ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 08, pp.19692-19696, August, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

A STUDY OF RADIOLOGICAL OUTCOME IN YOUNG PATIENTS WITH TRANS-CERVICAL NECK FEMUR FRACTURE OPERATED WITH CLOSED REDUCTION AND 3 SCREW FIXATION

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ARTICLE INFO

Article History:
Received 09th May, 2015
Received in revised form
13th June, 2015
Accepted 29th July, 2015
Published online 31st August, 2015

Key words:
Young,
Transcervical Neck Femur fracture,
Radiological outcome,
3 Screw.

ABSTRACT

A study was carried out at a tertiary care centre to analyze the radiological outcome in young patients who had sustained a transcervical neck femur fracture and were treated with closed reduction and internal fixation. The demographic and radiological data of 40 such patients operated between June 2012 and December 2013 was studied retrospectively. Patients were classified on the basis of Displacement of fracture and Acceptability of Osteosynthesis. The effect of these two determinants on union and final radiological outcome of the patient and various complications were analyzed. A total of 26 patients (65%) had acceptable Osteosynthesis whereas 14 (35%) had unacceptable osteosynthesis. 27 patients showed union at 6 months or less, 7 patients at 9 months and 1 patient at 12 months. Nonunion occurred in 5 patients. Mean time to union was 4.96 months. A very strong correlation was found between linear collapse and varus collapse at 12 months. 40% of patients (16 out of 40) were operated within 12 hours of injury, 42% between 12 to 24 hours and a further 18% were operated after 24 hours of injury. No relation was found between Injury-Surgery interval and time to union.

Citation: Dr. Kunal Dwijen Roy, Dr. Bibhas DasGupta, Dr. Rishi Aggarwal and Dr. Pradip Nemade, 2015. "A Study of radiological outcome in young patients with trans-cervical neck femur fracture operated with closed reduction and 3 screw fixation", *International Journal of Current Research*, 7, (8), 19692-19696.

INTRODUCTION

Femoral neck fractures account for about half of all hip fractures with the majority of them being in elderly patients. Geriatric hip fracture is a very common problem in orthopedics. Hip fractures, particularly femoral neck fractures, frequently occur in young adults. In such cases preservation of the vascularity of the femoral head is a priority to maintain the function, as it may be associated with avascular necrosis of the femoral head if the precarious blood supply is disturbed. This could then lead to occurrence of secondary osteoarthritis of the hip joint and loss of function. Hemiarthroplasty which is the treatment of choice in elderly cases of Transcervical neck femur fracture is contraindicated in physiological young patients as they have a long life expectancy and the life of the prosthesis is limited. The treatment option more frequently used in young patients with transcervical neck femur fracture is closed reduction and percutaneous osteosynthesis. The advantages of this technique are the limited amount of surgical trauma and preservation of the patient's femoral head. The disadvantages of Osteosynthesis are the potential difficulties faced during reduction, failure of the fixation and the associated chances of femoral head necrosis.

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It is very difficult to foretell whether a fixation surgery will lead to consolidation and healing of the fracture or to failure and the need for a secondary intervention. This outcome is purported to be dependent on various factors both patient and surgeon dependent. The various factors which have been proposed to influence the healing of fracture and surgical outcome after osteosynthesis are:

- Type of fracture – Displaced or Undisplaced
- Time elapsed between injury and reduction & fixation
- Quality of reduction
- Acceptability of fixation – Position of implant

MATERIALS AND METHODS

The study undertaken by us is a retrospective study. In this study the radiological data of patients with age 18-60 years who had sustained a transcervical neck femur fracture and treated with closed reduction and internal fixation with three cancellous screws at a Tertiary care centre were reviewed. The cases enrolled for the study were those operated from June 2012 to December 2013. Institutional Ethics Committee approval was obtained for the study. A written, valid and informed consent was administered to each patient meeting our inclusion and exclusion criteria.

