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Ilizarov Technique for Managing Fractures with Infection:
An Institutional Based Study

Indranil Dutt

Abstract

Background: Multiple treatment modalities have been reported for managing such cases like bone grafting, tissue transfers, antibiotic cement and Ilizarov technique. Bone grafting itself poses limitations of size and morbidity of the donor site. The aim of the present study was to determine the accuracy of Ilizarov technique in managing non-united infected tibial fractures.

Materials and Methods: The present prospective study was conducted in the Department of Orthopaedics, Mata Gujri Memorial Medical College, Kishanganj, Bihar (India) for duration of 2 years. All the subjects were followed up for a period of 10 months. Under complete aseptic conditions, all the subjects were taken up for surgery. Debridement of the area was done, and the material was sent for sensitivity tests. Bone nibbling was performed until fresh bleeding was encountered. At regular intervals, X-rays were taken to determine the radiological extent of bone healing. Assessment was done based on Fernandez Esteve grading. In case of any discharge from the tract, infected pin was removed and exchanged in the same sitting. Once healing was satisfactory, ring and fixator were removed, and cast was applied.

Results: The mean age of the subjects was 38.87±3.22 years. There were 13 males (59.1%) and 9 females (40.9%) in the study. There were 3 males and 2 females with bone shortening of 1-3 cm. The union time amongst them was 6 weeks and the consolidation time was 9-10 months. Conclusion: Treatment using Ilizarov method with infected tibial fractures provides promising results. Optimal fixation was seen amongst subjects in the present study.

Keywords: Consolidation; Fractures; Ilizarov; Infected.

Introduction

Nonunion of infection tibial fractures is common in orthopedic practice [1] and along with this there occur bone and soft tissue defects with inequalities in limb and multiple bacterial infections [2]. Managing such infected tibial fractures poses a great challenge to the clinicians [3]. Multiple treatment modalities have been reported for managing such cases like bone grafting, tissue transfers, antibiotic cement and Ilizarov technique. Bone grafting itself poses limitations of size and morbidity of the donor site. The defects in Tibia and fibula are very different from each other. The bony break generally results from traumatic bone loss at the location of the injury [4]. Due to high energy trauma there is gradually advancing area of cell death and this gap increases with subsequent debridements [5]. Repeated and consistent infection removes away at the end of bone due to various attempts at union. A multidisciplinary approach is required for the management of such cases. The operating team requires skills of limb lengthening, correction of deformity, and bone transport methodology [6-11]. For infected fractures of tibia with small defects antibiotic cement is suitable and bone grafting is
usually not possible for such cases. Other than these techniques may not be suitable for managing infected and bony non-united fractures simultaneously. This is only possible with the use of Ilizarov technique, and infection recurrence was rarely seen [12-14]. Bone transport is a form of Ilizarov technique, and it is apt for managing infected non-united fractures with bone defects of any length. Hence, bone transport technique has proved to be of great advantage in managing infected tibial nonunion. The aim of the present study was to determine the accuracy of Ilizarov technique in managing non-united infected tibial fractures.

Materials and Methods

The present prospective study was conducted in the Department of Orthopaedics, Mata Gujri Memorial Medical College, Kishanganj, Bihar (India) for duration of 2 years. All the subjects were followed up for a period of 10 months. All the subjects were informed about the study and a written consent was obtained from all in their vernacular language. The study included both males and females between the age group of 30 to 50 years with the bone loss of upto 7.5 cm. Subjects failing to give the consent and reporting for follow up were excluded from the study. Subjects with tuberculosis or blood thinning agents were also excluded from the study. Smokers were also not included in the study. Subjects with discharge from the infected site were managed daily with dressing of silver stream solution and it was only when the discharge was minimal that the subjects were taken for surgery. Under complete aseptic conditions, all the subjects were taken up for surgery. Debridement of the area was done, and the material was sent for sensitivity tests. Bone nibbling was performed until fresh bleeding was encountered. The numbers of rings of the Instrument were pre-decided based on the site of fracture and corticotomy. Keeping the anatomical positions in mind and based on the position of fracture full rings were placed between the proximal and distal anatomical cuts. Tensioning was performed for all the wires. Schanz pin were fixed with the posts attached to the ring if required. After complete fixing of the Ilizarov apparatus, the fracture location was compressed. Sterile pin dressing was done with povidone iodine. Limb vascularity was checked in all the cases. Postoperatively, injectable cefotaxime plus sulbactam antibiotics were given for 5 days. Analgesia was provided using injectable NSAIDS as and when required. Mobilization of knee and ankle were initiated at day 1. By day 5 to Day 14 weight bearing was initiated. In subjects with corticotomy, distraction was initiated by day 3 to day 5. Distraction was performed by 90 degrees every 4 hours in 4 installments, in a way that by the end of a day, distraction of 1 mm was performed linearly at the corticotomy site. On day 14, suture removal was done. Dressings were performed regularly. Subjects were tutored about the distraction themselves. Distraction was stopped when desired bone length was achieved. At regular intervals, X-rays were taken to determine the radiological extent of bone healing. Assessment was done based on Fernandez Esteve grading. In case of any discharge from the tract, infected pin was removed and exchanged in the same sitting. Once healing was satisfactory, ring and fixator were removed, and cast was applied. All the data was arranged in a tabulated form and analysed statistically.

Results

Table 1 shows the demographic distribution of the subjects. The mean age of the subjects was 38.87±3.22 years. There were 13 males (59.1%) and 9 females (40.9%) in the study. Maximum number (31.8%) subjects were between 35-39 years of age. There were 22.7% (n=5) subjects between 30-34 years of age. There were 27.2% subjects between 40-44 years of age and 18.2% subjects between 45-49 years of age.

Table 2 shows the outcome of the treatment. There were 3 males and 2 females with bone shortening of 1-3 cm. The union time amongst them was 6 weeks and the consolidation time was 9-10 months. There were 5 males with shortening of 5 cm and the union time amongst them was 6.5 weeks with consolidation time of 10 months. There were 2 males with shortening of more than 5 cm and the mean consolidation time was 11.5 months amongst them. Amongst females, 4 females showed shortening of more than 5 cm with union time of 9 weeks and consolidation duration of 12 months.

Table 1: Demographic distribution of the subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>13</td>
<td>59.1</td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
<td>40.9</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-34</td>
<td>5</td>
<td>22.7</td>
</tr>
<tr>
<td>35-39</td>
<td>7</td>
<td>31.8</td>
</tr>
<tr>
<td>40-44</td>
<td>6</td>
<td>27.2</td>
</tr>
<tr>
<td>45-49</td>
<td>4</td>
<td>18.2</td>
</tr>
</tbody>
</table>
Graph 1: Complications encountered during the study

Fig. 1: 45 years old male patient with infected nonunion tibia. Nail removed. Ilizarov frame applied. Infection controlled. Bony union in progress.

Fig. 2: 52 Years diabetic male patient with infected nonunion Tibia. Debridement, Masquelet technique, Ilizarov fixator applied. Sound bony union. Wound healthy.
Table 2: Outcome of the treatment

<table>
<thead>
<tr>
<th>Gender</th>
<th>Bone shortening</th>
<th>Frequency</th>
<th>Union time</th>
<th>Duration of consolidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1-3</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>3-5</td>
<td>5</td>
<td>6.5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>5-7.5</td>
<td>7</td>
<td>8.5</td>
<td>11.5</td>
</tr>
<tr>
<td>Female</td>
<td>1-3</td>
<td>2</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>3-5</td>
<td>3</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>5-7.5</td>
<td>4</td>
<td>9</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 3: Complications encountered during the study

<table>
<thead>
<tr>
<th>Complication</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin loosening</td>
<td>3</td>
<td>13.6</td>
</tr>
<tr>
<td>Infection of pin tract</td>
<td>4</td>
<td>18.2</td>
</tr>
<tr>
<td>Pin exchange</td>
<td>4</td>
<td>18.2</td>
</tr>
<tr>
<td>Removal of fixator</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Discussion

Due to road traffic accidents, open tibial fractures are becoming more common and also there are increased in facilities and rapid transfer to the trauma centers. Most of these fractures are operated during the golden window period and open reduction and internal fixation is done for type I and type II open fractures [15]. The incidence of infected non-unions range between 16-22% [16]. With the advent and use of Ilizarov internal fixators patient can be ambulated quickly and ambulation can be maintained throughout the treatment period. Also, the chances of fixation are increased with decreased incidence of infection [17]. In our study, the mean age of the subjects was 38.87±3.22 years. There were 13 males (59.1%) and 9 females (40.9%) in the study. Maximum number (31.8%) subjects were between 35-39 years of age. There were 22.7% (n=5) subjects between 30-34 years of age. As per Dervin et al. [18] and Keeling et al. [19] external fixations is the skeletal stabilization of optimal choice with lowest incidence of deep sepsis. Ilizarov method is a complex methodology that requires a lot of resources and time and it also exhibits various complications [20]. This theory has mostly changed with the use of better operation theatres and use of high amount of antibiotics. This is comparable to the study by Laishram Singh et al., and Shtarker H et al. [21]. In our study, there were 3 males and 2 females with bone shortening of 1-3 cm. The union time amongst them was 6 weeks and the consolidation time was 9-10 months. There were 5 males with shortening of 5 cm and the union time amongst them was 6.5 weeks with consolidation time of 10 months. There were 2 males with shortening of more than 5 cm and the mean consolidation time was 11.5 months amongst them. Amongst females, 4 females showed shortening of more than 5 cm with union time of 9 weeks and consolidation duration of 12 months. All the subjects were ambulated within 2 weeks with full weight bearing. This is consistent with the study by Dagherand Ronkoz., [22] whose subjects were also initiated with partial weight bearing at 2 weeks. The use of Ilizarov technique of bone transport including distraction osteogenesis proposes a sound substitute towards managing infective non-union fractures of tibia. Ilizarov frame for osteogenisisis resection of the infected bony region, repair of the bony defect and stabilization for bony consolidation and maintains the bony length. Joint function is favorably encouraged with the use of bone transport technique.

Conclusion

Treatment using Ilizarov method with infected tibial fractures provides promising results. Optimal fixation was seen amongst subjects in the present study. With appropriate surgical skills, patient cooperation and patience desired results can be achieved.

References


Crush Injury: HBOT and Placebo Controlled Randomized Clinical Trial

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Abstract

Background: Hyperbaric Oxygen Therapy (HBO) is an established treatment modality, which is internationally practiced since a long time ago. International protocols for the practice of hyperbaric oxygen therapy have been established in the United States by the Undersea and Hyperbaric Medical Society (UHMS) and in Europe by the European Committee for Hyperbaric Medicine (ECHM).

Objective: To look for outcome on Wound healing without tissue necrosis requiring surgical excision, new major surgical procedures in relation to progressive and massive revitalization after entry in trail, Time of healing and Length of hospitalization.

Study Design: A prospective Randomized double blind placebo controlled trial performed to realize the aim and objectives of this study.

Place of Study: The study was carried out at the Prana HBO Centre, which is owned by the Investigator and located in the Northern parts of Mumbai, in India.

Methods: On receiving the patient to the HBO unit at Prana, patients were randomly assigned to receive HBO therapy or Placebo. HBO therapy was given with compressed air at a pressure of 2.5 atmosphere absolute (ATA). At this pressure the patient breathed 100% oxygen via facial mask. The HBO therapy protocol included 90 minutes oxygen breathing at 2.5 ATA twice daily over 6 days as per study by G Bouachour et al. Placebo consisted of sessions in HBO chamber at a pressure of 1.1 ATA in order to stimulate compression and its effects on the ears, while the patient breathing normal air via facial mask. The placebo therapy included 90 minutes air breathing at 1.1 ata twice daily over 6 days.

Results and Discussion: Total 60 patients completed the study period and no patient was excluded during the study analysis. The demographic profile was comparable in the two groups of HBO and Placebo group. It was observed in the study that complete wound healing without any tissue necrosis requiring any amount of surgical excision was observed in 24 patients in HBO group whereas only 13 patients were observed with complete healing in the Placebo group. There s a threefold effect of Hyper oxygenation in HBO Therapy, a typical treatment pressure of 2 ATA, the plasma and the tissue fluid oxygen tension increase 10 fold from about 100 and 30 mm hg respectively to more than 1000 mm hg in the plasma and more than 300 mm hg in the tissue fluids.

Conclusion: HBO therapy is a very useful therapeutic adjunct especially in the management of severe trauma of the limbs in older patients with grade III soft tissue injuries. The side effects and complications of HBOT are so infrequent and/or minimal that contraindications for using this intervention as an adjunct in the management of crush injuries are almost nonexistent. However, in no situation should HBOT be used as a substitute for indicated surgical, orthopedic, and medical interventions.

Keywords: Crush Injuries; HBOT; Placebo; Clinical Trail.

Introduction

Spectrum of injuries to the body is the term used to explain Crush injuries. Soft tissues or the bony elements may be primarily involved in injuries often it’s the combination of both. It is the severity of the injury which differentiates the crush injuries from other types of injuries of the musculoskeletal system. Injury severity may range from minor with minimal contusion of soft tissue with or without a related fracture of limb which may be
threatening with nonviable soft tissue and may be associated with complex fractures. The likelihood of successful outcome decreases as the severity of injury increases. Tissue damage at certain point is so great that successful healing is unlikely and leading to limb amputation is mandatory. As such no universal classification system is available to encompass the spectrum of crush injury but it was Gustilo and Williams [1] and Johansen and colleagues [2] generated classifications that predict outcomes for open fractures and limb survival, respectively, but clinical judgment remains the common final denominator for making decisions about the management of crush injuries.

Hyperbaric Oxygen Therapy (HBO) is an established treatment modality [3], which is internationally practiced since a long time ago. International protocols for the practice of hyperbaric oxygen therapy have been established in the United States by the Undersea and Hyperbaric Medical Society (UHMS) [4] and in Europe by the European Committee for Hyperbaric Medicine (ECHM) [5]. These are generally accepted as the standard of care in the western world and treatment protocols were developed for around 17 indications overall. However, additional indications are accepted by other hyperbaric medical societies. Approximately 53 indications are accepted in China [5,8] twenty in Japan6 and 72 in Russia [9].

Transcutaneous Oxygen Monitoring (TCOM) is advised (in international guidelines) in all peripheral non-healing wounds before treatment in the chamber [7]. The UHMS published standard protocols, which is based on the current available medical evidence. These protocols would typically prescribed the type of patients who should be selected (i.e. establishing a bona fide indication for therapy), and the typical work-up required for evaluation. This would for instance include the use of TCOM for diabetic ulcers of the lower limb [6,8]. The protocols also describe the range of treatment depth (while breathing 100% oxygen) that would yield a therapeutic tissue oxygen tension for the disease being treated. These typically range from 150 kPa to 280 kPa (depending on the disease being managed). Apart from the treatment depth, the report also describes the typical number of treatments to be provided for each indication, ranging from one session (e.g. for decompression sickness) to as many as 40 sessions (e.g. for radiation-induced lesions).

