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FRACTURES OF TIBIA WITH INTERLOCKING NAIL- EVALUATION OF RESULTS IN OUR GOVERNMENT GENERAL HOSPITAL.

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ABSTRACT Fractures of tibia are among the most common fractures accounted in orthopedic practice since the bone is subcutaneous and is load bearing bone in lower extremity. Its fracture may result in extensive disability unless treatment is appropriate. Few topics regarding the care of fracture are as controversial as that of the treatment of fractures of shaft tibia because of high prevalence of complications associated with their management and so optimum method of treatment remains a subject of controversy. It is therefore incumbent on part of orthopedic surgeon to be skilled in a variety of treatment methods including closed functional bracing, external skeletal fixation and closed reduction and internal fixation.

Some authors documented their experiences with functional bracing in the successful management of closed tibial fracture. However not all fractures are amenable to brace treatment and the method is also not devoid of complications viz., shortening and angulation. In recent years, closed intramedullary nailing has become the method of choice for treatment of tibial fracture.

Conventional method of treatment of compound fractures aims at achieving good soft tissue coverage after debridement and external fixation followed with definitive management after wound healing. However infection, delayed union and non union are generally acknowledged as a sequelae for compound fracture.

Intramedullary nails without reaming have been employed successfully in the treatment of tibial compound fracture and have been associated with low rates of post operative infection.

This study of 25 cases is endeavored to study surgical techniques of interlocking nail and to evaluate its result in the treatment of closed and open fracture of tibial shaft.

It may seem to be a drop in the ocean, but we hope that it is the one, which will represent the best of all in the relevant situation.

KEYWORDS : Fracture, Interosseous, Haemodynamic, Interlocking, Dynamisation, Malalignment.

AIMS AND OBJECTIVES

1. Pre-operative assessment evaluating the age group affected, type of fracture, mechanism of injury and associated soft tissue status and plan surgical procedure.
2. To analyze the efficacy of closed intramedullary interlocking nail in achieving anatomical reduction and stable fixation and early return to function
3. To note the difficulties encountered in the operative procedures.
4. To study the intraoperative and postoperative complications.
5. To study the duration of period of union in different age, sex and types of fractures.

MATERIALS AND METHODS

The present study is carried out during November 2013 to october 2015 at king George hospital, visakhapatnam. Total 25 cases of fracture tibia were stabilized with tibial interlocking nailing and followed up for a period varying from 6 months to 18 months. Inclusion Criteria:

1) Fracture at least 5 cms from knee and ankle joints.
2) Closed and Open tibial shaft fracture Type I.

Exclusion Criteria:

- Patients with Grade Ill a, b, c open fracture and those with fracture in most proximal and distal fifths of tibia.
- Patients with limited prefracture level of activity.
- Patients with manifested infection.

Tibial interlocking nail was used for 25 fresh tibial fractures and no non unions. Of the 25 tibial fractures 18 were closed tibial fracture and 7 were open fractures. 6 closed fractures were displaced and lost reduction during non-operative plaster cast treatment and were taken up for closed nailing.

Mechanism of Injury:

Tibial shaft fractures are caused by either direct violence as in motor vehicle accidents, indirect stress and penetrating trauma. Direct violence accounts for an increasing number of tibial fracture. The exposed subcutaneous location of tibia offers little protection against direct blow and in a present day industrialized society, high energy trauma as a result of motor vehicle or pedestrian accidents involves the tibia in over 15% of accidents and is commonly associated with fracture of ribs, face and head. These high energy fractures, frequently are open with significant loss of skin, soft tissues and bone. Indirect injuries occur more commonly from recreational activities of falls from height. If foot is anchored during fall, the torque is applied to tibia and, if the foot is twisted, the force is transmitted to the tibia. This type of injury results in a either spiral / oblique fracture with minimal soft tissue injury. Most fibula fractures result from same injury that causes the associated tibia fracture. The rare, isolated fibula fractures results from direct injury. Severe comminution of fibula or diastasis of the interosseous membrane between tibia and fibula indicates unstable fracture with relative devascularisation of fracture fragments and surrounding soft tissue envelope, along with a tendency for a higher rate of delayed union, and non union. The fracture configuration conveys information regarding mechanism of injury and whether low energy on high energy injury.

