Supracondylar - Intercondylar Distal femoral fractures and coronal plane fractures: Association and review of fixation methods

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ABSTRACT
BACKGROUND: An isolated coronal plane fracture of posterior aspect of distal femoral condyle in an unusual injury. Coronal plane fractures of femoral condyle associated with supracondylar intercondylar fractures are not uncommon. The purpose of the study is to measure the incidence and review the fixation modalities of coronal plane fractures of femoral condyle. MATERIALS AND METHODS: 60 patients with supracondylar intercondylar fractures prospectively evaluated clinically, radiologically and intraoperatively. Confirmation of the diagnosis was made intraoperatively. Judgement sampling method was used. RESULTS: Coronal plane facture was associated in thirty six patients (60%) of the 60 patients. Out of 36 patient in 26 (72.22%) patients coronal plane fracture was involving single condyle, 3 (8.33%) patients was having coronal plane fracture medial condyle and 23 (63.88%) was having coronal plane fracture lateral condyle. Rest of 10 (27.77%) was having both condyle fracture in coronal plane. 34 out of total 60 were open fractures (GA type II or more). But almost 67% of coronal plane fracture patients i.e 24 had open injury in comparison to 42% i.e. 10 out of 24 simple intercondylar fractures. 27 out of these 36 patients were obviuos on plane xray to have coronal split but 9 could be identified intraoperatively. CONCLUSION: In this study incidence of coronal plane fracture of femoral condyle was 60%. Coronal split is common association with supracodylar intercondylar fractures due to high energy trauma.

Keywords: Coronal plane fracture with supracondylar fracture, Hoffa fracture.

INTRODUCTION
An isolated coronal plane fracture of posterior aspect of distal femoral condyle in an unusual injury. But fracture is not uncommon when associated with supracondylar or intercondylar fractures of distal femur sustained by high energy trauma. It is first mentioned by Friedrich Busch in 1869. It is described by Albert Hoffa1 in 1904. Letenneur et al2 proposed dividing Hoffa fractures in to three types, based on the distance of the fracture line from the posterior cortex of the femoral shaft. A subsequent report from Lewis et al3 failed to validate this classification.It is classified as a 33B3 according to AO classification. This type of fracture most commonly involves the lateral condyle but medial condyle may also be involved4. Association between intercondylar femoral fracture and coronal plane fracture of distal femoral has received attention because it is an unstable type of intra articular fracture and usually difficult to fix without compromising integrity of articular surface. Operative treatment recommended for combined supracondylar and intercondylar femoral fracture because it provide stability to articular surface and early mobility to joint. Preoperative recognition of this type of injury provides proper planning for surgical approaches, selection of suitable implant and their positioning. Purpose of this study was to measure the incidence of coronal plane fracture in association between supracondylar and intercondylar distal femoral fractures and to review literature regarding fixation planning and methods for better outcomes.

MATERIALS AND METHODS
This study was done in Gajjaraja Medical College and Jayarogya Hospital, Gwalior in between October 2012 to August 2013. Patients were identified through a search of a prospective orthopaedic database, and their records and radiographs were reviewed prospectively. All patients injured due to RTA high velocity trauma coming to the hospital with fracture supracondylar-intercondylar fracture pattern were included. Total of 60 patients with desired pattern of injury were identified. Sample was selected. Criteria for Exclusion was very old age i.e. >70 Yrs, Age below 20 Yr, inoperable patients unfit for anesthesia and neuro-vascular injury to same limb. Sampling method was based on non- probability sampling technique i.e. judgment sample. All patients who were included in study were studied in detail with regards to age, sex, occupation, mode of injury, and other associated injuries, time interval between