In present situation crush injuries are a big and significant challenge to our health care system, on both the front of management and expenditures. As a cause of trauma service hospital admission, one fifth of total admissions to level 1 trauma center diagnosis are crush injury [10]. For complex crush injuries, initial hospitalizations are typically prolonged and re-hospitalizations are frequently required to manage the residual complications. Significant challenge to health care system and devastating to the patient is the cost and period of convalescence. The leading causes of crush injury are motor vehicle accidents; gunshot/munition, wounds, and falls [10]. Even with optimal management, outcomes of crush injury are frequently less than desirable with an inverse relationship between good outcomes and the severity of injury. This generates the question whether outcomes even with state-of-the-art surgical and orthopedic interventions can be improved in those patients who have such severe crush injuries that poor outcomes are the expectation.

Several studies and research on series of patients had suggested the importance of HBO therapy in crush injuries. Even the comparison was made between standard treatment and adjunct use of HBO therapy in management of several injuries of the limbs by G. Bouachour and his colleagues in 1996. In this study we are also doing the prospective and randomized study to evaluate the effect of HBO in crush injuries of the limb and it use as an adjunctive measure. Classification of soft tissue injuries were derived from Gustillo RB [11]. Type I: wound less than 1 cm long and clean. Type II: Laceration more than 1 cm long without extensive soft tissue damage, flaps or avulsions. Type IIIA: Adequate soft tissue coverage despite extensive soft tissue laceration or flaps, or high energy trauma irrespective of the size of the wound. Type IIIB: Extensive soft tissue injury with periosteal stripping and bony exposure. Type IIIC: Arterial injury requiring repair.

**Patients and Methods**

**Study setting**

The study was carried out at the Prana HBO Centre, which is owned by the Investigator and located in the Northern parts of Mumbai, in India. The center has one Sechrist Monoplace hyperbaric chamber and a TCOM machine with 3 electrodes. The oxygen gas supply is from oxygen cylinders of 7000 liters’ capacity each. The center has all the requisite certifications and registrations as required by the local authority in Mumbai. Study was conducted over a period of 2 years and patient with severe limb injury referred to the Hyperbaric
Unit at Prana HBO center within 24 hours after the initial evaluation and surgical procedure were included. Written informed consent was obtained from the patient and patient’s relative.

Surgical procedures performed were as per the requirement of the case and discretion of the operating surgeon, debridement, irrigation of wound, primary closure without tension with regard to severity of the fracture and soft tissue injury and stabilization procedures. Vascular reconstructions were done with available local soft tissue or muscle rotation flaps. Accordingly the patients were covered by appropriate antibiotics and preventive antithrombotic treatment.

On receiving the patient to the HBO unit at Prana, patients were randomly assigned to receive HBO therapy or Placebo. HBO therapy was given with compressed with air at a pressure of 2.5 atmosphere absolute (ATA). At this pressure the patient breathed 100% oxygen via facial mask. The HBO therapy protocol included 90 minutes oxygen breathing at 2.5 ATA, twice daily over 6 days as per study by G Bouachour et al. placebo consisted of sessions in HBO chamber at a pressure of 1.1 ata in order to stimulate compression and its effects on the ears, while the patient breathing normal air via facial mask. The placebo therapy included 90 minutes air breathing at 1.1 ATA twice daily over 6 days. It was a double blind study hence the patient and the surgeons were not informed regarding the protocol of the treatment, whether HBO therapy or Placebo. After each session re-evaluation of the injured extremities was performed which included examination of motor, sensory functions, skin color, edema and palpation of peripheral pulses. In all cases wound dressings were performed in the surgical unit.

As per the study of Bouachour et al. [12], in our study too we made four primary study end points:
1. Wound healing without tissue necrosis requiring surgical excision
2. New major surgical procedures in relation to progressive and massive revitalization after entry in trail
3. Time of healing
4. Length of hospitalization.

Inclusion criterion

Based on following criterion the patients were included and enrolled in trial. Acute injury of the limb classified as type II or III depending on soft tissue injury as per Gustillo RB [11]. Surgical management within 6 hours after the injury; no history of peripheral arterial occlusive disease.

Exclusion criterion

Patients were excluded from the trail if the patient was enrolled in another trail, pregnant, Upper respiratory tract infection, neurologic or pulmonary or otorhinolaryngologic diseases contraindicating HBO therapy. In order to evaluate the effects of the treatment Transcutaneous Oximetry monitoring system was utilized for measuring tissue oxygenation (TcPO₂) in all the patients of both groups. Measurements were recorded on non inflamed skin 1 cm proximal to the upper margin of ulcer. TcPO₂ findings were recorded, and the findings were calculated by an electrochemical transducer, and it remains attached to skin and use of adhesive ring and contact liquid was used. The measuring site was cleaned carefully by a disinfectant (spirit). By analyzing and measuring the oxygen reduction current with the help of measuring cell it was concluded for skin oxygen partial pressure.

Ethics review

This study was performed within the scope of international ethical guidelines and legislation. Ethics review and approval was provided by Stellenbosch University (number: U16/06/015) and the ethics committee of the Hyperbaric Society in India.

Statistical Analysis

Comparisons of quantitative data between the HBO group and placebo group were made with paired and unpaired t test. All data are presented by descriptive statistics and graphics. P value of less than 0.05 was considered significant.

Results

![Mechanism of Injury](image)

**Fig. 1: Mechanism of Injury**
Fig. 2: Bones involved

Fig. 3: Comparison Open Fracture and Soft Tissue Injury

Fig. 4: Stabilization procedures and skin flaps or grafts performed on admission before randomization.

Table 1: Patients characteristic by treatment outcome

<table>
<thead>
<tr>
<th>Groups</th>
<th>HBO (n=30)</th>
<th>Placebo (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete healing</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>Tissue Necrosis</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>New Surgical Procedures</td>
<td>3 (2)</td>
<td>10 (7)</td>
</tr>
<tr>
<td>Skin flaps and grafts</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Vascular Surgery</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Amputation</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Wound dressings</td>
<td>17.3 (+ 6.41)</td>
<td>18.7 (+ 7.1)</td>
</tr>
<tr>
<td>Time of healing (days)</td>
<td>42.8 (+ 13.2)</td>
<td>49.3 (+ 11.7)</td>
</tr>
</tbody>
</table>
In the study total more than 69 cases were recruited and ended up with final 60 number of patients who fulfilled all the inclusion criteria for the study. Total 60 patients completed the study period and no patient was excluded during the study analysis. The demographic profile was comparable in the two groups of HBO and Placebo group. During the period of study neither of the group patient had any episodes of cerebral oxygen toxicity nor there were any adverse effects of pressurization observed. In study both the groups were relatively similar in terms of age 48.3 (+11.6) years for HBO group and 49.1 (+12.13) Years for Placebo group and to certain extent on risk factors. Total 7 patients were with Diabetes mellitus two and five respectively in the study in both groups. Mechanism of Injuries and bones involvement had been highlighted in Figures 1 and 2 respectively. As per Figures 2 and 3 differences was observed comparatively in severity of soft tissue injuries and fractures in both the group of study. Eight patients in the HBO group and ten patients in Placebo group had crush injuries without bony lesions. One patient in the HBO group required to have an end to end arterial repair for tibial artery. In HBO group one patient and in placebo group four patients were managed by primary amputation. In all the cases were required fracture stability was achieved as well stabilization procedures were achieved in both the group. In HBO group patients two cases and in Placebo group five patients’ skin flaps and grafts were performed. Neurologic deficit in four patient of HBO group and three patient of placebo group was observed. As such surgical procedures and there timing and location, and types were not statistically varying from each other among both the group.

Table 2: Results of treatment in groups of patients matched for age and severity of trauma

<table>
<thead>
<tr>
<th>Soft tissue injury</th>
<th>HBO Group</th>
<th>Placebo Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;40</td>
<td>&gt;40</td>
</tr>
<tr>
<td>Success</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Failure</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 3: Characteristics of the patients requiring new surgical procedures

<table>
<thead>
<tr>
<th>Groups</th>
<th>HBO (n=2)</th>
<th>Placebo (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>52, 54</td>
<td>54.4 + 7.3</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Fractures</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Soft Tissue injury*</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Grade IIIA</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Grade IIIB</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Grade IIIC</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Timing of new surgical procedures (Days)</td>
<td>5, 7</td>
<td>12.7 (+ 7.1) Range: 5-19</td>
</tr>
</tbody>
</table>

*Classification of soft tissue injuries derived from Gustillo

Fig. 5: Comparative analysis of healing

In the study total more than 69 cases were recruited and ended up with final 60 number of patient who fulfilled all the inclusion criteria for the study. Total 60 patients completed the study period and no patient was excluded during the study analysis. The demographic profile was comparable in the two groups of HBO and Placebo group. During the period of study neither of the group patient had any episodes of cerebral oxygen toxicity nor there were any adverse effects of pressurization observed. In study both the groups were relatively similar in terms of age 48.3 (+11.6) years for HBO group and 49.1 (+12.13) Years for Placebo group and to certain extent on risk factors. Total 7 patients were with Diabetes mellitus two and five respectively in the study in both groups. Mechanism of Injuries and bones involvement had been highlighted in Figures 1 and 2 respectively. As per Figures 2 and 3 differences was observed comparatively in severity of soft tissue injuries and fractures in both the group of study. Eight patients in the HBO group and ten patients in Placebo group had crush injuries without bony lesions. One patient in the HBO group required to have an end to end arterial repair for tibial artery. In HBO group one patient and in placebo group four patients were managed by primary amputation. In all the cases were required fracture stability was achieved as well stabilization procedures were achieved in both the group. In HBO group patients two cases and in Placebo group five patients’ skin flaps and grafts were performed. Neurologic deficit in four patient of HBO group and three patient of placebo group was observed. As such surgical procedures and there timing and location, and types were not statistically varying from each other among both the group.
It was observed in the study that complete wound healing without any tissue necrosis requiring any amount of surgical excision was observed in 24 patients in HBO group whereas only 13 patients were observed with complete healing in the Placebo group.

Seven patients belonging to the placebo group were managed by repeated debridement as there was progressive necrosis of tissues observed, in all these patients secondary flap coverage was performed. Four patients from this placebo group had flap loss affecting fracture coverage and thus finally ended up with amputation. On the contrary in HBO group only two patients had to undergo surgical procedure due to ischemia and flap coverage of which one patient ended up with amputation.

On statistical analysis it was clearly observed that repetitive surgical procedures were common in placebo group in comparison to HBO group of patients. Both the patient group were not matched for age and severity of injury, but the result of outcomes were taken into consideration and summarized accordingly as shown in Table 2. In the observation of subgroup of patient with more than forty years of age with grade III soft tissue injury, wound healing was obtained in eleven patients in the HBO group Vs four patients in the placebo group. By using paired t – test, In the HBO treatment the healing duration is reduced and the process of healing is faster with p value is 0.000001. Whereas in the placebo group healing duration and process of healing was delayed comparatively with p value of 0.0011. By using unpaired t – test it is evident that HBO treatment gives faster and efficient healing on the contrary in placebo group healing was delayed and less efficient with p value of 0.000034.

Discussion

There is a threefold effect of Hyper oxygenation in HBO Therapy, a typical treatment pressure of 2 ata, the plasma and the tissue fluid oxygen tension increase 10 fold from about 100 and 30 mmhg respectively to more than 1000 mmhg in the plasma and more than 300 mmhg in the tissue fluids. Approximately 25% increased in oxygen carrying capacity is being observed as a consequence on 70 second of hyper oxygenation. There is threefold increase in the diffusion distance of oxygen through tissue fluids and relative barriers which includes ischemic margins of wounds. All these effects of hyper oxygenation is transient which last in the period of HBO therapy period and shall continue in the subcutaneous tissues for a around period of four hours, similarly for around one and half hours in the muscles [13]. Important consequences occurring due to hyper oxygenation enough oxygen is dissolved in plasma to meet tissue oxygen requirements even without RBCs, and transient increases of oxygen in the tissues triggering secondary mechanisms of HBOT to begin their actions. It has potential to provide an oxygenated environment to resume functions of wound healing and infection control. Hyperoxia acts against infection; it induces the production of toxic oxygen radicals which have a direct lethal effect of strict anaerobic organisms such as Clostridia species [14].

It leads to vasoconstriction which reduces inflow by 20%, whereas oxygenation is maintained through hyper oxygenation [15], with decreased inflow, yet maintenance of venous outflow edema is reduced [16,17]. Edema reduction in turn benefits in two fold increase of oxygen and reduce external pressure leading to improvised microcirculation. Hyperoxia causes enhanced oxygen dependent intracellular killing mechanism of polymorphonuclear leukocytes and also affects bacterial clearance [18]. Depressed WBC killing capacity in infected ischemic tissues is reversed by oxygen tension of 4 mm Hg [19]. It is a mandatory requirement of hyper oxygenation t promote collagen production by fibroblasts in turn whose function are altered when an inadequate oxygen tension of less than 10 mm Hg is present in ischemic area [20]. Fibroblast differentiation collagen synthesis and angiogenesis is enhanced by HBO which ultimately leads to increased wound closure rate in hypoxic tissues [18,19,21].

HBO therapy to certain extent helpful to separate viable from nonviable tissues and thereby it helps to limit surgical excision. It also avoids soft tissue necrosis further preventing secondary exposure of joints, blood vessels, fractures and neural structures which radically modifies trauma prognosis [22]. The study made by Shupak A et al. in 1987 reported a clear improvement in prognosis in post traumatic acute ischemia in lower extremities after reconstructive surgery, in 8 cases out of total 13 studied cases complete limb salvage was accomplished and in three cases the level of amputation was lowered [23]. In our study it is clear evident that in patient with age more than forty years reduces the need for repetitive and aggressive debridement of tissues compromised by progressive necrosis in HBO group. HBO therapy is definitely helpful to segregate viable from nonviable tissues and thereby to limit the
surgical excision.

Recently study and experience from Chinese Shanghai which included 21 traumatic or near amputation of the limbs and fingers, of which 18 cases involved upper limb, 2 cases involved single fingers and one with lower extremity. The average time of limb ischemia before re plantation was around 16 hours with a range of 6 to 36 hours. In this study all the patients received HBOT after surgery. It was observed in the study, Limb survival occurred in 10 of 15 detached limbs, including 2 fingers that were ischemic for less than 10 hours, and in 4 of 6 patients with ischemic times greater than 20 hours. This study is noteworthy for the high survival rates observed in those patients with prolonged ischemia times [24].