PROTOCOLAT AED:

Mode of injury:

A detailed history was obtained regarding the mode of injury to assess the velocity of trauma and mechanism of injury, the time of accident and any primary treatment received. Past history of any medical illness is noted.

General Examination:

The general condition of patient was evaluated with respect to Haemodynamic status and associated significant injuries and accordingly patient was stabilized.

Local Examination:

Deformity of leg, usually angulation or rotation of foot is most obvious clinical sign. Palpation of tibia along subcutaneous border will localize the fracture line or defect. Tenderness is mostly over fracture site. Local swelling occurs rapidly from bleeding and soft tissue reaction. Swelling and tightness of the individual compartments of leg is noted and recorded.

The soft tissue injuries were classified according to the system of Gustilo et al(1).

Special attention was given to distal neurovascular status viz., Peroneal nerve injury in a flbular neck fracture (foot drop) or damage to major blood vessels like anterior tibial, posterior tibial and

dorsalispedis arteries (presence or absence of arterial pulsations) were noted.

Investigations:
Roentgenograms of the extremity in 2 planes A.P. and lateral with inclusion of one joint above and below the fracture.

Routine haematological and surgical profile were done to evaluate the status of patient, to assess fitness for anaesthesia For description tibia was divided in 3 zones of equal length proximal 1/3, middle 1/3 and distal 1/3.

Initial treatment:
Patients with closed stable fracture patterns, were taken up for manipulation and plaster cast under general anaesthesia, If reduction was acceptable it was followed up regularly with check x ray every 3 weeks, If reduction was lost or not acceptable patient was taken up for closed tibial interlocking nail.

In a open fracture, wound was cleaned with hydrogen peroxide and irrigated with 4-6 litres of normal saline and sterile dressing pad soaked in betadine was kept over it.

Fracture was immobilized with above knee POP slab support and elevated over 2 pillows.

Medicines:
All patients were given analgesics.

Antitetanus prophylaxis and antibiotics with 1st generation cephalosporins with metronidazole were started for open fractures.

IMPLANTS AND INSTRUMENTATION
The interlocking nail for the tibia has two transverse holes approximately 5 cms apart from proximal end and a distance of 1 inch between 2 holes. 3 holes at the distal end of the nail of which 2 holes are of transverse and 1 in anteroposterior direction is in between them. They are available in sizes ranging from 8-14 mm in the increments of 1mm diameter and from 280-400mm in lengths. The interlocking screws are 3.5mm to 5mm in diameter and vary in shaft length from 25 to 40mm. Differentiation between left and right nails is not necessary: The instruments required are the beaded tip guide wire, curved bone awl, cannulated flexible reamers, proximal jig etc.

The C-arm image intensifier is a prime requisite for closed interlocking intramedullary nailing.

PRE-OPERATIVE PLANNING:
The nail length was measured by TMD (Tibial tubercle and medial malleolar distance) method. The TMD is determined by measuring the length between highest point on the medial malleolus and tibial tubercle. The size of nail corresponds to the width of isthmus on X-ray after making the deduction of radiological magnification. Nails of varying length and width were kept available during surgery.

OPERATIVE TECHNIQUE:
The patient was placed supine under suitable anaesthesia and under strict aseptic conditions, on an ordinary radiolucent table, facilitating c-arm viewing. When an ordinary table is used, an assistant is required for giving traction and holding reduction. The uninjured leg is placed in such a way that it does not interfere with positioning of c-arm machine. The c-arm fluoroscopic unit is draped and positioned on the unaffected side of the patient. The limb is prepared and draped under strict aseptic precautions. A midline vertical skin incision is given corresponding to mid point of patella to about 3-4 cm below the tibial tuberosity. The patellar tendon is split vertically for 4-5 cms is line with main incision and is retracted for exposure of the entry portal. An entry point is made with the help of a bone awl slightly medial and just above the tibial tuberosity. In order to obtain a circular hole, rotate the awl by more than 90° as you push it as far as possible into the medullary canal, until the handle is in line with the shaft axis. Tilt the awl into the axis of tibia at an early stage to avoid penetrating the posterior cortex. Next the guide wire with bulbous tip is passed through the entry portal into the proximal fragment and then across the fracture site (under the image intensifier control, after reduction is carried out by closed manipulation) into the distal fragment. If there is difficult in reduction of fracture open reduction may be resorted. In Communited fractures anatomic reduction is rarely achieved and is not necessary as long as guide wire is in the middle of the medullary canal.