The patients having any of the following characteristics were excluded:

- Pathological fractures
- Fixation combined with Osteotomy or other augmentation
- Associated fractures of head of femur/ shaft of femur Acetabulum
- Patients treated after more than 3 weeks from injury.
- Patients with incomplete or inappropriate records.
- Specific parameters were measured on the immediate post operative x-rays and x-rays at 5 follow-ups (6weeks, 3 months, 6 months, 9 months and 12 months) of the patients.

1) Based on preoperative radiographs, the patients were classified according to Garden's Classification (Type I - Type IV). Garden's Type 1 and Type 2 were grouped together as Undisplaced fractures whereas Garden's Type 3 and Type 4 were grouped as Displaced fractures for the purpose of analysis of results.

2) Based on the Injury-Surgery interval, they will be classified into four groups viz.

- Upto 6 hours,
- 6 hours to 12 hours
- 12 hours to 24 hours
- 24 hours to 3 weeks

3) Based on immmediate post-operative radiographs, patients were also classified according to the acceptability of the fixation and reduction into acceptable and unacceptable respectively.

- The criteria used for acceptability of fixation was the standard inverted triangle configuration with a screw along the inferior femoral neck, a posterior screw up against the neck posteriorly and the anterior superior screw peripherally in the head of the femur. The tip of screw should be at least 5 mm from the articular surface.
- Reduction was accepted according to the "S shaped or reverse S shaped"curves as described by Lowell *et al* (1980).
- All the cases in which both the reduction and fixation were deemed acceptable were grouped together as "Acceptable Osteosynthesis" (Fig. 1).
- On the other hand all cases where either reduction or fixation was unacceptable or both are unacceptable were grouped together as "Unacceptable Osteosynthesis" (Fig. 2).

4) Various radiological parameters were analyzed by studying the immediate post operative radiograph and 5 follow-up antero-posterior radiographs of pelvis with both hips of each patient.

- During the study of the aforementioned radiographs following parameters were measured and compared:

a) Collapse – The distance between the center of head or centre of trabeculae to the point of intersection of axis of neck and femur shaft axis was measured and the decrease if any is noted in the follow-up radiographs.

a) Neck Shaft angle – Angle between the femoral neck and femur shaft angle is measured and comparison of immediate postop & follow-up x-ray for angle of operated side. Occurrence of varus collapse and extent was noted.

b) Avascular necrosis – By comparing the immediate postop and follow-up x-rays the occurrence of radiographic changes of avascular necrosis of femoral head was looked for.

c) Occurrence of Union or Non-Union was noted by comparing the x-ray for signs of union or non-union at the fracture site and the time period at which union occurred was noted.

Fig. 1. Acceptable Osteosynthesis

All the cases in which both the reduction and fixation were deemed acceptable were grouped together as "Acceptable Osteosynthesis"

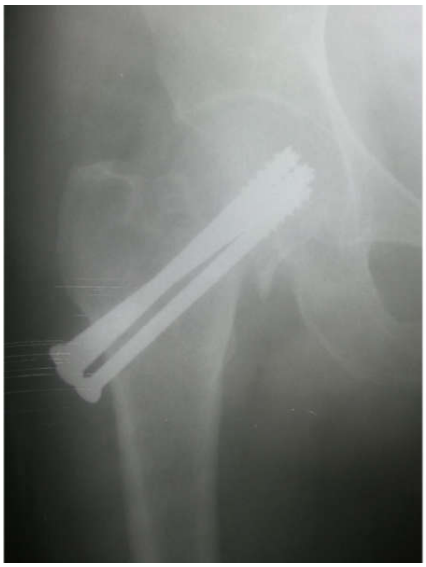

Fig. 2. Unacceptable Osteosynthesis

Unacceptable Osteosynthesis' constitutes cases where either reduction or fixation is unacceptable or both are unacceptable.

Statistical Analysis

The various contingency tables were analyzed using the Fisher's exact test and Chi square test as appropriate. Correlation between the parameters was found by calculating the Pearson's Correlation coefficient with 95% confidence interval.

RESULTS

Out of the 40 patients included in the study 26 were males and 14 females. The age wise distribution of the patients has been shown in Table 1. According to the Garden's classification 12 patients were found to have undisplaced fractures (Garden's type 1 and 2) whereas 28 patients had displaced fractures (Garden's type 3 & 4).Osteosynthesis was acceptable in 26 patients with the remaining 14 patients were classified as having an unacceptable osteosynthesis. The mean time period for fracture union was 5.74 months and ranged between three and 12 months.