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injury and presentation. A thorough clinical evaluation was carried out by Orthopaedic Surgeon, General Surgeon and Physician. Plane X-ray AP /Lateral/ Oblique view was taken. Confirmation of diagnosis was done intra operatively only as we were supposed to operate upon all patients and considered all the patients to have this desired pattern of injury. This fracture were classified according to AO type 33B3. Remaining patients of intraarticular fractures of distal femur were managed by operatively in JAH Hospital, Gwalior. Data analysis was done with Microsoft Excel for frequency of distribution. **Review of fixation technique:** While fixing the Hoffa Fragments it’s always better to keep the knee in flexed position as this helps the posterior fragment to deliver distally against the pull of gastrocnemius and adds to reduction and compression against bony support of tibial plateau and support of collateral ligaments. We usually prefer placement of one partial-thread 6.5-mm cancellous screws in an anteroposterior (AP) direction. The choice of screws may vary; Holmes et al.\(^7\) reported achieving fixation using four 3.5-mm cortical screws in the AP direction, plus washers. The change in the direction of the screw insertion was studied in a biomechanical study by Jarit et al.\(^7\) found the posteroanterior (PA) manner of screw insertion to be superior to AP insertion, taking either a lateral or posterior surgical approach is necessary when using the PA direction, but these carry higher risks. The lateral approach used For putting screws in a lateral condyle hoffa fracture, between the iliobibial band and the biceps femoris tendon, carries risks of damage to the common peroneal nerve and the popliteal vessels. Screws should be as lateral or medial as possible to midline and just proximal to the patellafemoral joint but perpendicular to fracture line to avoid injury to patellar tract, the screw heads have to be countersunk beneath the articular surface, a new fixation method developed by Y. Xu\(^6\) where they used fixation with one screw inserted from the femoral intercondylar notch and two screws inserted from the nonarticular lateral (or medial) surface of the fractured condylar fragment; the two sets of screws were crossed...... Borse\(^6\) treated by open reduction and internal fixation using two headless compression screws. Recently, some investigators\(^1,2\) have suggested that fixation with a single compression screw may be sufficient since fracture site interdigititation and compression may be sufficient to prevent fracture fragment rotation. The disadvantage to the use of multiple screws in fixation of Hoffa fractures is that their placement requires additional violation of the articular surface. The use of larger diameter screws also requires greater area violation of the articular surface. Because screws fixing posterior femoral condyle fractures usually have to be placed through an area of articular cartilage, the ideal fixation construct would use the smallest size and number of screws to minimise the damage to the articular cartilage A cadaveric study\(^11\) compared the stiffness and load to failure of 3.5-mm cortical lag screws, 4.5-mm cortical lag screws, and 6.5-mm cancellous screws used to fix experimentally created Hoffa fractures."