REAMING AND NAILING
Once the reduction is achieved and guide wire is passed into the distal fragment. The tibia is reamed serially with increments of 0.5mm diameter using flexible reamers. During reaming the soft tissue around the entry portal are protected with a soft tissue protector. Then the bulbous tipped guide wire is replaced with a plain guide wire over Teflon tube. Then a nail of appropriate length and diameter 1 mm less than the size of the last reamer is passed over the guide wire with its tip 2- 3 ms above the ankle mortise and the proximal end should be flush with the entry portal so that it do not irritate the patellar tendon. The final position of the nail is checked under C-arm.

INTERLOCKING MODES:
Once the nail is insitu, the guide wire is removed. The choice of static or dynamic interlocking depends on the type and location of the fracture. For Static Locking" screws are inserted on both the sides of the fracture. Communited and segmental fractures require static locking. For dynamic locking only the proximal or distal fragment is secured with two screws, whichever is nearer to the fracture site. Transverse and short oblique fractures in distal one third of tibia are managed by distal locking screws and proximal third fractures above isthmus are managed by two proximal interlocking screws. This controls rotation and allows axial compression at the fracture site with weight bearing. However the recent trend is to do static interlocking for all the fractures as there is increased risk of shortening and malalignment in dynamically locked fractures. The proximal interlocking is done by using a special Zig attached to the proximal end of the nail. Through the holes in the Zig or Targeting device, which correspond with the holes in the proximal end of the nail, holes are drilled and self tapping screws of appropriate length are applied. Extreme care must be taken to avoid injury to popliteal vessels at the back of the knee, while drilling and putting the antero posterior proximal interlocking screw

Distal interlocking screws can be inserted using:
i) Distal targeting device attached to nail,
ii) Distal targeting device attached to image intensifier, or
iii) By free hand technique under c-arm control.

The commercially available nail mounted targeting devices have proved to be unreliable because of long lever arm and torsional deformities of the nail.

In free hand technique a drill guide or a bone awl is inserted through stab skin incision down to the medial cortex and moved back and forth under image intensification until holes in the nail coincides with hole of the drill guide or tip of the bone awl. A cortical rent is made with the help of the bone awl and the cortical hole is then engaged by a 3.2 mm drill bit, to drill holes in the near and far cortex. The locking screw of appropriate length is inserted. The procedure is repeated for other distal screw. For distal interlocking, two screws should always be used to prevent rotation of distal fragment.

WOUND CLOSURE:
All skin incisions are sutured. Antiseptic dressing done and a elastocrepe pressure bandage is applied immediately at the end of surgery.

POST-OPERATIVE PROTOCOL
Intravenous antibiotics were given for 3 to 5 days.

First dressing was done after 2 days and drain removed, subsequent dressings done on 6th and 10th post-operative day. Depending on the status of the wound, Sutures were removed on the 10th day.

PATIENT MOBILIZATION:
Early motions of the knee and ankle was encouraged after 2-3 days. Non-weight bearing walking with support of crutches started within one week. Patient was discharged from the hospital after suture removal within in two weeks depending on the condition of the wound and condition of the patient. Partial weight bearing was allowed at 6 weeks depending on the progression of healing and associated injuries. If required, dynamisation was done at 8-14 weeks when insufficient callus was seen at the fracture site. Patients with associated injuries (those with additional ipsilateral fracture or fracture of opposite limb)

were mobilized when permitted by the respective injuries.

FOLLOW-UP PROTOCOL

Cases were followed up clinically and radiologically every 6 weeks post surgery till the consolidation of fracture and thereafter, every 3 months provided the patients were asymptomatic. All cases were clinically evaluated with subjective and objective findings in the form of pain, swelling, deformity, limb length discrepancy and wound healing, knee and ankle range of movement and weight bearing, respectively. Patient were radiologically evaluated in the form of union status, malalignment and implant failure. The duration of follow up averaged from 3 to 18 months. Demographic, injury related, operative and post-operative data were collected prospectively at the time of admission, at the time of operation and at the time of discharge from hospital. Follow up data were collected from clinic records of subsequent visits.