Radonic and colleagues [25] describe their experience using HBOT as an adjunct for managing 28 patients with combat-related crural (lower extremity) vascular injuries during the Croatian War. All injuries were of the penetrating type. All patients had injuries that required vascular, orthopedic, and plastic surgery management in addition to fasciotomies. Thirteen patients who had a combination of extensive bony and soft-tissue injuries coupled with an ischemic time of greater than 6 hours received HBOT as an adjunct to their management. Good prognostic signs associated with HBOT included increase in blood pressure, improved skin color, increase in temperature on the injured side, and maintenance of temperature. Outcomes were assessed at discharge from the hospital and were described as “very good,” “good,” or “fair.” The authors conclude that HBOT helped decrease the amputation rate.

Transcutaneous oxygen pressure is linked to oxygen delivery which is the result of oxygen content and blood flow. This noninvasive method of exploration was validated during HBO therapy [26]. It is possible to predict 100% sensitivity and 94% specificity whether or not secondary amputation of the traumatized limb should be performed, moreover during HBO therapy PtCO2 monitoring seems to be useful to evaluate the evolution of the traumatized limb.

Conclusion

Although the evidentiary evidence supporting the use of HBOT for crush injuries is scant, the conclusions are consistent with our study which can be concluded with that HBO therapy is a very useful therapeutic adjunct especially in the management of severe trauma of the limbs in older patients with grade III soft tissue injuries. When the decision is made to use HBOT, current evidence suggests it should be started as soon after the injury as possible, preferably in the immediate postoperative period. If surgery is delayed, it is desirable to give HBOT while awaiting surgery. The side effects and complications of HBOT are so infrequent and/or minimal that contraindications for using this intervention as an adjunct in the management of crush injuries are almost nonexistent.

Consequently, when pairing the clinical experiences and laboratory data, justification for using HBOT as an adjunct for managing crush injuries is strong. However, in no situation should HBOT be used as a substitute for indicated surgical, orthopedic, and medical interventions.

Conflict of Interest: The author declares no conflict of interest for this study.

Acknowledgement

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Functional Outcomes after Triceps Sparing Surgery for Distal Humerus Fractures

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Abstract

Introduction: Surgeon’s primary goal in distal humerus fracture is to obtain fixation with sufficient stability so that the elbow can be mobilized as early as possible. The present study aimed at assessing the functional outcomes in distal humerus fracture patients managed with open reduction internal fixation with triceps sparing approach. Methodology: The present study included adults presenting with distal humeral fractures and managed with open reduction and internal fixation with triceps sparing approach at the Department of Orthopedics, AJ Institute of Medical Sciences, Mangalore from August 2015 to April 2017. The Mayo Elbow Performance Score (MEPS) was used as an objective measure of overall outcome. Grades of MEPS were compared between different age groups and different fracture types. Results: There was only one case of extra-articular type fracture. In the fractured elbow, the mean range of motion increased significantly from 63.4±14.2 at 6th week to 120±6 at 24th week. In our study population, the mean MEPS was 81.7±10.7. The MEPS was found to be excellent in 40% of the patients, fair in 20%, good in 36.7% and poor in only one patients. The MEPS was found to be similar among different age groups (p value = 0.92). Similarly, MEPS did not vary with the fracture type (p value = 0.21). Conclusions: Excellent grade of MEPS was observed in majority of the patients and only one case yielded poor grade. Age and fracture type were not found to be associated with the grade of MEPS.

Keywords: humerus; open reduction and internal fixation; triceps-sparing

Introduction

Fractures of distal humerus are becoming increasingly common due to increased physical activity and increasing number of road traffic accidents. Fractures of the distal humerus remain a challenging problem despite advances in our knowledge about the biomechanics and implants. Non-operative treatment can be performed in some cases like advanced osteoporosis or fractures with extensive bone loss, however, the functional outcomes are typically less than optimal [1]. Surgeon’s primary goal is to obtain fixation with sufficient stability so that the elbow can be mobilized as early as possible. Olecranon osteotomy is considered the gold standard for treating distal humerus fractures. This technique provides excellent articular exposure, but has been associated with complications like delayed union, non-union and prominent hard-ware [2]. One alternative technique to approaching through the posterior elbow is the triceps-sparing approach described by Bryan and Morrey [3]. In this technique, the triceps mechanism is spared and reflected from the medial to the lateral direction without being detached. Few single centre studies have demonstrated satisfactory functional outcomes using this technique [4]. The present study aimed at assessing the functional outcomes in distal humerus fracture
patients managed with open reduction internal fixation with triceps sparing approach.

**Methodology**

**Study Design and Sampling**

The present study included adults presenting with distal humeral fractures at the Department of Orthopedics, AJ Institute of Medical Sciences, Mangalore from August 2015 to April 2017. All skeletally mature patients with distal humerus fractures and operated at our center with open reduction and internal fixation with triceps sparing approach were included in the study. Patients with open injuries, associated with neurovascular injury, skeletally immature patients and pathological fractures. During the study period 30 cases underwent surgery and were included in the final analysis. The study was approved by the institutional ethics committee. All patients were explained the purpose of the study and an informed written consent was obtained from them.

**Surgical technique**

On admission of the patient a careful history was elicited from the patients and or attendants of injury and the severity of trauma. Radiograph of distal humerus i.e. antero-posterior view and lateral view were taken and fractures were classified according to AO/OTA classification. Patients were placed in the lateral position under suitable anaesthesia with the involved elbow at 90° placed over an elbow support. Under aseptic measures, open reduction and internal fixation of the fracture was done with plates of adequate size. The fascia overlying the triceps was then divided and two fasciocutaneous flaps were raised. The lateral and medial borders of the triceps were then readily visualized, as was the tricipital aponeurosis. The radial window was developed by initially lifting the lateral triceps from the lateral intermuscular septum and then the posterior surface of humerus. The ulna window was developed by lifting the medial triceps from the intermuscular septum and the dorsal surface of the humerus. In extra-articular distal humerus fractures, the two windows gave good enough access for fracture reduction, temporary fixation and application of 90/90 or parallel plates. In simple intra-articular fractures, where no joint comminution was encountered, a combination of anatomical reduction of the condyles and intra-operative imaging of the joint surface was all that was needed for an accurate reduction and fixation. When the articular surface was comminuted, then the whole distal articular surface needed to be accessed. Connection of the medial and lateral dissections by mobilisation and elevation of the triceps muscle from the fracture and posterior humeral periosteum allowed visualisation of the entire posterior distal humerus. After that, the fracture was reduced and fixed provisionally with 1.5 or 2.0 mm K wires under fluoroscopic control in two planes. The intercondylar fracture was fixed with a 3.5-mm lag cortical screw in the coronal plane across the trochlea, thus converting the fracture into a supracondylar type. The articular fragment was then secured to the humeral shaft with two 3.5 reconstruction plates or condylar plates contoured to fit along the involved columns. An intraoperative radiograph was made to check reduction and fixation. The elbow was moved through a range of motion to test the stability of the fixation. The reconstructed distal articular block was then approximated to the humeral diaphysis. Kirschner-wire fixation was converted to definitive fixation with the application of either parallel or orthogonal plate constructs, depending on the surgeon’s choice. All patients were admitted as inpatients and mobilization of the elbow was encouraged immediate postop. Postoperative physiotherapy was followed according to the protocol, and functional outcome was assessed at 6 weeks, 12 weeks and at 6 months. All patients were encouraged to start range of motion exercises on the first day following surgery depending on the patient compliance and surgeon’s discretion regarding a stable fixation.

**Data Collection and Data Analysis**

Patients’ baseline demographic and clinical information was noted from the hospital records. Routine clinical and radiological evaluations were done for all patients. Fractures were classified according to the AO/OTA classification of fractures and dislocations. Anteroposterior and lateral elbow radiographs were obtained at the time of examination and assessed for reduction, alignment, fracture union, posttraumatic arthrosis, and heterotopic ossification. All data were analysed in SPSS version 21 (IBM Corp, NY). Quantitative and qualitative variables were described as mean (standard deviation) and frequency (percentage) respectively. The Mayo Elbow Performance Score (MEPS) was used as an objective measure of overall outcome [5]. This score is based on a 100-point scale, with maximum scores of 45 points for pain relief, 25 points for function, 20 points for motion
and 10 points for stability. There are four grades of MEPS: ≥90 is Excellent; 75–89 is Good; 60–74 is Fair; and <60 is Poor. Using Fisher’s exact test, grades of MEPS were compared between different age groups and different fracture types. The significance level of this study was set at two-sided $\alpha = 0.05$.

**Results**

During the study period 30 patients were included in the study, of which 70% were below the age of 40 years. The mean age of the total population was 37.7±13.8 years. There were 57% males and 43% females and left side was more commonly affected (60%). Patients were classified according to AO classification. There was only one case of extra-articular (A2- moderate) type fracture (Table 1). Partial articular fracture was seen in eight patients, of which one was simple, three were moderate and four were severe type. Intra-articular fracture was seen in 21 patients, of which eight patients had simple type, seven had moderate types and six patients were severe type. Post-operatively, only one patient reported complication of ulnar neuritis. The range of motion in the normal elbow ranged between 0 to 140 degrees in majority of the patients (46.7%). Furthermore, in the fractured elbow, the mean range of motion increased significantly from 63.4±14.2 at 6th week to 120±6 at 24th week. In our study population, the mean MEPS was 81.7±10.7. The MEPS was found to be excellent in 40% of the patients, fair in 20%, good in 36.7% and poor in only one patients (Table 2). Table 3 describes the association of MEPS with age and fracture type of the patients. The MEPS was found to be similar among different age groups ($p$ value = 0.92). Similarly, MEPS did not vary with the fracture type ($p$ value = 0.21).

![Fig. 1: Operative steps for open reduction internal reduction with triceps sparing approach](image)

A. Triceps is freed from its attachment on the posterior humerus and elevated  
B. Ulnar nerve retracted, fracture fragments stabilized with K-wire  
C. Reconstructed intra-articular distal humerus  
D. Medial columnar plating
Discussion

The present study describes our experience of managing patients of fractures distal humerus managed with open reduction internal fixation with triceps-sparing approach. As the age of the patient may significantly affect the functional outcomes of surgically managed intra-articular distal humerus fractures and is especially true for patients above 60 years of age [6], we assessed functional outcomes categories with age. Although in our study we did not find any association between age and functional outcome, different observations have been suggested by previous authors. Chen et al reported that as compared to triceps-sparing, open reduction internal fixation with olecranon osteotomy resulted in better function outcomes in patients aged more than 60 years [7]. The authors reported that the rate of excellent/good MEPS was more than 80% for all ages in the group of patients treated with olecranon osteotomy. In contrast, only 37.5% patients in the triceps-sparing group >60 years of age obtained excellent/good MEPS and these patients tended to have more extension loss. However, the rate of excellent/good MEPS was 100% in patients aged less than 40 years of age treated with triceps-sparing.

In our patient population, one patient (3.3%) had ulnar neuritis post-operatively, which is one of the most common complications following distal humerus fracture. Reported incidence of ulnar neuropathy following open reduction internal fixation is between 7% and 15% [8]. Unfortunately, the management of the ulnar nerve damage during distal humerus fixation remains controversial. Few authors have recommended ulnar nerve transposition has been recommended by some [9]. Gofton et al. did not observe any objective ulnar nerve findings in their series of distal humerus fracture after ulnar nerve transposition [10].

There are a few limitations of the study. First, definition of excellent/good joint function varies across different scales. MEPS uses an objective measure of functional outcome. Some authors have used the Aitkens and Rorabeck, in which an excellent result had an arc of flexion of 110° or more, full use of the arm including heavy labor, and no pain [11]. Pajarinen et al. used the Orthopedic Trauma Association (OTA) method for evaluating elbow function [12]. Different scales have different definitions for excellent range of joint motion, which eventually makes the comparison difficult. Second, there were only two patients above the age of 60 in our study population. So the results of our study may not be applicable to older patients.
Conclusion

Patients of distal humerus fracture managed with triceps sparing approach in our department had a significantly improved range of motion at 24th week follow up. Excellent grade of MEPS was observed in 40% of the patients with only one case yielded poor grade. Age and fracture type were not found to be associated with the grade of MEPS. Results of our study need to be supported by large multicentric randomized controlled studies.

References

Efficacy of two Versus three Drug Regimen in Induction of Remission in Early Active Rheumatoid Arthritis: A Comparative Study

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Abstract

Introduction: Rheumatoid arthritis is the most common inflammatory disease of the joints with an incidence of about 4-13 in 100,000 males and 23-36 in 100,000 females. It is recommended that the drug treatment should start within short period of 6 weeks to arrest progression of disease, joint erosion and deformation. Aggressive treatment in the initial stage of the disease with DMARDS reduces the disease progression. The responses of patients with rheumatoid arthritis to treatment with a single so-called disease-modifying drug, such as methotrexate, are often suboptimal. Despite limited data, many patients are treated with combinations of these drugs. Objective: The aim of the study was to compare the efficacy of hydroxychloroquine, methotrexate and combination of hydroxychloroquine, methotrexate and sulfasalazine in induction of remission in early rheumatoid arthritis. Methodology: The present study included 50 randomly selected cases of rheumatoid arthritis, who presented at PES Hospital, during July 2014 to July 2016 fulfilling the inclusion and exclusion criteria. Following collection of data in a pretested proforma, which included brief history, physical examination and ACR criteria, the patients were divided randomly into two groups. The first group, Group A, was treated with once a week oral methotrexate 7.5 mg and twice daily oral Hydroxychloroquine. The second group, Group B, was treated with once a week oral methotrexate 7.5 mg and twice daily oral Hydroxychloroquine 200 mg and sulfasalazine 500 mg twice daily. Patients in both the groups received additional oral folic acid 5 mg thrice daily once a week. Patients in both the study group received oral sustained release aceanofenac and paracetamol twice daily for the first 10 days. All the patients were followed up in the out-patient department of the hospital at 4 weeks interval for 12 weeks and evaluated by the ACR criteria for remission and improvement in symptoms. Blood investigations like haemoglobin level, RA factor, ESR, and liver enzyme levels were done before initiating treatment for all patients. All patients underwent haemoglobin level, ESR, and liver enzyme levels at every follow-up visit. Results: At the end of three months group A which was treated with two drug regimen had remission in 32% and group B patients treated with three drug regimen had 52% remission rate according ACR criteria for remission. Remission was more in seronegative arthritis than seropositive. Conclusion: Remission was induced in higher number of patients on combination therapy with methotrexate, hydroxychloroquine and sulfasalazine when compared to patients on treatment with methotrexate and hydroxychloroquine.

Keywords: RA factor; methotrexate; Rheumatoid arthritis; Hydroxychloroquine.

