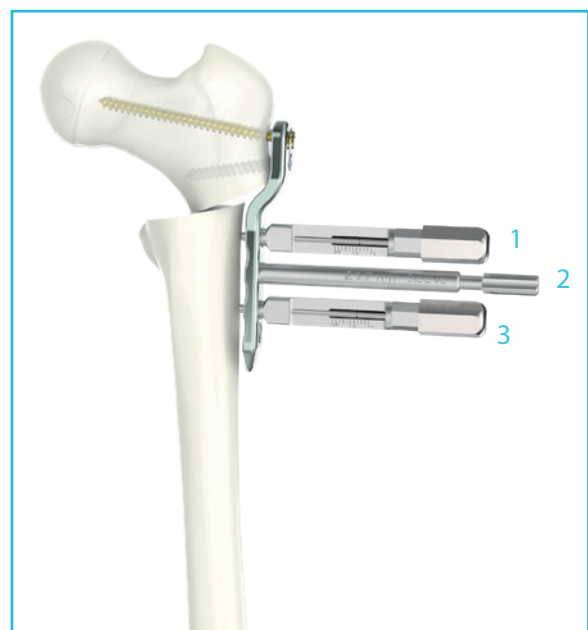
*Note: In order to avoid problems in removing the locking screws; It's recommended not to use quick release screwdriver bits under power during inserting the screws; if necessary to use, to use in low speed and that final tightening must be certainly done manually with the screwdrivers having torque limiting attachment.*



## Medialization Procedure

The distal part of the plates are designed to allow medialization. Desired medialization distance is adjusted on the Medialization Devices, and these instruments are attached in the way that their threaded tips will be placed into the 1st and 3rd locking holes of the plate.

The threaded tipped 2.7 mm Drill Sleeve Guide is attached into the other remaining 2nd hole, and pre-drilling process is carried out with the 2.7 mm drill bit. Then the Drill Sleeve is removed and the length of the screw to be used is determined with the Depth Gauge, and the 3.5 mm Self-Tapping Locking Cortical Screw in appropriate length is placed into this hole.



At this stage, the Medialization Device in the 1st hole is removed first and instead of this, 2.7 mm Threaded Tip Drill Sleeve Guide is attached; and pre-drilling process is carried out with the 2.7 mm drill bit. Then the Drill Sleeve is removed and the length of the screw to be used is determined with the Depth Gauge, and the 3.5 mm Self-Tapping Locking Cortical Screw in appropriate length is placed into this hole.

The same process is repeated for the 3rd hole of the plate, and the Locking Cortical Screw is placed; the locking process is completed while the distance between the plate and the bone exists. In this way, the fragment is displaced to the medial by the Locking Pediatric Hip Plate doing a task just as an external fixation. *(The Medialization process for 4.5 mm Standard Plates; is performed by using the Medialization Device having the tip compatible with the hole of the plate, 5 mm Cortex Screw and compatible 4.2 mm Drill Sleeve and 4.2 mm Drill Bit.)*

## Rotation Osteotomy

If the rotation osteotomy will only take place without changing the neck-shaft angle, the threaded tipped 2 mm guide K-wire sent to the femoral head must be placed at an angle of 120°. Similarly with the techniques for the other plates; the process can be completed by using 120° 4 holes Trauma Plate and 120° & 150° Plate Guide Block of this plate.

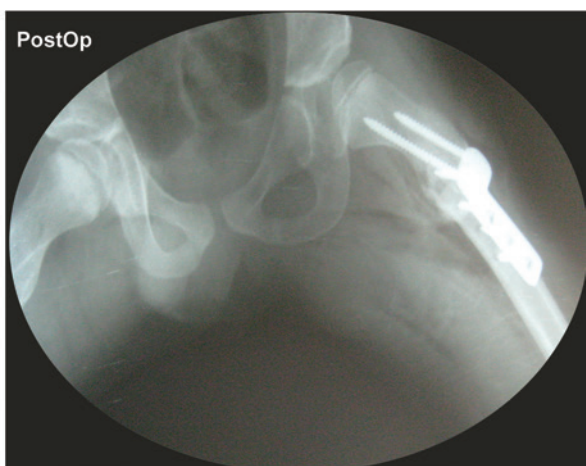
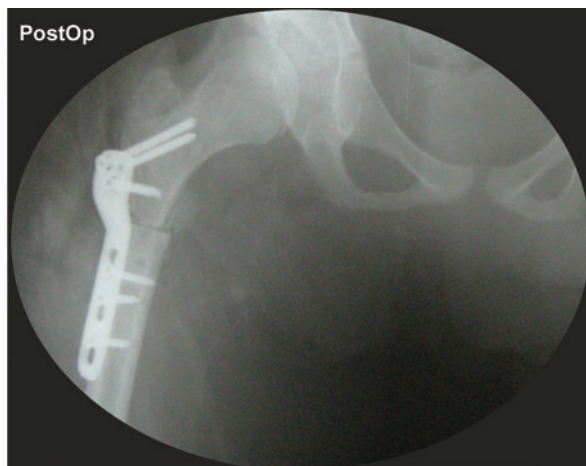
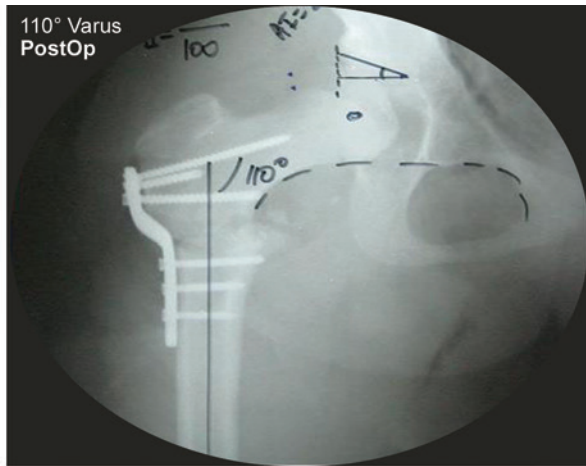
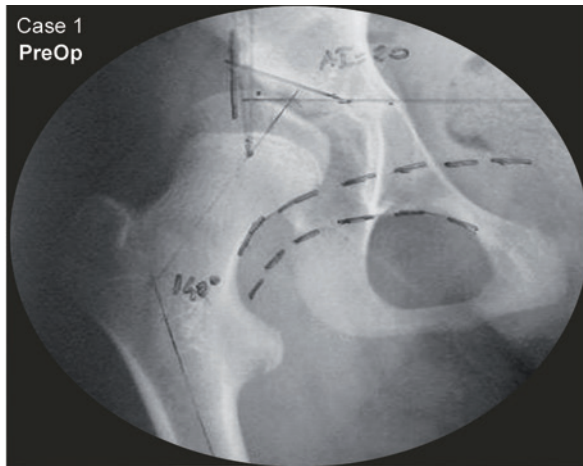
## Proximal Femur Fractures