OBSERVATION AND ANALYSIS

Total 25 cases followed in this Hospital from the period of November 2013 to October 2015.

In our series 88% of the cases were males and rest female and average age was 25 years, involving right limb more than the left.

In this study closed fractures made up of 80% of cases. Open fractures made up of 20% of cases of tibial shaft fractures.

Cause of Fracture:
(TOTAL 25 CASES)

About 94% of the fractures in our series were due to road traffic accidents and most of the fractures were caused by high energy trauma.

Level of fracture:

For description the tibia was divided into 3 zones of equal length, proximal 1/3, middle 1/3 & distal 1/3 and 15 cases in our series were associated with fibular fractures. Ten fractures were transverse, nine were oblique, five had local comminution, and one of the 25 cases were segmental fracture. The time from the admission to the surgery ranged from 24 hrs - 23 days.

3 patients were operated within first 48 hours post injury while 16 cases were operated within the first two weeks post injury. 5 patients were operated after
2 weeks because of medical problems due to which they were not fit for anaesthesia.

Nail Length and Size:

In our series of fractures we used AO interlocking nails of diameter 8-10mm and length ranged from 280mm - 400mm.

The site and the fracture geometry dictated the choice of the locking mode.

The locking screws for these nails are varying from 3.5 to 5.0mm. All nails were locked in static mode. No fracture were left unlocked. In all closed fractures reaming was done. In all cases of open fractures unreamed interlocking nail was done.

The mean operating time was 40 minutes (Range 30-50mm) operating time was appreciably less once were relatively experienced with the procedure. Duration of Hospitalization:

The duration of hospitalization ranges from 5days -7days. Maximum hospitalization in 4 patients is for 4 weeks since these patients had associated musculoskeletal injuries and medical problems for which they stayed in hospital for associated management. The maximum number of patients were discharged within 2 weeks.

Mobilization:

The patients are encouraged to perform range of motion exercises for the knee & ankle along with static & strengthening exercises for quadriceps and hamstrings on 1st post operative day. The patient is also encouraged non-weight bearing ambulation using axillary crutches or walker as soon as pain subsides. Patients with isolated fractures were mobilized by 5th day while that of patients with associated injuries were mobilized when permitted by the respective injuries. Weight bearing was dictated by the fracture pattern, size of the nail and associated injuries.

The patients returns to the orthopedic clinic at 4-6 weeks intervals for routine anterior posterior and lateral X-rays. At approximately 6 weeks post injury. If healing status permits the patient allowed partial weight bearing. Full weight bearing mobilization was dependant upon clinical and radiological evidence of healing. Patients with associated injuries were mobilized when permitted by the respective injuries.

(7) Dynamisation

When there was a delayed union or insufficient callus formation at the fracture site, dynamisation was done by removing the most distant screw away from fracture site at 8-12 weeks to allow collapse at fracture.

Follow-up of the patients in our series between 3-8 months was 60% of the cases, between 9-12 months was 16% and between 13-18 months was **24%.**

RESULTS

The observations were analysed by using subjective and objective evaluation. The functional results were assessed by using Thoressen criteria(2).

1. Subjective evaluation
2. Objective evaluation

1) SUBJECTIVE EVALUATION:

- **Pain** : The frequency of nail related anterior knee pain was noted, 5 patients had mild anterior knee pain, 5 patients had associated pain at fracture site after prolonged walking, which was treated with short course of analgesics and assurance.
- **Swelling** : Three cases complained of mild to moderate swelling over leg and around the ankle joint which was treated with limb elevation and crepe bandage support.
- **Deformity** : There is no deformity in any of the case One patient with ipsilateral supracondylar fracture femur had terminal restriction of movements. The patient were encourage to have physiotherapy. The time taken in weeks to return to various basic activities was also noted.