Introduction

Rheumatoid arthritis (RA) is a chronic autoimmune systemic inflammatory disease affecting articular and extra articular structures with significant morbidity and mortality rates if left untreated [1,2]. Persistent inflammation leads to erosive joint damage and functional impairment in the vast majority of patients [2,3]. Identification of RA at initial presentation and treatment at earlier stage can affect disease course, prevent the development of joint erosions or retard
progression of erosive disease [4,5]. Early diagnosis and treatment may affect disease outcomes even to a remission state [6,7]. Mainstay of treatment is pharmacotherapy [8]. The commonly used drugs are analgesics, non-steroidal anti-inflammatory (NSAIDs), glucocorticoids, biologic and disease-modifying antirheumatic drugs (DMARDS). Combinations of these therapies are tried and found to be more effective.

There are many studies comparing efficacy of monotherapy with methotrexate and combination therapy of DMARDS. Many studies showed combination therapy gives better results. Whereasonly few studies are found comparing efficacy of two drugs regimen and three drugs regimen. In our study we compared the efficacy of 2 drug regimen and 3 drug regimen in induction of remission in early rheumatoid arthritis.

Methodology

The present study is an prospective randomised study which included 50 cases of rheumatoid arthritis, who presented at PES hospital, during july 2014 to july 2016 fulfilling the inclusion and exclusion criteria. Clinically diagnosed and patients whose age is above 18 years, fulfilling the criteria of american rheumatology association 2010 guidelines were included in study [9]. Patients who are already on DMARD drugs, patients using DMARD drugs with side effects, patients with elevated liver enzymes, patients who are having deformities with rheumatoid arthritis were excluded from study.

Following collection of data, which included brief history, physical examination and ACR criteria, laboratory investigations, the patients were divided randomly into two groups. Randomisation was done by choosing every alternate patient for same treatment. The first group, group A was treated with once a week oral methotrexate 7.5 mg and twice daily oral hydroxychloroquine 200 mg. The second group, group B, was treated with once a week oral methotrexate 7.5 mg and twice daily oral hydroxychloroquine 200 mg and salfasalazine 500 mg twice daily. Patients in both the groups received additional oral folic acid 5 mg daily. Both groups were given oral paracetamol for pain relief until good response to DMARDs was achieved (around 10 days) [10]. Group A received a placebo oral drug to avoid bias.

All the patients were followed up in the out-patient department of the hospital at 4 weeks interval for 12 weeks and evaluated by the ACR criteria [8] for remission and improvement in symptoms. Blood investigations hb%, RA factor, ESR and liver enzyme levels were done before initiating treatment for all patients. All patients underwent hb%, ESR, and liver enzyme levels at every follow-up visit.

Statistical methods applied: Statistical analysis was done using spss software (version 16.0).

Results

Our study included 12 (24%) males and 38 (76%) females. The age of onset was between 41-55 years in 44% of the patients. Mean age of the patients was 46.71. RA factor was positive in 42 (84%) of the cases. All the patients in both groups had morning stiffness for more than one hour. At the follow up period of three months in group A eight patients (32%) had morning stiffness whereas in group B only six patients (48%) had morning stiffness and the duration of morning stiffness reduced to less than 15 minutes.

Frouyty eight patients (98%) in both group A and group B had swollen joints at the start of the study. At the time of last follow-up (three months) 14 patients (56%) in group B and 12 patients (48%) in the group A had relieved of swollen joints.

At the start of the study all patients (100%) in both Group II and Group I had tender joints. At the time of last follow-up 11 patients (44%) in the Group II and 8 patients (32%) in the Group I are relieved of tender joints.

At the start of the study 18(72%) patients in the group A had an ESR level of >50 mm at the end of one hour. At the end of third month follow-up eight patients (32%) had a normal esr. At the start of the study 76% of the patients in the group B had an esr level of >50 mm at the end of one hour. At the end of third month follow-up 9 patients (36%) had a normal esr. More number of patients on the three drug had reduction in esr levels to normal when compared to the patients on double drug.

Liver enzymes of all the patients remained in the normal range through out the study period. All patients had normal range of haemoglobin at end of follow up.

Remission-

At the end of three months, remission was induced in 8 patients (32%) in the group B and 13 patients (56%) in the group A according to the ACR criteria for remission [10].
Discussion

Rheumatoid arthritis (RA) is a systemic inflammatory progressive disease which mainly involves joints and in the absence of appropriate treatment can lead to joint destruction, disability and mortality. The distribution of joints affected (synovial joints) is characteristic. It typically affects the small joints of the hands and the feet, and usually both sides equally in a symmetrical distribution, though any synovial joint can be affected. In patients with established and aggressive disease, many joints will be affected over time.

Persistent inflammation leads to erosive joint damage and function impairment in the vast majority of patients [2,3]. Risk factors for the development of RA include smoking, obesity, concurrent infections, advancing age, female gender, and genetic inheritance, while oral contraceptives and some dietary constituents may be protective. The onset and progression of disease depends on number of variables like genetic background, frequency, level of autoantibody in blood, severity of inflammatory process [6,7]. It is now considered as a malignant disease and with increase mortality and morbidity and poor prognosis. Life expectancy decreases by 3-10 years according to severity and age of onset of disease. It is debilitating disease and limits the patient daily activities [11]. Rheumatoid arthritis usually affects individuals in their 4th and 5th decade [12,13], in our study the mean age of incidence was 46 years.

Rheumatoid arthritis is more prevalent in females than compared to males. As per available literature, in western population one male patient is affected for every three female patients [14] where as in Indian population male to female ratio is 1:9 [15]. In our study male to female ratio of was 1:3, which is similar to western population. We feel there is no difference in sex ratio affected by rheumatoid arthritis in Indian and western population. However there is lack of study conducted on larger population in Indian region to support our view.

Usually blood markers like RA factor, ESR, CRP are used in diagnosis of rheumatoid arthritis (ACR criteria 2010 guidelines) [9]. Same blood markers are used in follow up visit for evaluating prognosis and remission. Higher RA factor suggest poor prognosis. RA factor is even used as a prognostic factor, where higher titres carry a poor prognosis [16]. RA factor was found to be positive in 70%-80% of patients of rheumatoid arthritis in a study conducted in the west [13]. In our study, RA factor is found positive in 84% of patients. Higher remission was found in patients with seronegative rheumatoid arthritis in our study.

Early diagnosis and early aggressive treatment can affect disease course, prevent joint destruction, retard joint erosions [17,18]. The longer active disease persists, the less likely the patient is to respond to therapy [19]. Achieving early remission and retarding disease progression have become foremost goal of many treatment strategies. Treatment modalities include both pharmacological and non pharmacological methods. Pharmacotherapy is the main stay of treatment of rheumatoid arthritis [8]. Many nonpharmacologic treatment options are available for this disease, including exercise, diet, massage, counseling, stress reduction, physical therapy, and surgery. Many classes of drugs are available like NSAIDS, DMARDS, steroids, biologics.

Over the past two decades, treatment of rheumatoid arthritis has been revolutionized due to better understanding of pathology behind rheumatoid arthritis and developing drugs which target them. Various treatment protocols have been put forward by many studies which included monotherapy, combination of two or more drugs. Methotrexate was initially used as monotherapy for treatment of rheumatoid arthritis. In 2010, cochrane systemic review done by Katchamart W et al. emphasized lack of evidence of a statistically significant advantage for initial combination therapy using MTX and other conventional DMARDS over monotherapy with MTX [20]. In a study done by Davis JM et al., suggested that initial treatment for rheumatoid arthritis is a combination of methotrexate and prednisolone for three months and step up to combination therapy with non biologic DMARDS if no improvement in symptoms is found [21]. In a study by o dell JR et al. remission rate was found to be 77% in patients who received combination of methotrexate, hydroxychloroquine and sulfasalazine at the end of nine months.

We compared two drugs to three drug regimen. We found higher remission rate patients (52%) treated with three drug regimen when compared to patients (32%) treated with two drug regimen at the end of three months. There was no significant side effect of drugs at follow up visit. Hence we recommend three drug combinations over two drugs for treatment and early remission of rheumatoid arthritis.

Conclusion

We recommend early and aggressive treatment with combination therapy to induce early remission and halt the disease progression in rheumatoid arthritis. We recommend three drug combinations over two drugs.
Fig. 1: Sex Distribution of Sample

Fig. 2: Age Distribution of Sample

Fig. 3: Distribution of the Sample by Ra Factor

Table 1: Distribution of Cases by Remission

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<th>Group I</th>
<th>Group II</th>
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<tr>
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<td>12</td>
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<td>Remission</td>
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Correlating Anthropometric Measurements with Length and Diameter of Hamstring Tendon Graft for Anterior Cruciate Ligament Reconstruction

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Abstract

Introduction: The anterior cruciate ligament (ACL) is an important stabilizing ligament of the knee that is frequently injured in athletes and trauma victims. We aimed to evaluate the correlation between anthropometric measurements of the patients and their graft dimensions. Methodology: This observational study was conducted on 50 patients with ACL injury treated by arthroscopic quadrupled hamstring graft reconstruction at AJ Institute of Medical Sciences and Research Centre, Mangalore between May 2017 and April 2018. Patient related data like age, gender, side involved, symptoms reported, anthropometric measurements, graft length and diameter was replace was with ‘were’ noted. Correlation of graft length and diameter with age and anthropometric measurements was assessed. Results: Mean graft length of all patients was 11.39±1.31 cms, and was significantly higher in male as compared to female patients (11.82 ±0.76 vs 9.13±1.36, p value <0.001). Average graft diameter was 7.24±0.75 cms and was also significantly larger among male patients as compared to female (7.40±0.69 vs 6.38±0.35, p value <0.001). Graft length was found to have a significant inverse correlation with age of the patient (r = -0.39, p value <0.01), significant direct correlation with height (r = 0.71, p value <0.001) and weight (r = 0.29, p value <0.05) of the patients. Diameter of graft used was found to have a significant positive correlation with height of the patients (r = 0.50, p value <0.001). Conclusions: Anthropometric measurements can be used for preoperative planning and to help counsel patients on appropriate graft choices prior to surgery.

Keywords: Anterior cruciate ligament; ACL reconstruction; Hamstrings; Anthropometry

Introduction

The anterior cruciate ligament (ACL) is an important stabilizing ligament of the knee that is frequently injured in athletes and trauma victims. ACL injuries can occur by a variety of mechanisms, including both high-energy (eg, motor vehicle collision) and low-energy (ie, noncontact field sports). Low-energy injuries may involve contact (eg, blow to the lateral knee), but non contact injuries are more common, accounting for approximately 70% of ACL tears [1]. Appropriate treatment for an ACL injury depends upon the extent of injury, patient characteristics and activities, and available resources. ACL reconstruction is generally performed with arthroscopy using a graft to replace the ruptured ACL. Graft selection remains a source of debate among orthopedic surgeons. The three most common grafts are the patellar tendon graft, the hamstring tendon graft, and the allograft and each has its advantages and disadvantages. Graft
length and diameter have been shown to affect the
failure rates and overall functional outcome [2],
however, it can be challenging for the surgeon to
predict the size of these grafts prior to harvest. With
pre-operative planning for ACL reconstruction,
graft with adequate size can be harvested, or
alternative graft options can be explored. We aimed
to evaluate the correlation between anthropometric
measurements of the patients and graft dimensions.

Methodology

Study design and sampling

This observational study was conducted on
patients with ACL injury treated by arthroscopic
reconstruction at AJ Institute of Medical Sciences
and Research Centre, Mangalore. Reconstruction
was done by trans-portal technique (anatomical)
by a single surgeon using a quadrupled hamstring
graft. Fifty consecutive cases operated between
May 2017 and April 2018 were included in the
study. Cases with bony avulsion of ACL, arthritic
tibia, associated ligament injuries, cartilage lesions,
articular fractures, and pediatric cases were
excluded from the study. The diagnosis of ACL
injury was made clinically by consultants using
Lachman, Anterior Drawer and Pivot shift tests and
were confirmed with magnetic resonance imaging.
The study was approved by the institutional ethics
committee. Patients were explained the purpose
of the study and an informed written consent was
obtained.

Operative technique

For majority of patients, general anesthesia was
preferred as it allows for adequate joint exposure,
complete muscle relaxation and tourniquet pain is
more common under general anesthesia (53–67%)
is minimal, but the choice depended on patients’
general condition and the preference of the patient,
surgeon and anesthesiologist. In all our patients,
arthroscopic ACL repair was obtained through the
accessory anteromedial portal technique (anatomical
reconstruction). Anterolateral portal is the standard
viewing portal where the arthroscope was first inserted and is usually located in the
callaneous lateral ‘soft spot’, approximately 1.5 cm
above the lateral joint line and adjacent to the lateral
margin of the patellar tendon. Remnants of the torn
ACL were carefully inspected and an attempt was
made to preserve large tibial stumps and ACL fibers
with intact connections from the tibia to the femur.
After selecting and confirming the desired location
for the ACL femoral tunnel, a microfracture awl
was used to mark the location along the lateral
wall of the intercondylar notch. In our study, an
endobutton was used for the femoral fixation in all
cases. First we used a 4 mm drill bit to drill a tunnel
through the lateral femoral cortex. The depth of
drilling was calculated by deducting the preferred
endobutton length from the initial tunnel length and
then adding 10 mm; required for the endobutton to
flip. While viewing through the anteromedial and
anterolateral portal, ACL tip aimer jig was inserted
at a 55° angle through the anteromedial portal into
the knee joint. In all we used a single bundle,
quadrupled hamstring graft. An oblique incision
was placed over the medial border of the proximal
tibia, about one centimeter above the ‘pes anserius’.
The Sartorius fascia was split transversely and
the semitendinosus and gracilis tendons were
identified. These tendons were then separated from
its tibial attachment with a #11 blade. Using a tendon
stripper, they were then harvested. The tendons
were then cleared off their muscle fibres and then
fastened together with ‘whip-stitch’ sutures using 2
ethybond. The prepared graft was then mounted on
a graft preparation board and pre-tensioned. Using
an arthroscopic probe or grasper, we retrieved the
suture loop that was left in the ACL femoral tunnel
and pulled the suture out of the knee joint through
the tibial tunnel. The endobutton was then flipped
tension was applied to the free end of the graft.
The knee was then completely extended and the
free end of the graft was attached to the proximal
medial tibia with the help of ‘U’ staple.