There was no difference in stiffness between any of the groups, but the load to failure was significantly higher for 6.5-mm screws compared with 3.5-mm screws. The investigators questioned whether that result was clinically significant and noted that smaller screws, such as 3.5-mm cortical screws, may be much easier to fit around a rigid implant if such fixation is necessary, as in the case of a supracondylar femur fracture with an associated Hoffa fracture. In biomechanical study by David et al\(^2\) when comparing the single 6.5 mm screw to the use of a single 3.5 mm screw, significantly greater load was recorded at 1.2 and 3 mm of displacement. However, when comparing the single 6.5 mm screw to the double 3.5mm screw construct there was no significant difference in the mean loads at 1 and 2 mm of displacement, and only at 3 mm of displacement was there a significant difference between the mean loads? Concluding, If 3.5 mm screws are used in the fixation of posterior femoral condyle fractures, at least two screws should be used to approximate the biomechanical stability of a single 6.5 mm screw. What master’s technique series\(^1,3\) opinion is “Typically, coronal plane fractures are reduced and stabilized prior to reduction of the intercondylar component. For coronal plane fractures of the lateral femoral condyle, the articular surface can be reduced and compressed with a pointed clamp, followed by placement of lag screws. The location and angulations of the fracture plane determine the direction and location of the screws. Usually, 3.5-mm lag screws can be placed from anterior to posterior, perpendicular to the fracture, and angulated approximately 10 degrees from medial to lateral. The screw heads should be countersunk beneath the patellofemoral articular surface when necessary. For coronal fractures of the medial femoral condyle, angulation of up to 25 degrees from lateral to medial may be required. Two screws are usually adequate for simple coronal plane fractures. “When dealing with coronary splits in Supracondylar with intercondylar fractures the lag screws can only provide interfragmentary compression, there is no available single hardware to both neutralise the physiological shearing stress and, at the same time, easily placed over the posterior side of the distal femur, which is the site
where superior migration of the fragment can be stopped. In order to buttress the fragment against the shearing force, Plating adds to the fixation of posterior condyle. Plates with broad distal expansion, such as condylar buttress plates and locking compression condylar plates, allow screw insertion into the posterior fragment in a transverse manner. This is an uncommon circumstance where the broad distal expansion of these less popular plates may have a modest advantage over the Less Invasive Stabilisation System plate, by providing better coverage of the posterior aspect of the femoral condyles\textsuperscript{19}. In many cases where displacement of the fragments is not much or we can achieve a good reduction temporary fixation with K-wires provides us the opportunity to put the plate directly without using lag screws for Hoffa fragments. Stability of the construction must be tested intra-operatively with adequate knee movement. This reproduces the physiological stresses and intraarticular events that would happen during physical rehabilitation. To achieve favourable long-term results, open reduction, stable fixation with corticocancellous lag screws, buttress plate and early mobilization are mandatory. In fixation of these fragments after putting a lag screws, its, many a time is very difficult to put a locking plate with fixed direction screws in condylar part as the lag screw often hinders the way of locking screws. Again, too much of the negotiation may harm the condyle and end up in further comminution. Physical rehabilitation should be initiated as soon as possible to minimize joint contracture The timing of full weight-bearing after treatment for a Hoffa fracture depends on several factors and has differed considerably in the literature, occurring at 6\textsuperscript{15,17}, 10\textsuperscript{5}, 16\textsuperscript{19}, Again, too much of the negotiation may harm the condyle and end up in further comminution. Physical rehabilitation should be initiated as soon as possible to minimize joint contracture The timing of full weight-bearing after treatment for a Hoffa fracture depends on several factors and has differed considerably in the literature, occurring at 6\textsuperscript{15,17}, 10\textsuperscript{5}, 16\textsuperscript{19}, and 12 weeks\textsuperscript{20}. The clinician must remain vigilant and investigate any unexplained increase in pain or swelling during the course of rehabilitation .In cases of doubt, Lewis et al 11 recommended plaster immobilisation in full extension for 6 weeks, because in such a position the posterior joint capsule is tightened to provide splintage to the condylar fragment, and any axial loading can be borne by the anterior portion of the condyles.

RESULTS

Purpose of this study was to measure the incidence of coronal fracture in supracondylar and intercondylar fracture femur. 36 out of 60 patients had sustained coronal fracture in supracondylar and intercondylar fracture of distal femur. In these study 44 patients are male and 16 patients are females .In 3 patients involving medial condylo fracture, 10 out of 36 were bicondylar involvement. 34 out of total 60 were open fractures (GA type II or more). But almost 67% of coronal plane fracture patients i.e 24 had open injury in comparison to 42% i.e. 10 out of 24 simple intercondylar fractures. An associated coronal fracture is more occurs in open supracondyle intercondylar distal femur then closed fracture probably due to higher velocity trauma. 27 out of these 36 patients were obvius on plane xray to have coronal split but 9 could be identified intraoperatively. Out of total 60 patients 44 patient were male and 16 were female male: female ratio is 2.75. 36 patients (60%) were having coronal plane fracture of femoral condyle.

Table 1: Association with condyles

<table>
<thead>
<tr>
<th>Association with condyles</th>
<th>Coronal fracture</th>
<th>Coronal fracture</th>
<th>Coronal fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>with condyles</td>
<td>Medial condyle</td>
<td>Lateral condyle</td>
<td>both condyle</td>
</tr>
<tr>
<td>Patients</td>
<td>36</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td>Percentage</td>
<td>8.33%</td>
<td>63.88%</td>
<td>27.77%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Out of total 36 patients with coronal plane fracture of femoral condyle incidence of medial condyle fracture was 8.33%, incidence of fracture lateral femoral condyle was 63.88% and both condyle was 27.77% (Table 1).