FUNCTIONAL RESULT

Sl. No.	Thoressen Criteria	Excellent	Good	Fair	Poor
1.	Pain / Swelling	None	Sporadic/ Minor	Significant	Severe
2.	Knee Flexion (in Degrees)	> 120	90 - 120	Upto 90	< 90
3.	Extension deficit (in Degrees)	< 5	5 - 10	10 - 15	> 15
4.	Internal Rotation (in Degrees)	< 5	Upto 10	10 - 15	> 10
5.	External Rotation (in Degrees)	< 10	Upto 5	15 - 20	> 20
6.	Shortening (Cms)	< 1	Upto 2	2 - 3	> 3
7.	Mal alignment of tibia (in Degrees) varus / valgus	< 5	Upto 5	5 - 10	> 10
8.	Pro / Recurvatum (in Degrees)	< 5	Upto 10	10 - 15	> 10
9.	No. of cases	20	3	2	0
10.	Percentage	80%	18%	2%	0%

The over all functional results were excellent in 80% and good in 18%.

2) OBJECTIVE EVALUATION:

a) Peri-Operative Complications :-

We did not encounter any complications.

b) Wound Healing:

Healing of surgical wound was observed. Almost all wounds healed within 2 weeks1 only two patients who had superficial infection required 3 weeks for wound healing.

C) Union:

Union was defined as the presence of bridging callus on two radiographic view and the ability of the patient to bear full weight on the injured extremity, if other injuries allowed. All 25 (100%) of fractures united. The time to union ranged from 12 weeks to 20 weeks with an average of 12 weeks.

d) Range of motion:

Data on the range of motion of the knee flexion are averaged 110

Degrees. Motion of the ankle averaged 20 Degrees of dorsiflexion and 30 Degrees of plantar flexion.

e) Infection:
There was only 2 cases of superficial infection, which resolved with dressing and antibiotics for 2-3 weeks.

f) Malunion:
Malunion was defined as a varus or vagus angulation of more than 5 Degrees, and anteroposteror angulation of more than 10 Degrees and shortening of more than 1cm.

DISCUSSION

Our present study included 25 locked intra medullary nailing done for unstable tibial diaphyseal fractures during the period of November, 2013 to october, 2015 in king George hospital, Visakhapatnam.

-Interlocking intramedullary nailing solves the problem because it provides the ability to control length, angulation and rotation. **Our observations were compared with studies of Wiss and William B. Stetson, Paul Gregory and Roy Sanders and A.G. Riquelme(3)**.

-In our present study which included 25 fractures, 18 (72%) fractures were closed fractures and 7 fractures (28%) were open.

-In the study of Wiss and William B. Stetson there were 101 closed (75) open (25%) fractures (20 Grade-I fractures, 12 Grade-Il fractures and I fracture was due to gun shot wound)(3).

-In our present study 17 (68%) of the 25 cases were due to road traffic accident and 1 (4%) was due to assault. 88% of the cases were in males and rest in females, highlighting the fact that males being mobile in the society are more prone to traffic accident. The median age of 25 years in our study correlates to the fact that younger population is at increased risk of sustaining tibial fractures.

- In the study of Wiss and Stetson there were 108 (82%) males and 23 (18% females. The median age is 32 years with range from 15-66
-In our present study most of the fractures were located in the middle third (52%) followed by middle 1/3; lower third (12%), lower third (20%) and in upper third (12%).

Which is correlating with the study of Wiss and Stetson 69 fractures (51%) in middle third, 40 (30%) in distal third and 9 (7%) in proximal third. In the study of Riquelme et al. there were 12% comminuted fractures.

-In our present study 4 cases (16%) had significant associated injuries. Wiss and Stetson had 59 patients (45%), who had significant associated injuries. In the study done by Paul Gregory and Roy Sanders there were 24 (53%) cases with multiple injuries. In a serial of 50 tibial Grosse Kernpf nailings studied by Riquelme et al(4). 48% of patients had multiple injuries. 12% of which were comminuted.

-In our present study closed nailing was done in 24 cases (96%) and open nailing was done in 1 case (4%), for compound Gr-ll fracture both bones. For 7 of the open fractures unreamed interlocking nail was done.

-Wiss and Stetson used static locking in 62 (46%) fractures and 29 (22%) were dynamically locked. For 43 (32%) fractures a reamed intra medullary nail without locking screws was used. All the nails were locked in static mode in the series of paul Gregory and Roy Sanders.

UNION:
The average time for fracture union in our present study is 15 weeks ranging from 12 weeks to 24 weeks. Bone healing achieved in all cases, with 100% union rate within 6 months.