Data Collection and Data Analysis

Patients were encouraged to walk from the
next day and active straight leg raises, active knee
curls against the resistance, isometric exercise of
quadiceps and active knee bending was initiated.
Using a predesigned semi-structured form patient
related data were collected. Demographic data like
age and gender, side involved, symptoms reported,
anthropometric measurements were noted for all
patients. The graft diameter was measured using the
ACL reconstruction graft diameter measurement
guides (Smith and Nephew, Andover, USA), with
increments of 0.5 mm. Graft length and diameter
was noted and gender specific differences were
analysed. Correlation of graft length and diameter
with age and anthropometric measurements was
assessed. The statistical analysis was done with
SPSS Version 18.0 (SPSS Inc, USA) and p value less
than 0.05 was taken as statistically significant.
Results

Table 1 describes the distribution of patients according to their demographic and clinical characteristics. Forty-six percent of all patients were from 21 to 30 years age group; 84% were males. Left side was involved in approximately two thirds of all patients. Instability of knee was reported by three fourths of all patients. Mean height of patients was 1.66 meters, weight was 72.98 kgs and mean body mass index was 26.39 kg/m$^2$. Mean graft length of all patients was 11.39±1.31 cms, and was significantly longer in male as compared to female patients (11.82±0.76 vs 9.13±1.36, p value <0.001). Average graft diameter was 7.24±0.75 cms and was also significantly larger among male patients as compared to female (7.40± 0.69 vs 6.38±0.35, p value <0.001). Graft length was found to have a significant inverse correlation with age of the patient (r = -0.39, p value <0.01), significant direct correlation with height (r = 0.71, p value <0.001) and weight (r = 0.29, p value <0.05) of the patients. Graft length was also found to have an inverse correlation with body mass index but it was not statistically significant (Table 3). Diameter of graft used was found to have a significant positive correlation with height of the patients (r = 0.50, p value <0.001). Age, weight and body mass index were not correlated with the graft diameter.

Discussion

Hamstring grafts are preferred by many surgeons due to low morbidity of the donor site and good cosmetic results [3]. However, graft failure may occur if the diameter of the graft is small and poor clinical outcome scores have been reported especially using grafts less than 8 mm in diameter [4]. The present study was done to understand the correlation of patient’s anthropometric measurements with graft

<table>
<thead>
<tr>
<th>Variables</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age distribution</td>
<td></td>
</tr>
<tr>
<td>Less than 20 years</td>
<td>06 (21%)</td>
</tr>
<tr>
<td>21 to 30 years</td>
<td>23 (46%)</td>
</tr>
<tr>
<td>More than 30 years</td>
<td>21 (42%)</td>
</tr>
<tr>
<td>Gender distribution</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>08 (16%)</td>
</tr>
<tr>
<td>Males</td>
<td>42 (84%)</td>
</tr>
<tr>
<td>Side involved</td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>32 (64%)</td>
</tr>
<tr>
<td>Right</td>
<td>18 (36%)</td>
</tr>
<tr>
<td>Symptoms reported by patients</td>
<td></td>
</tr>
<tr>
<td>Pain in knee</td>
<td>13 (26%)</td>
</tr>
<tr>
<td>Instability of knee</td>
<td>37 (74%)</td>
</tr>
<tr>
<td>Anthropometry</td>
<td></td>
</tr>
<tr>
<td>Height (in meters)</td>
<td>1.66 ± 0.08</td>
</tr>
<tr>
<td>Weight (in kilograms)</td>
<td>72.98 ± 11.75</td>
</tr>
<tr>
<td>Body mass Index (kg/m$^2$)</td>
<td>26.39 ± 4.32</td>
</tr>
</tbody>
</table>

All number are numbers (%) or mean ± standard deviation

| Table 2: Graft length and diameter of the patients included in the study |
|----------------------|----------------------|
|                      | Graft length | Graft diameter |
|                      | Mean ± SD | p value | Mean ± SD | p value |
| All patients (in cm) | 11.39 ± 1.31 |       | 7.24 ± 0.75 |       |
| Females | 9.13 ± 1.36 | <0.001 | 6.38 ± 0.35 | <0.001 |
| Males | 11.82 ± 0.76 |       | 7.40 ± 0.69 |       |

| Table 3: Correlation of graft length and diameter with patient related variables |
|----------------------|----------------------|
| Patient variables | Graft length | Graft diameter |
|                      | Correlation coefficient | p value | Correlation coefficient | p value |
| Age | -0.39 | <0.01 | -0.21 | 0.14 |
| Height | 0.71 | <0.001 | 0.50 | <0.001 |
| Weight | 0.29 | <0.05 | 0.09 | 0.51 |
| Body mass index | -0.16 | 0.25 | 0.22 | 0.11 |
length and diameter in ACL injury reconstruction surgery. Previous authors have found a significant association between gender of the patient with hamstring graft length. Xie et al. described that women had significantly shorter hamstring tendons than men [5] and Treme et al. found that women had significantly smaller and shorter grafts compared to men [6]. Concurring with these results, our study also found gender to be significantly correlated with the length and diameter of semitendinosus and gracilis tendon. The present study also found a strong positive correlation of the quadrupled hamstring graft length and diameter with patient’s height. Janssen et al. demonstrated that among the anthropometric measures, the patients height was more important in predicting the quadrupled hamstring graft dimensions [7]. Chiang et al. studied a group of 100 Chinese patients and found a significant correlation between height and length of both semitendinosus and gracilis tendons after multiple linear regression analysis [8]. This is similar to the results of a study by Boisvert et al., who found correlation between height and graft diameter [9].

Graft diameter has been shown to affect final clinical outcomes in patients. Significantly higher graft failures were noted by Park et al. with graft diameter less than 8 mm [10]. We found the graft diameter to be significantly larger in males and correlated with height of the patients alone. Similarly, Ma et al. found positive correlation between height and graft diameter in a multivariate regression analysis and that men had significantly larger grafts than women [11]. In contrast, correlation between graft diameter and body weight and leg length has been described by Schwartzberg et al. [12] Variations in study population sex ratio, ethnicity and sample size might explain these difference in results.

There are a few limitations of this study. Firstly, though the anthropometric measurements were performed by the same investigator, removing inter-observer bias, percent of body fat and lean body mass were not assessed, which are more specific measurements. Secondly, we did not assess the clinical outcomes after the reconstruction procedures. Lastly, surgeon specific variations in graft harvesting technique, method of graft stitching and tensioning may potentially affect the overall length and diameter of the graft. Multi-centric studies utilizing a standardized surgical technique are needed in future.

Conclusion

We found that female patients were more prone to have quadrupled hamstring graft of smaller dimensions, irrespective to their height, weight or body mass index. Graft length was found to have a significant correlation with patient height and weight. Graft diameter was found to have a significant relation only to patient’s height. These measurements can be used for preoperative planning and to help counsel patients on appropriate graft choices prior to surgery.

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Functional Outcome of Locking Compression Plate in Supracondylar Fracture of Distal Femur

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Abstract

Background: Utilization of LCP system in supracondylar fractures of distal femur couples the advantage of conventional plate osteosynthesis together with internal fixator systems. LCP involves use of compression plating and locked internal fixation method into one implant. The study was carried out to clinically explore the practical consequence of LCP in fracture associated with supracondylar region of distal femur on several aspects under investigation.

Materials and methods: Ninety patients with age more than 18 years, with prolonged comminuted supracondylar fracture of femur were regarded eligible for the investigation. On the contrary, patient exemption criteria for the study included existence of pathological and periprosthetic fracture, patients with existing deformity of same limb or open fracture, or condition of polytrauma. Patients were operated, and the LCP was grafted according to standard surgical procedure. Post-operative follow-up data was collected for 6 months.

Results: More than 50% patients exhibited outcome score as good, of which most them were above 30 years age. Less than 10% patients exhibited complications in both the cases of open and closed fracture. In patients with open fracture, reunion took place between 20-22 weeks, whereas in closed fractures, 70% patients indicated reunion between 16-18 weeks. Time of union was 16-18 weeks for maximum patients.

Conclusion: Results reflected that the LCP condylar plate is the treatment of choice in the management of comminuted distal femoral fractures. LCP helped in maintaining limb length and had fewer complications, emphasizing the need to follow basic principles of fracture fixation.

Keywords: LCP; Supracondylar; Neer’s score; femoral fracture.

Introduction

The supracondylar area constitutes the distal 9-15 cm of distal femur [1]. Supracondylar fractures of femur have a bimodal age distribution, with a high incidence in young adults from high energy trauma, such as motor vehicle accidents and a second peak in elderly with minor fall [2,3]. Contrary to difficulty in treating and devastating outcomes, the supracondylar fractures constitute only 7% of all femur fractures [1]. They are often unstable and comminuted and tend to occur in elderly or in patients with multiple injuries following road traffic accidents [4]. Femoral fractures are often associated with fractures of femoral neck, shaft, acetabulum, patella, tibia condyle and shaft. Anatomically, the femoral shaft is oriented 7° of valgus in relation to the knee joint, however maintaining this alignment is critical to the function and durability of the limb. Associated ligament injury of knee has been reported in 20% cases [5].

Earlier, during 1960’s, these fractures were mainly treated by traction. Few fractures have been as difficult to treat as the supracondylar fracture.
of the femur and few have resulted in as much disability. Stewart and Neer and their colleagues strongly support the concept that supracondylar fractures should be treated conservatively in traction. Stewart felt that the additional trauma and the proximity of the implant to the joint caused excessive reaction and subsequent adhesions [6]. Neer rightly indicated that no method of internal fixation was available which would provide sufficiently rigid fixation to eliminate postoperative splintage and permit early knee motion. In his opinion, this, coupled with the possibility of sepsis, far outweighed any possibility of gain by operative means [7]. Newer advancements include use of implants and various techniques targeting anatomic reduction of articular surface, limb alignment, surgical stabilization and early mobilization [8].

The Locking Compression Plate (LCP) system in supracondylar fractures of distal femur combines the facilities of conventional plate osteosynthesis with those of the internal fixator systems. It combines the two treatment methods (i.e., the compression plating and locked internal fixation methods) into one implant [9]. The aim of the investigation envisaged was to study the results in terms of improvement in functionality of LCP system employed in fractures associated of distal femur.

Materials and Methods

The investigation was carried out at the Department of Orthopedics, Acharya Vinobha Bhave Rural Hospital, Sawangi (Meghe) Wardha. The interventional study and the patients follow-up was done for year, from June 2017 to May 2018. The investigation involved 90 patients with comminuted supracondylar fracture of femur admitted in the host department. Clinical examination and interviewing methodology data was collected and subjected to statistical treatment using SPSS software (version 25.0.0.0).

Management of patient

On arrival of the patient in the emergency room, initial emergency management is carried out by maintaining airway, breathing and circulation. Thorough assessment of the patient is then done to rule out head, chest, spinal or pelvic injury. Musculoskeletal examination is done to look for associated fractures. Stabilization of the patient with intravenous fluids, oxygen and blood transfusion as required. The distal neurovascular status is carefully assessed. Then the fractured extremity is immobilized in a Thomas splint and sent for radiological examination. For open fractures thorough irrigation and lavage, debridement, intravenous antibiotics and delayed wound closure is done. Lower tibia skeletal traction is applied using a Steinmann pin or Denham pin under local anesthesia followed by continuous traction is given using Bohler Braun splint in ward.

Pre-operative assessment

On admission relevant investigations for surgical workup are done in all patients which include hemogram, blood sugar level, renal function test, liver function test, blood grouping, Rh typing, bleeding time, clotting time, retroviral screening, hepatitis B antigen assay, hepatitis C antigen assay.

Fracture is classified according to the AO classification with the help of radiographs. Preoperative planning was done to assess the size of plate and screws to be used. The limb to be operated was prepared. Third generation cephalosporin given early morning on the day of surgery.

Surgical procedure: Anesthesia was induced through spinal epidural, or general.

Patient positioned supine on the operating table with a pillow below the knee to flex the knee. A pneumatic tourniquet is applied in the upper thigh. Tibial pin is then removed, the limb is scrubbed with povidone iodine. Iipsilateral iliac crest and contralateral leg is also prepared.

Lateral standard approach is mostly used. A lateral incision parallel to the shaft of femur, extending across the midpoint of lateral femoral condyle, anterior to fibular collateral ligament, across the knee and gently curved anteriorly to end distal and lateral to tibial tubercle. The Vastus lateralis is elevated from the lateral intermuscular septum and retracted anteriorly and medially exposing the distal femur.

The condyles are reduced and stabilized temporarily by K-wires and fixed with cancellous screws. Fibular strut graft is harvested from the ipsilateral side and inserted in the medullary cavity of the proximal femur and into the distal femur maintaining axial and coronal alignment. Supracondylar part is reduced, and distal femoral LCP placed. Cancellous bone graft from the iliac crest is placed to fill the gap. Wound is closed in layers after attaining hemostasis over suction drain.
Post-operative period

Vitals of the patients are monitored. Blood transfusion was given if postoperative hemoglobin is below 9 g/dl. Intravenous antibiotics are continued in the postoperative period for 5 days and oral antibiotics till suture removal. Analgesics are given as per patient’s compliance. Sutures removal done on the 14th postoperative day. Patients are discharged once the surgical wound is healed and the general condition is stable.

Follow up: All patients were followed up at monthly for 6 months. At every visit patient is assessed both clinically (Table 1) using Neer’s functional criteria and using radiographs (Fig. 1).

Results and Analysis

In our study, incidence of fracture is high in young patients and elderly (Fig. 3). In the study, both sides were affected equally (Fig. 4). In the study, 02 (2.22%) patients sustained fracture due to assault, 24 (26.67%) patients by fall, and 64 (71.1%) patients by RTA. (Fig. 5).

Prevalence of closed fractures was higher in comparison to closed ones (Fig. 6). The final outcome score was higher in good and excellent

<table>
<thead>
<tr>
<th>Table 1: Neer’s score chart</th>
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<tr>
<td><strong>Functional (70 points)</strong></td>
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<tr>
<td><strong>A) Pain [20 points]</strong></td>
</tr>
<tr>
<td>No pain</td>
</tr>
<tr>
<td>Intermittent</td>
</tr>
<tr>
<td>With fatigue</td>
</tr>
<tr>
<td>Limits function</td>
</tr>
<tr>
<td>Constant or at exertion</td>
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<tr>
<td><strong>B) Walking capacity [20 points]</strong></td>
</tr>
<tr>
<td>Same as before accident</td>
</tr>
<tr>
<td>Mild restriction</td>
</tr>
<tr>
<td>Restriction stair sideways</td>
</tr>
<tr>
<td>Severe/cane</td>
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<tr>
<td>Crutches/brace</td>
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<tr>
<td><strong>C) Movement – flexion [20 points]</strong></td>
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<tr>
<td>Normal or 135°</td>
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<tr>
<td>Upto 100°</td>
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<td>Upto 80°</td>
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<td>Upto 60°</td>
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<td>Upto 40°</td>
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<tr>
<td>Upto 20°</td>
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<tr>
<td><strong>D) Work capacity [10 points]</strong></td>
</tr>
<tr>
<td>As before</td>
</tr>
<tr>
<td>Regular with handicap</td>
</tr>
<tr>
<td>Alter work</td>
</tr>
<tr>
<td>Light work</td>
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<td>No work</td>
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Fig. 1: Radiographs of supracondylar fracture of distal femur region and (A) pre-operative, (B) post-operative, (C) post-operative after one month, (D) post-operative after two months, (E) post-operative after six months.
category, as interviewed by the patients (Fig. 7). Complications, such as infection, knee stiffness, malunion and shortening, were less dominant, and almost equally distributed among all patients, whereas the rest had no complication (Fig. 8). After LCP plating, around 63% patients exhibited 16-18 weeks as time taken for reunion (Fig. 9). Data collected from patients to elucidate the score at the follow-up from time to time, reflected higher mean score values in patients with progression of time (Fig. 10).
Out of the total number of patients, 27% were between age 18-30 years, 31% between 31-50 years and 42% were above the age of 50 years. More than 50% subjects marked outcome score as good, and most them were between age 31-50 years and above (Fig. 11). Higher proportion of male and patients indicated good score, as depicted in Fig. 12. Outcome score awarded as good was higher

Fig. 8: Distribution of patients according to the complications

Fig. 9: Distribution of patients according to the time of union

Fig. 10: Distribution of patients according to increase in score at follow up

Fig. 11: Correlation of age with outcome

Fig. 12: Correlation of gender with outcome

Fig. 13: Correlation of type of fracture with outcome
for both open and closed fracture cases (Fig. 13). Less than 10% patients exhibited complications in both the cases of open and closed fracture (Fig. 14). In patients with open fracture, reunion took place between 20-22 weeks, whereas in closed fractures, 70% patients indicated reunion between 16-18 weeks (Fig. 15). Age wise, maximum number of the patients revealed time of union duration between 16-18 weeks (Fig. 16).