Table 2: Association of coronal fracture in open fracture Vs close fracture

<table>
<thead>
<tr>
<th>Association of coronal fracture</th>
<th>Patients with open fracture</th>
<th>Open fracture with coronal fracture</th>
<th>Patients with close fracture</th>
<th>Close fracture with coronal fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>34</td>
<td>24</td>
<td>26</td>
<td>12</td>
</tr>
<tr>
<td>Percentage</td>
<td>100%</td>
<td>70.58%</td>
<td>100%</td>
<td>46.15%</td>
</tr>
</tbody>
</table>

Incidence of coronal plane fracture of femoral condyle in open fracture (70.58%) was higher than in close fracture (46.15%) (Table 2).

DISCUSSION

Of the 24 supracondylar intercondylar distal femoral fractures in the study all are not associated with coronal plane fracture. Coronal fracture in association of 36 patients (60%) with supracondylar intercondylar distal femoral fracture is important for surgery and implant choice may be change in finding. Heightened awareness in this pattern of injury should be fully evaluated in all open distal femur fracture for presence of associated condylar comminuation. In unicondylar coronal fracture lateral condyle are more commonly involve than medial condyle. Surgical approach for fixation of distal femur are usually from lateral side. However, medial condylar coronal plane fractures were not as uncommon. Malhotra\textsuperscript{18} suggested that although the Hoffa fracture may affect either condyle, the
preponderance of lateral condylar fractures indicates an anatomical-biomechanical vulnerability due to the physiological valgus. Other studies have implicated direct violence to the knee region\(^\text{21}\), an oblique transverse force resulting from the impact of the upper part of the tibia on the femoral condyles with the knee flexed at an angle \(\geq 90^\circ\)\(^\text{20}\), and direct trauma to the knee combined with an element of abduction\(^\text{3}\). In this case, the fracture resulted from the femoral condyles being squeezed between two heavy pipes, with the force from the lateral side possibly breaking the medial condyle on the pipe on the medial side. Bicondylar coronal plane fractures in association with a supracondylar-intercondylar distal femoral fracture occurred in 10 (16\%) of the 60 extremities. The high-energy nature of the injuries observed in the present series may not reflect the prevalence of associated coronal plane fractures seen in patients with lower-energy supracondylar-intercondylar distal femoral fractures. Since the surgical approach for fixation of distal femoral fractures usually is from the lateral side, preoperative identification of a medial coronal plane fracture can be critical to surgical decision-making. The diagnosis often was missed on plain radio- graphs, with only 75\% of coronal plane fractures being identified with this method of imaging while visual inspection may be considered one of the best diagnostic tools, direct visualization of the medial femoral condyle is not routine during most surgical exposures of the distal part of the femur so we need to develop some other diagnostic tool like CT scan and 3D Imaging to identify the pattern of fractures and plan for fixation. Patients with distal femoral fractures do not routinely require CT. However, the presence of a supracondylar fracture with intraarticular extension suggests that there may be an occult associated coronal-plane Hoffa fracture. Whittle\(^\text{20}\) recommended treatment with open reduction and internal fixation with a lag screw because hoffa fractures, which appear harmless on roentgenograms, may produce a marked disability. If the fragment is not properly reduced, roughening of the articular surface and avascular necrosis may occur. Holmes et al.\(^\text{3}\) also suggested operative treatment because weight-bearing creates shear forces along the fracture line, making nonoperative management unpredictable and adequate stabilization challenging.

**CONCLUSION**

Coronal split is common association with supracondylar intercondylar fractures due to high energy trauma. Confirmation can only be done intraoperatively hence one should be always prepared for such occurrence. In this study incidence of coronal plane fracture of femoral condyle was 60%.

**REFERENCES**