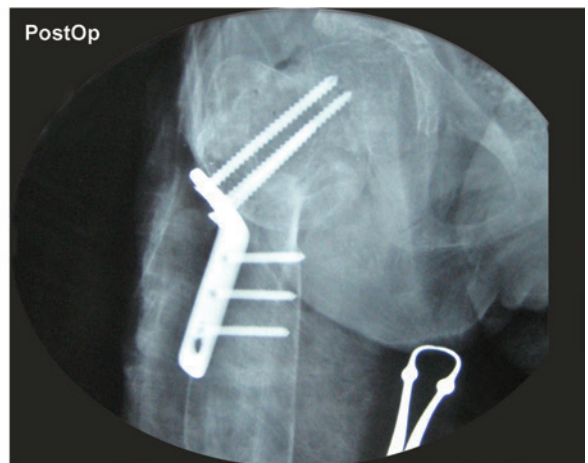
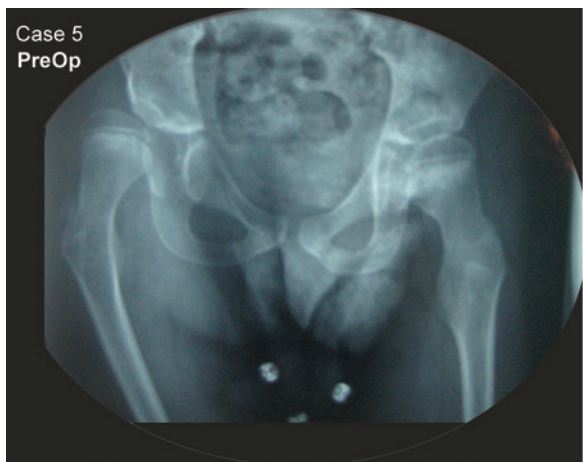
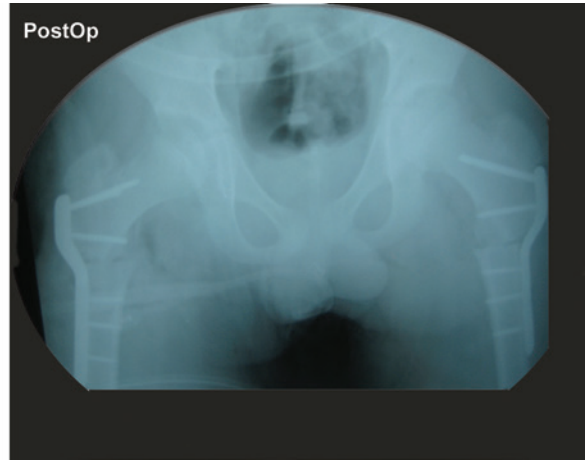
Although the fracture fixation varies according to the severity and the classification of the fracture; it can be performed by using the 120° Trauma Plate having four holes on its shaft, and the locking-nonlocking screws compatible with the plate. After compression is performed, angular stability must be ensured by using the locking screws.

For implant removal; it can be decided according to the results of clinical and radiological evaluation to be made after about 6-8 months.



# Sample Cases





# Analyses

Fixation of the Locking Pediatric Hip Plate and the Angled Blade Plate to the models of the proximal femoral osteotomy (transverse osteotomy, non-anatomical reduction) were applied.

Tensile force of 1000 N in the manner to form pull-out strength, from the regions marked with purple arrows in the following figures was applied to both plates.

Fixation was applied to the femoral head in the areas indicated by the green arrows in the pictures.

As a result of the applied tensile load (1000 N), max. Stress on the Angled Blade Plate was 390758.6 kgf/cm<sup>2</sup>, and this value as for the Locking Pediatric Hip Plate was max. 19316.5kgf/cm<sup>2</sup>.

As a result of comparison of the max. Stresses occurring on the plates; it's seen that the Locking Pediatric Hip Plate has been exposed to less stress (strain) than the Angled Blade Plate.

Fatigue analysis was based on 1.000.000 cycles. As a result, while an increase in deformation area was observed in the Angled Blade Plate after 100.000 cycles, deformation in the Locking Pediatric Hip Plate after 1.000.000 cycles was not observed.