Discussion

Comminuted supracondylar fractures of femur historically have been difficult to treat. Problems such as varus collapse, malunion and nonunion frequently resulted before fixed angle plates and indirect reduction techniques were popularized.

The minimum age of the patient was 18 years, whereas the maximum age was 75 years old. The mean age in the series was 45.6 years. The comparative age occurs in other studies as well [6-9]. The maximum (80%) patients were males in our study; one of the causes of preponderance in the males could be the fact that this fracture is usually associated with high energy trauma to which males are more commonly exposed than the females [8]. The right and left side were almost equally affected, showing no predilection for any side.

Studies done in 1960’s by Watson-Jones, Charnley, and Neer et al. [7] revealed better outcome for patients treated non-operatively than for those treated operatively. However, complications of non-operative treatment included angular deformity, joint incongruity, knee stiffness and delayed patient mobilization [6,7,10].

But as per majority consensus of orthopaedicians now open reduction and fixation is the method of choice. Intra-medullary nails, external fixation, plates and prosthesis are the various strategies while fixing distal femoral fractures. Currently, most commonly used method is locking screwsplates and intra-medullary nailing. The mean union time in our series was 18.9 weeks and this was comparable to that in the standard series [8,11,12].

LCP is a single beam construct whose unique biomechanical function is based on splinting rather than compression which gives good stabilization, protects from stress shielding and induction of callus formation. It can be applied through a minimally invasive technique preserving blood supply that allows prompt healing, lower rates of infection and reduced bone resorption. This intramedullary device maintains the anatomical axis, therefore failure of fixation in osteoporotic bone is less. Hence can preferably be used in osteoporotic fractures where it provides a solution to the age-old problems of screw cut out, late collapse, and malalignment.
since the stability of the construct does not entirely depend on the quality of the bone. In addition, a retrograde intra-medullary supracondylar nail has got distinct advantages of preservation of fracture hematoma, decreased blood loss, minimal soft tissue dissection, less operative time and reduced rate of infection. In addition, since this is unicortical fixation it has least chance of plate back out [13]. The LCP construct showed higher axial stiffness than the RAFN construct for both Normal and Low BMD groups (80% and 60%, respectively) which can be explained by higher axial load sharing in the LCP construct. Also, the larger number of screws in the LCP resulted in more load sharing and consequently less local deformation [14]. In the study conducted by Ginger K. Bryant et al., locked-plates maintained fracture alignment beyond the time to fracture union and also concluded that the locked-plate-screw construct provided the strength to maintain plate position in the area of the femoral stem, negating the need for additional stability from cerclage cables or wires. This sole method of stabilization appears to neutralize flexion-extension, varus-valgus, and torsional forces [15].

It has been suggested that using a long plate that spans the greater part of the femur provides additional strength along the femur, decreasing the risk of future peri-implant fracture that may occur secondary to the patients with osteopenia [16]. Thus we concluded that the LCP condylar plate is the treatment of choice in the management of comminuted distal femoral fractures especially Type A fractures where we have found higher Neer scores [17,18]. However in Type C fractures the outcome is poorer. But still LCP remains the implant of choice for type C fractures also, though there are complications like knee stiffness and extensor lag were encountered in a few cases. LCP show better results than dynamic condylar screw and Angle Blade Plate [18,19]. Our technique and results are consistent with basic and empirical evidence that minimal soft-tissue dissection promotes fracture union [20,21]. Our technique of using LCP helped in maintaining limb length and had fewer complications, emphasizing the need to follow basic principles of fracture fixation [22].

Conclusion

Distal femoral LCP is a good implant in fixation of comminuted supracondylar fracture of femur. Early knee mobilisation can be done even in osteoporotic patients with modern locking compression plate fixation (LCP) techniques. Primary debridement has a great role in achieving better results in compound injuries. Early fixation and mobilisation of knee with proper physiotherapy regime and timely follow-up is essential to achieve excellent results in these notorious supra-condylar distal femur fracture and prevent complications.

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Original Article

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Functional Outcome of Paediatric Subtrochanteric Femur Fracture Treated with Titanium Elastic Nails

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Abstract

Introduction: Subtrochanteric femur fractures are the commonest paediatric fractures. These fractures are quite challenging injuries to treat. Intramedullary nails though have been used to treat paediatric femur shaft fractures, their effectiveness for managing the subtrochanteric fractures are of doubt. Aim: The union rates and fracture alignment after elastic nailing of paediatric subtrochanteric femur fractures. Materials and methods: The study was conducted between June 2016 and Dec 2017, in which 22 subtrochanteric fractures were treated with elastic stable intramedullary nails and were followed up for clinical and radiographic union. For subtrochanteric fractures especially after failed spica cast treatment in children of 5 to 15 years age group, elastic nailing was used. Fracture union and alignment were measured clinically and radiographically. Results: Among the 22 cases, 09 were female cases and 13 were male cases. Out of this, 20 fractures were healed with acceptable complications which included malunion (n = 4), loosening of nails (n = 2), re-fracture (n = 1), wound dehiscence at the nail insertion site (n = 1) and limb length discrepancy (n = 1) and only 2 (6%) had poor outcomes. Hence on overall, there were 13 (61%) excellent, 7 (33%) satisfactory and 2 (6%) poor outcomes. Conclusion: Although complication rates were variable (40 %) with elastic nailing for paediatric subtrochanteric femur fractures, it represents an important option for complex subtrochanteric femur fractures.

Keywords: Functional Outcome of Paediatric Subtrochanteric Femur Fracture Treated With Titanium Elastic Nails.

Introduction

Femoral subtrochanteric fractures represent approximately 1% of all fractures and 4% to 10% of femur fractures [1,2] in paediatric age group [3]. The literature shows very few studies regarding the management of paediatric subtrochanteric fractures [2,4]. Few of these studies support open reduction, whereas others support conservative methods [1,5,6].

Subtrochanteric femur fractures are difficult to treat due to inherent fracture instability, a short metaphyseal fragment, and close proximity of the fracture to the growth plate [7,8] and also difficult to maintain reduction conservatively because of the flexion, abduction, and external rotation produced by the proximal fragment [9,10].

The treatment of subtrochanteric femoral fractures in children is quite variable, ranging from traction, spica casting, intramedullary nailing and plating. The treatment choices depend on the age and fracture pattern. In children below 5 years of age the fractures are generally well treated with a hip spica cast. The choice of treatment becomes dilemmatic in children more than 5 years. The various options in this group being intramedullary
nailing, compression plating and external fixation. Coming to the fracture pattern, different pattern of fractures like transverse, short oblique, long oblique, spiral and comminuted fractures gives different outcomes.

The oblique or spiral fracture patterns make the fracture unstable, affecting the outcome of the limb length. This is because the growth from the proximal femur is lesser than the growth from the distal femur. Elastic intramedullary nailing has been widely used in the western countries for the past few decades in the management of paediatric femur shaft fractures and has now been studied for use in the treatment of subtrochanteric fractures of femur [11,12,13,14].

We have therefore studied the outcomes after elastic nailing of paediatric subtrochanteric femur fractures. The elastic intramedullary nailing has become the choice of internal fixation in paediatric femoral shaft fractures [15,16]. The various advantages of this technique being early union, early mobilization and weight bearing and easy implant removal.

Aim

The union rates and fracture alignment after elastic nailing of paediatric subtrochanteric femur fractures.

Material and methods

This is a prospective study conducted at Department of orthopaedics, Acharya Vinoba Bhave Rural Hospital, Sawangi, Wardha between June 2016 to December 2017. There were 22 cases included in this study. Cases with age group in between five to 15 with closed displaced subtrochanteric fractures were included. Cases with open fracture, pathological fracture and children medically unfit for anaesthesia were excluded.

Procedure

The total femur length was measured on preoperative or postoperative femur radiographs

Surgical Description

Two elastic intramedullary nails were inserted, medially and laterally in a retrograde fashion into the distal femur. The medial nail was advanced into the femoral neck, just short of the proximal femoral physis and the lateral nail up to the trochanteric apophysis, under fluoroscopic guidance. Postoperative immobilization was given, with non-weight bearing until clinical and radiographic union.

The follow up was with sequential radiographs at 1, 3 and 6 months, for assessment of radiographic union. Return to full activity was mostly after six months of surgery.

Institutional ethical committee approval was obtained.

Results

There were 22 cases including 09 female and 13 were male cases. Out of the 22 cases of subtrochanteric femur fractures, 20 of them united completely while 2 of them had non union.

The 20 fractures healed with acceptable complications. These included malunion noted in 4 cases, loosening of nails in 2 cases, re-fracture in 1 case, wound dehiscence at the nail insertion site in 1 case and limb length discrepancy 1 case (Table 1).

Hence on overall, there were 13 (61%) excellent, 7 (33%) satisfactory and 2 (6%) poor outcomes (Table 2).

Complications were more likely after high velocity injuries like motor vehicle accident than from simple injuries like fall.

<table>
<thead>
<tr>
<th>Type of complications</th>
<th>No. of cases (n=20)</th>
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<tbody>
<tr>
<td>Malunion</td>
<td>4 (20%)</td>
</tr>
<tr>
<td>Loosening of nails</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>Re-fracture</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Wound dehiscence at nail insertion site</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Limb length discrepancy</td>
<td>1 (5%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>No. of cases (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>13 (59.09%)</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>7 (31.81%)</td>
</tr>
<tr>
<td>Poor</td>
<td>2 (0.90%)</td>
</tr>
</tbody>
</table>
Diagram 1: Showing various types of complications in united cases.

Diagram 2: Showing outcomes of operative procedure.

Image 1: X-Ray of subtrochanteric femur fracture post of day 1 (AP and lateral view)

Image 2: X-Ray of subtrochanteric femur fracture post of sixth month showing complete union (AP and lateral view)
Discussion

Paediatric subtrochanteric femoral fractures has not been extensively studied as compared to the mid shaft femur fractures in the literature. Very few published studies directly address the management of paediatric subtrochanteric fractures [2].

Subtrochanteric femur fracture fixation has widely evolved over the past few decades, from traction, hip spica casting, plate fixation and external fixation to methods such as elastic intramedullary nailing.

The earlier methods like traction and hip spica methods though provided high levels of union; they were largely associated with family psychosocial impacts. The external fixation method was associated with more complications like refractures, pin tract complications and arthrofibrosis.

However, the intramedullary nails allows early union, rapid mobilization with fewer complications and hence is becoming the treatment of choice amongst most of the surgeons [17,18,19,20].

Paediatric subtrochanteric femur fractures can be challenging to treat because of displacement of the short metaphyseal fragments and limited remodelling potential of the proximal femur. Elastic intramedullary nailing is advantageous as it decreases morbidity, decreases length of the hospital stay, and early functional recovery.

The treatment for subtrochanteric femur fracture in children aged 5 to 15 years is most dilemmatic. The various treatment options offered being traction, hip spica cast, elastic intramedullary nailing, plating and external fixation.

Tolo et al., in his study described that many surgeons preferred traction followed by hip spica cast as a method of treatment of subtrochanteric femur fracture in children aged 5 to 15 years. However, that method required a relatively long hospitalization and frequent follow up to assess accuracy of the fracture with radiographs [21].

Reeves et al. concluded in his study that, children weighing more than 45 kgs or in children older than 10 years of age, the 90/90 skeletal traction with post traction spica was not suitable, due to high incidence of femoral shortening and malrotation [22].

However, Staheli & Sheridan, in their study showed that immediate spica casting was suitable for isolated femoral shaft fractures in children below 6 years of age [23].

Gregory et al. has found satisfactory results with external fixators, but the complication rates were high in the form of pin tract infection, refractures and loss of reduction [24].

Ziv & Rang, had shown that though plate fixation worked well in the paediatric age group, they also posed lots of disadvantages like poor cosmetic appearance of the scar, blood loss associated with exposure and reduction of the fracture and higher degree of overgrowth induced by the plates compared with intramedullary fixation [25].

Humberger et al., had shown that internal fixation showed better results than conservative methods [26].

Theologis and Cole, described the management of subtrochanteric fractures with various surgical methods and concluded that, traction and casting was useful in children younger than 10 years of age and for surgical intervention a careful selection of patients was required [10].

Schwarz in his study recommended that in cases where conservative treatment failed, dynamic compression plate could be considered as a treatment of choice [27].

Daum et al. in his study concluded that operative treatment was a preferred modality over conservative method to obtain anatomical reduction and to prevent later complications [1].

Ireland and Fisher preferred treating children younger than 10 years with conservative methods and those above 10 years with internal fixation, especially when conservative methods which failed to achieve acceptable alignment [4].

Barfod et al. suggested that the limb length discrepancies was due to normal overgrowth of the femur and not likely a complication of intramedullary elastic nailing [28].

Patients in prior studies had an average of 22 days of hospitalization and had 8% to 23% unsatisfactory early results and 4% to 10% unsatisfactory late results with traction and spica casting [10].

The results of our study are superior, compared to those of prior study results, with minimal hospital stays and better satisfactory results (Table 1 and 2).

However, a future larger prospective study is needed to enhance these results.

Nevertheless elastic intramedullary nailing should be considered as a safe and sound option in treating paediatric subtrochanteric femur fractures. This technique provides several advantages like short periods of immobilization, minimally invasive techniques, and fewer complications, to name a few.
Limitations

Since at our institution elastic nailing was the main modality of treatment used for treating these subtrochanteric fractures, comparison with other treatment options as a control group could not be done.

Conflict of interest

No conflicts of interest

Conclusion

This retrospective study on functional outcome of subtrochanteric femur fractures in paediatric age group treated with elastic stable intramedullary nails shows satisfactory to excellent results in 91% of the cases. This suggests that elastic intramedullary nailing is a good and effective option for the management of these paediatric femur fractures.