In their study Riquelme et al. achieved 100% union before 6 months and no non unions. Donald Wiss and Stetson36 in their study achieved fracture union in 88 cases (87%) within 6 months. The average time to union in their study was 28 weeks (range, 12-20 weeks) in closed fractures and 39 weeks in open fractures and they had 14 (8%) cases of delayed union and 7 (5%) non unions. In our present study there were 2 cases (8%) of delayed union, which united after dynamisation. **We did not encounter any non union in our study.** The rate of nonunion is negligible in locked intramedullary nailing as compared to Functional Case Bracing or Plate Osteo Synthesis.

INFECTION:
In our present study 2 cases of superficial infection noted. The infection was Controlled with intravenous antibiotics. The fracture united eventually and there was no chronic osteomyelitis. There was 1 (2.6%) superficial infection and 1 case (2.6%) of osteomyelitis in the study of Paul Gregory and Roy Sanders. There were no cases of superficial or deep infection in the Study of Court Brown et al. In the study of Donald A. Wiss and Stetson, infection developed in 13 (10%) cases. In closed fractures there were 2 (2%) superficial and 3 (3%) infections. In open fractures. There was 1(3%) superficial and 7(21%) deep infections.

DEFORMITY:
In our study 90% of the fractures united with out shortening. We had 2 cases with shortening of 0.5 cm. One case with shortening of 1-2 cm. The shortening in this case is however due to comm united supracondylar fracture of the femur on the same side.

The axial and rotational malalignments in our study were minimal. One patient who had severely communited distal third fracture had 5 Degrees of valgus angulation.

In the study of Paul Gregory and Roy Sanders there were three cases of angular deformity (valgus angulation of > 5 Degrees in two cases and 100 of procurvatum in one case). All these patients had fractures in the proximal third of the Tibia.

WEIGHT BEARING:
In our study the average time for full weight bearing was 12-14 weeks. The results obtained in our present study compare favourably to such similar studies conducted by Riquelme et al, Paul Gregory and Roy Sanders,(5) Donald A. Wiss and Stetsons, The results in our series were comparable with any series.

COMPARISON OF RESULTS

	Whittle, Russell & Taylor & Series (50)	Our Series (25)
Union	42 (84%)	25 (100%)
Range of movements	Knee (any) 139^0 Ankle 16-38	Knee (any) 135^0 Ankle 15-35
Mal union	0	0
Superficial infection	2	2
Deep infection	4	0
Implant failure	5	0

The overall result in our study, 92% EXCELLENT and 8% GOOD. Results were comparable with that of the previous such studies. In the study of Riquelme et al(4) there were 96% EXCELLENT and 4% GOOD results.

Interlocking nail provides the ability to control length, angulation and rotation and thus has advantages of early mobilization of patient, reduced morbidity and decreased time for union with extremely low rates of complications. The indications have widened for LOCKED INTRA MEDULLARY NAILING and it has become the treatment of choice for unstable tibial diaphyseal fractures. However one should keep in mind the affordability of the patient, expertise and familiarity of the procedure and the availability of facilities.

SUMMARY AND CONCLUSION

Our observations regarding the use of interlocking nail in the treatment of fracture of tibia are:

(i) The interlocking nail has widened the range of indications for intra medullary osteosynthesis of tibial shaft fracture.
(ii) Stability is achieved by transverse threaded screws in pre-fabricated holes in the nails which anchor the implant directly to the cortical bone, thereby controlling length, alignment and rotation of the limb.
(iii) It allows early weight bearing and the joint movement.
(iv) It has decreased the morbidity and dependency of patient.
(v) The rates of infection, non-union and malalignment are low unlike those seen in closed reduction and POP cast.

(vi) The risk of refracture after implant removal is very low unlike plate osteosynthesis.
(vii) Interlocking intramedullary nailing has proved to be an excellent mode of treatment for complex, comminuted segmental and unstable tibial fractures especially in the multiple injured patients.
(viii) Since closed nailing does not disturb the fracture hematoma it aids in better healing.
(ix) Static nailing with locking screws above and below the fracture site gives the best stability for the fracture.
(x) Dynamisation allows fracture site to be compressed during weight bearing and helps in promoting union in cases of delayed union.

Interlocking nail for management of fracture of tibia, acts as Internal Splint, which Stabilises Fracture Fragments, Maintains Alignment, Allows Early Mobilization and Promotes Sound Union.

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