Although the complication rates are variable, up to 40% with elastic nailing for paediatric subtrochanteric fractures, this method represents a better option for difficult-to-manage paediatric fractures.

References


Original Article

Valgus Inter-trochanteric Osteotomy for Management of Neglected Fracture Neck of Femur in Young Adults: A Simplified Operative Technique

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Abstract

Introduction: Neglected fracture neck of femur in young adults has high rate of non-union, avascular necrosis (AVN) and secondary arthrosis. Only stable fixation is under surgeon’s control as other complications are part & parcel of injury itself. We achieved hip preservation with a simplified operative technique of valgus inter-trochanteric osteotomy fixed with 120 degrees double angled barrel plate and cancellous screws. Objectives: To develop an easily reproducible surgical technique with stable fixation to convert high grade pauwel fractures to low grade leading to hip preservation in majority of young adults & delay the need for future arthroplasty. Materials and Methods: 18 cases of Neglected fracture neck of femur (>3 weeks) in young adults (<50 yr) were operated using the simplified technique and followed from June 2016 to April 2018. Average presentation was 37 days from injury & average follow-up of 10.4 months. Radiological parameters analyzed were fixation and union at osteotomy and fracture site. Functional outcomes were assessed using modified Askin & Bryan Criteria. Results: Out of 18 cases, Good (9) to Excellent (6) results were seen in 15. 3 had fair outcomes necessitating replacement arthroplasty. AVN was seen in 5 cases and non-union at fracture site in 3 cases. Osteotomy united in all cases. No implant failure was encountered. 13 were able to perform activities of daily living satisfactorily and showed no signs of AVN till last follow-up. Conclusion: The simplified technique offers good results in majority of young adults with neglected fractures neck of femur with minimal complication rates.

Keywords: Valgus Osteotomy; Fracture Neck of Femur; Hip Preservation; Operative Technique; AVN.

Introduction

Fracture neck of femur is still the unsolved fracture and neglected cases (>3 wks) in young (<50) age group are a treatment dilemma. In developing countries, late and neglected presentation is common because of many socio-economic reasons like lack of awareness, manipulation by local bone setters, lack of transport facilities & financial constraints.

Sandhu et al. defined neglected fractures as those which are left untreated for 3 weeks [1]. High incidence of non-union and avascular necrosis (AVN) [2,3] of femoral head are due to poor blood supply, inaccurate reduction, hematoma washout by synovial fluid and lack of cambium in periosteeum. Delayed presentation as well as manipulation & massage by local bone setters further jeopardize the final outcome leading to neck resorption, smoothening of fracture margins, sclerosis and eventually unfavorable outcome.

Replacement surgeries [4,5] are unsuitable for rural population in view of financial constraints as well as socio-cultural habits of squatting, sitting.
crossed legged & using indian style toilets. Various biological treatment modalities [6-11] have been described for hip preservation such as vascularised bone grafts, muscle pedicle grafts, fibular grafts with or without osteotomy but still the best form of treatment remains inconclusive as these procedures are technically demanding and have not provided consistently reproducible results. Similarly, various fixation methods are described ranging from angled blade plate, 135 degree dynamic hip screw and double angle barrel plate with or without cannulated screws but, till now, no consensus has been reached on the best mode of fixation.

Pauwel [12] postulated that in non-union of femoral neck the problem is both biological and mechanical and by changing the high grade pauwel fracture geometry to a low grade (≤ 30°), the shear forces can be converted to compressive forces, resulting in union. However, stability of fixation and surgical technique plays a major role in final outcome.

In our study, we have used a simplified operative technique of valgus inter-trochanteric osteotomy fixed with 120 degrees double angle barrel plate (DABP) & Cannulated Cancellous Screws (CCS), so as to provide stable fixation and achieve union. Aims of our study were to develop an easily reproducible surgical technique with stable fixation to convert high grade pauwel fractures to low grade leading to hip preservation in majority of young adults & delay the need for future arthroplasty.

Materials & Methods

The observational study done on 18 cases of neglected fracture neck of femur (> 3 weeks) in young adults (<50yr) by This observational study was done on 18 cases of neglected fracture neck of femur (> 3 weeks) in young adults (<50 yrs) in Department of Orthopedics, Vardhman Mahavir Medical College & Safdarjung Hospital, New Delhi, India.

Inclusion Criteria
1. Neglected (>3 weeks old) intra-capsular fracture neck of femur
2. Age <50 yrs
3. Patient Anesthetically fit for surgery
4. Cases with Non-collapse stage of AVN were also included

Exclusion Criteria
1. Fractures <3 weeks old (managed by fixation alone)
2. Age >50 yrs (managed by primary arthroplasty)
3. Neglected Fracture with AVN in Collapse stage
4. Multiple co-morbidities with poor ASA grade

Pre-operatively, all patients were thoroughly evaluated clinically as well as radiologically with X-Rays, MRI (to look for AVN) and pre-anaesthetic check-up. Informed consent was taken from every patient with proper explanation of the procedure and associated complications along with possible need of future hip arthroplasty. Fractures were classified using pauwel classification and shear angle calculated in all cases. Our aim was to achieve correction upto 30 degrees in all the cases to provide compressive forces at fracture site. Hence the osteotomy wedge was calculated by subtracting 30 degrees from shear angle (Osteotomy wedge = Shear Angle-30). Based on the calculated wedge and the nature of our implant (120 degrees DABP), lag screw guide wire positioning angle (the angle at which guide wire needs to be placed in head via trochanter, with the horizontal) was calculated by subtracting wedge angle from implant angle i.e. 120 degrees.

The Simplified Operative Technique (Fig. 1)

All patients were operated on fracture table with C-arm assistance. Maximum possible closed reduction achieved on traction assembly was accepted followed by painting & draping. Using lateral approach, skin & soft tissues were dissected & tensor fascia lata was split. Proximal femur was exposed proximally till greater trochanter. Further step-wise operative technique is as follows-

1. First guide wire for lag screw is inserted from the most prominent part of the trochanter to inferior part of the head of femur at a pre-calculated angle (as described above) to get the best purchase in trochanter as well as to achieve the most desirable post-osteotomy correction with 120 degrees double angle barrel plate.
2. Second guide wire for CCS inserted parallel to the first guide wire 1.5 cm proximal to the first guide wire to superior part of the head for rotational stability, as well as to provide space for lag screw insertion.
3. Cannulated drill passed over second guide wire and appropriate size 6.5 mm CCS passed and partially tightened to align the fracture fragments.
4. Appropriate length lag screw inserted after reaming over first guide wire, so as to allow the coupling screw to give intra-operative compression at fracture site.

5. 120 degrees DABP passed over lag screw and coupling screw tightened to give compression at the fracture site. After that, coupling screw is partially loosened to allow plate rotation.

6. Femur is marked at the angle of plate by multiple drill holes under direct vision as well as C-arm. This will be the mark for proximal horizontal osteotomy site.

7. Based on pre-operative wedge angle calculation to achieve pauwel angle upto 30 degrees (as described above), distal oblique osteotomy site marked with multiple drill holes meeting the proximal osteotomy site, leaving the medial cortical hinge intact.

8. Osteotomy wedge removal is done initially with oscillating saw followed by completion with osteotome & hammer.

9. Lowman’s clamp applied between the distal end of plate and femur and after traction loosening, gradual closure done along with manual abduction of the limb to proximate the plate toward femur and closing of wedge verified on c-arm.

10. CCS & Coupling screw tightened & plate secured with screws in dynamic compression mode. A proximal cancellous screw via plate is also applied to give extra stability in the proximal fragment.

Drain was put after thorough wound lavage & closure done in layers. X-Rays were taken post-operatively & compared with pre-operative x-rays to assess the angle of correction. IV antibiotics were given for 5 days post-operatively followed by oral antibiotics for a week till suture removal, depending on wound dressing. Operative time was usually 1-1 1/2 hrs with 200-300 ml blood loss. Patients were kept non-weight bearing for 6 weeks followed by gradual partial to full weight bearing in 3 months when signs of union were observed.

Initial follow-up was done every 2 weeks till 3 months, followed by monthly visits till 9 months. Radiologically fracture site and osteotomy site were assessed for union, quality of fixation (implant failure), loss of reduction and head collapse/AVN. Functional outcomes were assessed using modified Askin & Bryan Criteria (Table 1).

### Results

Total 18 cases (14 males & 4 females) of neglected fracture neck of femur (>3 weeks) in young adults

<table>
<thead>
<tr>
<th>Clinical Findings</th>
<th>Results</th>
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<tbody>
<tr>
<td>No pain, near normal gait, &lt;20% restriction of ROM, normal activity</td>
<td>Excellent</td>
</tr>
<tr>
<td>Mild pain and limp, 2040% restriction of ROM, mild restriction of activity</td>
<td>Good</td>
</tr>
<tr>
<td>Continuous pain, marked restriction of ROM and activity, need walking aid</td>
<td>Fair</td>
</tr>
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<table>
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<tr>
<th>Table 2: Master chart showing details, follow-up &amp; outcomes</th>
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<tbody>
<tr>
<td>S No.</td>
<td>Age/Sex</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
</tr>
<tr>
<td>1</td>
<td>32/M</td>
</tr>
<tr>
<td>2</td>
<td>21/M</td>
</tr>
<tr>
<td>3</td>
<td>16/M</td>
</tr>
<tr>
<td>4</td>
<td>48/F</td>
</tr>
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<td>5</td>
<td>40/M</td>
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<td>6</td>
<td>36/M</td>
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<td>7</td>
<td>24/F</td>
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<td>8</td>
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<td>11</td>
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<td>12</td>
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<td>16</td>
<td>23/M</td>
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<td>17</td>
<td>29/M</td>
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<tr>
<td>18</td>
<td>46/M</td>
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(<50 yr) were operated using Simplified Technique and followed from June 2016 to April 2018. Average duration of presentation from injury was 37 days and average duration of follow-up 10.4 months. Parameters assessed during follow-up were:-

1. Passive and active hip range of motion. Any pain during movements & ease of performing activities of daily living
2. Radiological signs of union at fracture site & osteotomy site, associated with any loss of reduction or implant failure
3. Signs of AVN of femoral head
4. Gait analysis & necessity of walking aids

Final outcome was assessed using modified Askin and Bryan’s criteria. No implant failures were seen in any of the cases. Osteotomy site united in all the cases (10-12 weeks). Average pre-operative neck shaft angle was 105 degrees. Up to 30 degrees of maximum correction in pauwel angle were achieved post-operatively. Fracture site union (3 cortex contact on AP and Lateral radiograph) was seen in 15 cases (16-18 weeks). Pre-op AVN changes were seen in 3 cases (1 showed reversal during follow-up). Post-op AVN was seen in 5 cases (in 2 of these cases, fracture had already united). Non-union was seen in 3 cases, however, one of these cases (36/M) had good outcome with mild pain with limp and minimal difficulty in performing activities of daily living.

Femoral head collapse was seen in 1 patient; however, he was satisfied with his functional status with mild limp & on/off pain which didn’t interfere with his daily activities. Follow-up cases with radiologically persistent/newly diagnosed AVN (5) might require arthroplasty in near future, nevertheless, it was delayed. Preoperatively, 11 cases were pauwel Grade I/II and 7 were pauwel III. During follow-up, all pauwel III had persistent (2)/newly detected (3) AVN changes. Reversal
of AVN was seen in 1 case with Pauwel III type fracture. Based on modified Askin & Bryan Criteria, out of 18 cases, Good (9) to Excellent (6) results were seen in 15 cases. 3 had Fair outcomes necessitating arthroplasty (Table 2). Two of our operated cases with follow-up x-rays are shown in Figure 2.

Discussion

Femoral neck fractures in young adults must be treated with early closed reduction and internal fixation (CRIF). Despite improvement in the results of internal fixation due to better understanding of fracture morphology, reduction techniques and accurate positioning of implants, non-union results in 4%-30% cases [13-16].

In our country late and neglected presentations are common as initial treatment is usually done by local bone setters. Literature suggests that if neck fracture is more than 2-3 weeks old then primary fixation alone does not give good results [17,18]. Although the vascularized grafts (fibular/muscle pedicle) appear more biological, they are technically difficult and results are not uniformly predictable. Moreover, there are associated donor site complications as well.

Valgus osteotomy biomechanically converts shearing forces to compressive forces by altering the fracture geometry. It also enhances union by augmenting blood flow through the proximal fragment. Hence it acts both biologically & mechanically. The largest series in literature is that of Marti et al. [19] They presented results of valgus osteotomy in 41 patients of non-union of femoral neck, with union rate of 86% and implant failure in 6 patients, necessitating re-fixation. Their 7 patients required arthroplasty due to persistent non-union, late collapse and implant failure. Hence, stable and long lasting fixation is one of the most essential factors deciding union in these complicated scenarios. Various fixation methods for osteotomy fixation are mentioned in literature such as traditional double angled blade plate [20,21], fibula grafting with blade plate/screw fixation [11,22], Double Angled Barrel plate with CCS [23-25] and conventional DHS [26].

Studies comparing blade plate with dynamic compression screw for fixation have reported a higher rate of suboptimal implant positioning, cut out and failure with blade plate. [27] While using blade plate, hammering can displace the fragments as well. Advantages with dynamic hip screw include no hammering, compression at fracture site along with some play for fixation as the assembly can be rotated for ease of osteotomy, while doing the same in blade plate is not possible. In our technique, we re-enforced rotational stability to the fixation by using cannulated cancellous screws in all the cases.

In our series, there was no case of implant failure & osteotomy site united in all the cases primarily due to stable fixation & pre-operative wedge calculation, appropriate to the implant as well as fracture morphology.

Pauwel recommended placing the final fracture inclination up to 30°. This can be explained bio-mechanically for the merit of osteotomy in promoting union [12]. Stromquist and Harrison [28] used tetracycline and isotope studies to show that vascular damage may be increased during overcorrection to more than 30 degrees. Excessive valgus angle or mal-rotation will affect the remaining vessels and increase the chances of AVN.

Pre-collapse avascular necrosis is not a contraindication for valgus osteotomy in non-united fracture neck of femur as revascularization of head is still possible both by artery of ligamentum teres and by vessels crossing the unifying fracture [29]. In our series, 5 cases had AVN changes at the final follow-up out of which, 2 cases already had pre-operative AVN changes & rest 3 developed AVN during due course of time. 1 case (Pauwel III) showed reversal of AVN changes. All previous studies [23-25] showing results of DABP with or without CCS fixation show union rates of around 80-90% but with complications related to implant failure/loosening. Our results were comparable with union rate 83.3% (15/18) with no case of implant failure.

Good (9) to Excellent (6) functional outcomes were seen in majority of the patients (83.3%). Even the patients with fair outcomes were satisfied subjectively with their functional results.

Conclusion

Neglected femoral neck fractures in young adults must always be preserved. The easily reproducible Simplified Operative Technique of valgus intertrochanteric osteotomy along with stable fixation provides good to excellent results in majority of young adults with minimal complication rates. This technique offers favorable results even in cases with pre-operative AVN changes and delays the need for arthroplasty.
References

Assessment of Efficacy of Dynamic Hip Screw and Proximal Femoral Nail in the Treatment of Intertrochanteric Fracture of Femur: A Comparative Study

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Abstract

Background: Dynamic hip screw has been regarded as the average implants in the management of fractures of trochanter. Even with various studies that indicate the advantages of proximal femoral nail, they were still associated with failures at technical level. The aim of the present study was to evaluate the Effectiveness of Dynamic Hip Screw and Proximal Femoral Nail in the management of Inter-Trochanteric Femur fracture. Materials and Methods: Patients were arbitrarily classified into two groups. Group I patients were managed with dynamic hip screws and Group II subjects were managed with proximal femoral nails. A total of 50 patients were enrolled in this study. Any post-operative complications occurring during the stay at hospital was managed before discharge. All the subjects were made to follow up for four months. Student test and chi square test were used for statistical analysis. Probability value of less than 0.05 was considered as significant. Results: The mean intraoperative time in Group I was 103.6±37.64 minutes and in group II was 93.8±23.5. There was no significant difference between the two groups. The mean blood loss in Group I and Group II was 485.3±176 ml and 275±141.0 ml respectively. There were 5 cases of bed sore in Group I and no case of bed sore in Group II because of early mobilization. Conclusion: When dynamic hip screw was compared with proximal femoral nails, the study found no characteristic difference in the groups.

Keywords: Dynamic; Trochanteric; Fractures; Femur.

Introduction

The chances of hip fracture are elevating with age in all population subgroups around different parts of the globe, and the frequency of hip fractures is predictable to increase to around 512,000 in 2040 [1]. Hip fractures crucially consist of trochanteric or femur neck fractures, and the mortality percentage associated with femoral fractures fluctuates between 15% to 30% in the United States of America [2]. With surgical treatment using fixation, rapid mobilization is likely and it also reduces the occurrence of complications. There are two different types of fixations for fractures of the trochanter, initially plate fixation and secondly intramedullary implants [3,4]. Dynamic hip screw has been regarded as the average implants in the management of fractures of trochanter [5-10]. However, when compared with intramedullary implants, they ought to have a biomechanical drawback because of their broad length between the axis and the implants [11]. The proximal femoral nails were found by the AO/ASIF in the year 1998 and have become communal in the treatment of fractures of trochanter in the current years [12–15]. Even with various studies that indicate the advantages of proximal femoral nail [16–18], they were still associated with failures at technical level [19,20]. The cost of proximal femoral nails is also an issue. The aim of the present study was to
evaluate the Effectiveness of Dynamic Hip Screw and Proximal Femoral Nail in the management of Inter-Trochanteric Femur fracture.

**Materials and Methods**

The present prospective study was performed in the Department of Orthopedics, Government S K Hospital, Sikar, Rajasthan, India. Written consent was obtained from all the subjects. Patients elder than 50 years were enrolled in the study and were dividedas per the Evans classification. Patients were arbitrarily classified into two groups. Group I patients were managed with dynamic hip screws and Group II subjects were managed with proximal femoral nails. A total of 50 patients were enrolled in this study. The time duration between fracture occurrence and time of surgery was recorded. All the patients were managed under general anesthesia. A typical surgical treatments strategy was used for operating the patients. Proximal femoral nail, 240 mm in length was used. The total time duration of surgery, amount of blood transfusion, blood loss and the complications encountered intraoperatively were also recorded. Any post-operative complications occurring during the stay at hospital was managed before discharge. All the subjects were made to follow up for four months. All the data thus obtained were recorded in a tabulated form and analyzed using SPSS software. Student test and chi square test were used for statistical analysis. Probability value of less than 0.05 was considered as significant.

**Results**

There were 50 subjects involved in the study, with 25 subjects in each category. The mean age of the subjects was 58.35±4.65 years.

Table 1 demonstrates the intraoperative information in both the groups. The mean intraoperative time in Group I was 103.6±37.64 minutes and in group II was 93.8±23.5. There was no significant difference between the two groups. The mean blood loss in Group I and Group II was 485.3±176 ml and 275±141.0 ml respectively. There was a significant difference between the groups. The mean units of blood transfusion in group I and group II was 1.28±0.32 and 1.26±0.24. The mean hospitalization days in Group I was 19.2±2.14 days and in Group II was 18.6±5.28. There was no significant difference between the groups.

**Discussion**

The ideal device for fixation of trochanteric fractures is still an issue of debate. As per Jones et al. [21], when they compared the intramedullary nails, eg gamma nail, intramedullary hip screws and proximal femoral nails, with the sliding hip nails for the management of extracapsular proximal femoral fractures, no significant difference in the rate of complication and the surgical implications was observed. As per a study by Haentjens P et al., the mean blood loss in patients with dynamic hip screw was approximately 780 ml and in the BH Group was approximately 680 ml and the mean time duration of surgery was around 82 minutes and 102 minutes in each category [22]. On the contrary, according to the study performed by Pajarinen J et al., the blood loss amongst the subjects with dynamic hip screw was around 357 ml and in the patients with
proximal femoral nail was around 320 ml [23]; and the mean surgical duration was approximately 45 minutes and 55 minutes in both the categories respectively. A study by Patil SS and Panghate A, the mean blood loss in Group with dynamic hip screw was around 450 ml and in the BH Group was approximately 420 ml and the mean duration of surgery was 102 minutes and 110 minutes in the groups respectively [24]. As per Xu YZ et al., the blood loss was significantly smaller in the subjects with Proximal Femoral Nail than in the subjects with dynamic hip screw and the duration of surgery was significantly greater in the Group I than Group II [25]. According to our study, The mean intraoperative time in Group I was 103.6±37.64 minutes and in Group II was 93.8±23.5. There was no significant difference between the two groups. The mean blood loss in Group I and Group II was 485.3±176 ml and 275±141.0 ml respectively. There was a significant difference between the groups. The mean units of blood transfusion in Group I and Group II was 1.28±0.32 and 1.26±0.24. The mean hospitalization days in Group I was 19.2±2.14 days and in Group II was 18.6±5.28. There was no significant difference between the groups. There was no significant difference in the mean hospitalization days between the groups. Central location of the screw in femoral neck is mostly dictated, as that allows the cut out rate of approximately 13%. The rate of fixation is contingent on location of screw and the superiority of bone [24]. As according to the study by Parker and Handoll [26] on comparing the gamma and other condylar intramedullary nails with extramedullary implants for managing extracapsular hip fractures, they found four studies that enrolled PFN and Targon Proximal femoral nail and compared all with SHS. They did not find any significant difference between the categories when blood loss and transfusion and related complications were compared. As per the present study, there were 5 cases of bed sore in Group I and no case of bed sore in Group II because of early mobilization. 6 cases Group I and 5 cases in Group II presented with urinary tract infections. There were 8 cases of thrombophlebitis in Group I and 5 cases in Group II. Infection was seen in 5 patients in each group. Amongst late complications, implant cut out and femoral head AVN was seen in 6 subjects each of Group II. There was no significant difference in the early and late complications between both the groups. According to a study performed by Saudan M et al. no significant change was observed in complication rate related with treatment of femoral fractures with proximal femoral nails and dynamic hip screw [27].

Conclusion

The treatment of fractures of the intertrochanteric region remains a controversial management protocol. There are various management options present for management of femur fractures. When dynamic hip screw was compared with proximal femoral nails, the study found no characteristic difference in the groups. The amount of blood loss demonstrated a significant difference in the groups.

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Management of Intra-Capsular Fracture Neck of Femur in Case of Ebstein’s Anomaly

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Abstract

Ebstein’s anomaly is a rare congenital heart disease, which involves downward displacement of tricuspid valve and atrialisation of right ventricle associated with either atrial septal defect or patent foramen ovale through which shunting of blood occurs. In such patient, clinical presentation varies from congestive cardiac failure in childhood to incidental diagnosis in adulthood. If such patient presents with fracture neck of femur, it will be a challenging job for orthopaedic surgeon as well as anaesthesiologist. The main goals of treatment are to stabilize the hip, decrease pain and restore the level of pre-fracture function with minimal operative intervention.

Keywords: Ebstein’s anomaly; intra-capsular femur neck fractures; hemi-replacement arthroplasty; avascular necrosis; epidural anaesthesia.

Introduction

Hip fractures are common in a frail elderly patients which can be difficult to manage. The mortality rate is in the 20% to 24% range at 1 year; many patients will lose their independence after hip fracture. Ebstein’s anomaly is an abnormality of tricuspid valve in which valve leaflets are displaced downwards into right ventricle, resulting in large right atrium, small right ventricle and tricuspid regurgitation or stenosis [1]. It occurs in 1 percent of congenital heart defects [2]. The incidence in general population is 1:110,000 and there is no sex difference. This anomaly was described by Wilhelm Ebstein in 1866 in a report titled, “Concerning a very rare case of insufficiency of the tricuspid valve caused by a congenital malformation”[3]. It is associated with either atrial septal defect (septum secundum) or patent foramen ovale through which shunting of blood occurs. Haemodynamic derangement depends upon status of tricuspid valve displacement and right to left shunt. Patients with fracture neck of femur with associated Ebstein’s anomaly have to be addressed with a proper approach for definitive fracture management keeping in mind the deleterious effects of uncorrected congenital heart defect on health of the patient.

Case Report

A 52 year old male with history of fall from bike due to skid 3 days back at presented at Emergency Department with complaints of pain in left hip, inability to bear weight on left lower limb with painful and restricted movements of the left hip joint. Moreover, patient gave history of being a cardiac patient suffering from congenital heart disease – Ebstein’s anomaly. He had exertional dyspnoea (Grade 2 NYHA) since 15 years due to which he limited his activities. He was on treatment with Digoxin and Torsemide with Spironolactone.
However patient was not compliant with these medications.

On examination, patient was conscious and well-oriented with Pulse Rate - 112 bpm, right radial pulse, no radio-radial delay, radio-femoral delay, BP-130/80 mmHg in both arms in supine position. On systemic examination of cardiovascular system- S1S2 were heard with ESM (ejection systolic murmur) in pulmonary area (Grade 2), and in respiratory system- bilateral air entry was present with no added sounds.

On local examination, swelling and tenderness were present over left hip with restricted range of movements of left hip with left lower limb externally rotated. Pelvic compression test was positive. Neurovascular examination was unremarkable and Ankle-Brachial index was 1.0 on the injured leg. On further radiological evaluation, X-rays revealed trans-cervical (trans-cervical) type of neck of femur fracture, with no other bony injuries. When subjected to CT scanning, it was found that it was indeed a comminuted fracture of neck of femur (trans-cervical). Patient’s basal oxygen saturation was 90% on an average (85-92%), which was improved up to 94% with 4 to 8 L of oxygen per min. Cardiology opinion and pre-operative fitness was taken to optimize patient’s cardiac condition. Pre-operative 2D ECHO was suggestive of -situs solitus with D-Loop Ventricle, acyanotic congenital heart disease, Ebstein’s anomaly of the tricuspid valve, apical displacement of tricuspid septal leaflet, atrialised right ventricle and dilated right atrium, intact IAS/IVS, aortic valve thickened with trivial AR, grade 1 TR. With grave-risk consent, uncemented bipolar hemi-replacement arthroplasty of neck of femur fracture was performed through antero-lateral approach under epidural anaesthesia with adequate analgesia. Throughout the surgery patient’s vital signs were unchanged to any significant degree with oxygen saturation being 85% with 100% Oxygen @ 10L/min by face-mask. Post-operative period was uneventful except for the patient’s oxygen saturation that was 85 to 90% with O2 mask which gradually improved over 3 days and patient maintained the 90% saturation without O2 mask. Gradual passive ROM exercises were started within 2 days with partial to full weight bearing mobilization with a walker over a period of 2 weeks. With active physiotherapy sessions during follow up, the patient progressed to full weight bearing without assisted device by 4 weeks post-operatively with satisfactory range of motion at left hip. Patient is satisfied with his function and stability, and feels able to perform job related activities and activities of daily living.
Discussion

In patient with Ebstein’s anomaly, disease severity depends upon the degree of valvular abnormality, direction of intra-cardiac shunting, pulmonary hypertension, ventricular and supraventricular tachycardia and association with Wolf-Parkinson-White syndrome. These patients are at risk of paradoxical embolism, brain abscess, CCF and sudden death [4]. Similarly, in our case septum secondum ASD was present in the previous echocardiography which had got resolved over the years probably, hence not detected in preoperative ECHO. Moreover, the intraoperative findings of low oxygen saturation did not correlate with the pre-operative 2D-Echo findings of absent ASD and PAH. If such patient comes for emergency surgery, anaesthesia technique is to be optimized to avoid worsening of the pre-existing condition, that is to avoid decrease in systemic vascular resistance or increase in pulmonary resistance. In this patient it was bidirectional shunt, mainly left to right shunt. Because of that he was asymptomatic. The main aim was to maintain left to right shunt and avoid reversal of shunt. During general anaesthesia, increased intrathoracic pressure due to positive pressure ventilation aggravates right to left shunt and also increased sympathetic response during intubation and extubation which can precipitate adverse cardiac events, and so it is not preferred. To avoid complication of general anaesthesia and to provide benefits of regional anaesthesia to clinically stable patient for bipolar hemi-arthroplasty we preferred epidural anaesthesiato minimize hemodynamic changes which cause an increase in right-to-left shunt and hypoxemia. Fractures involving the femoral neck can disrupt the vascular supply to the femoral head and result in avascular necrosis (AVN) or nonunion [5]. A meta-analysis of the outcome of displaced femoral neck fractures found the rates of osteonecrosis and nonunion to be as high as 20% to 30% [5]. Surgical stabilization should be performed as soon as possible—ideally, within 48 hours to achieve primary osteosynthesis. In delayed presentation following injury in hip fractures hemi or total hip replacement is considered to be better option, to avoid risk of further avascular necrosis and need for revision surgeries in high risk elderly patients. Given the complexity of his congenital cardiac anomaly with a relatively normal acetabulum, the patient was treated with bipolar hemi-arthroplasty instead of extensive surgical intervention like total hip replacement.

Conclusion

The successful management of a patients with Ebstein’s anomaly requires a deep understanding of the pathophysiology of this cardiovascular disease and its effects on bone healing. Such patient should be considered as high risk cases and must be managed in tertiary centres by a multidisciplinary team. If patient is clinically stable and optimised, minimal needed intervention i.e. bipolar hemi-arthroplasty under epidural anaesthesia provides better option for fracture neck of femur cases.

References


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