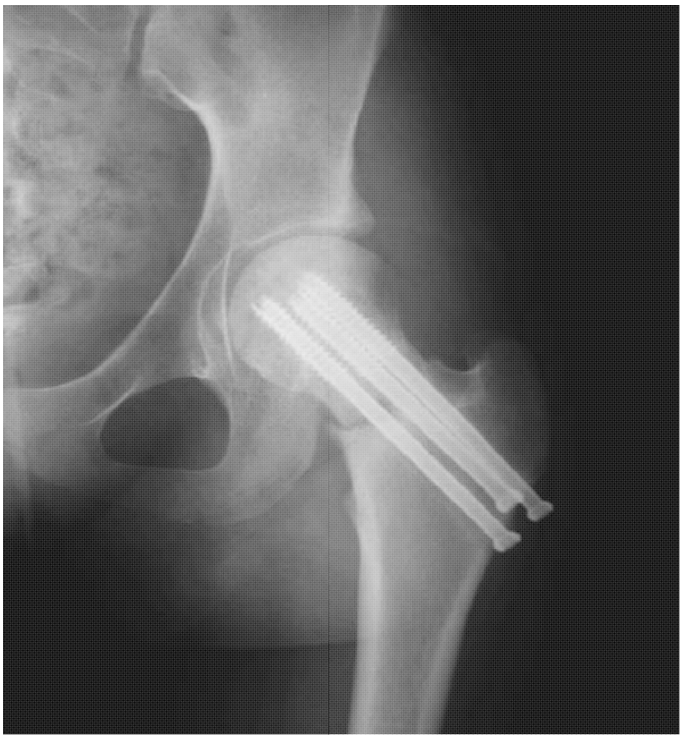

Fig. 3. 12 months follow-up x-ray demonstrating non-union at fracture site

Table 1. Age Distribution amongst Displaced and Undisplaced Fractures

Age (years)	Number of Patients		
	Undisplaced (Garden's type 1 & 2)	Displaced (Garden's Type 3 & 4)	Total
16- 20	0	2	2 (5%)
20-29	1	4	5 (12.5%)
30-39	5	4	9 (22.5%)
40-49	3	11	14 (35%)
50-59	3	7	10 (25%)

Table 2. Variation in occurrence of Union, Significant linear collapse and Significant Varus collapse according to type of fracture

Type of Fracture	Number of patients with Union	Non-Union	Average time to Union	Moderate to Severe Linear Collapse (>5 mm)	Moderate to Severe Varus Collapse (>5 degree)
Number of patients with Undisplaced fracture (out of 12)	12	0	3.25 months	0	0
Number of patients with Displaced Fracture (out of 28)	23	5	7 months	21 (75%)	18 (64%)

Table 3. Variation in occurrence of Union, Significant linear collapse and Significant Varus collapse according to Acceptability of synthesis

Acceptability of Osteosynthesis	Number of patients with Union	Non-Union	Average time to Union	Moderate to Severe Linear Collapse (>5 mm)	Moderate to Severe Varus Collapse (>5 degree)	Total out of 40
Acceptable Osteosynthesis (out of 26)	26	0	4.96 months	8 (31%)	7 (27%)	26
Unacceptable Osteosynthesis (out of 14)	9	5	8 months	13 (92.85%)	11 (78.6%)	14

Table 4. Relationship between Injury-surgery interval and Time to Union

Time from Injury to Surgery (in hours)	Union at 3 months	Union at 6 months	Union at 9 months	Union at 12 months	Non-Union	Total out of 40
Upto 6 hours	0	2	0	0	0	2
>6 hours to 12hours	4	6	3	0	1	14
>12 hours to 24 hours	7	3	4	1	2	17
More than 24 hours	1	4	0	0	2	7
Total	12	15	7	1	5	40

(p=0.44 using Chi square test.) [There is no relationship between time from injury to surgery and time for union of fracture]

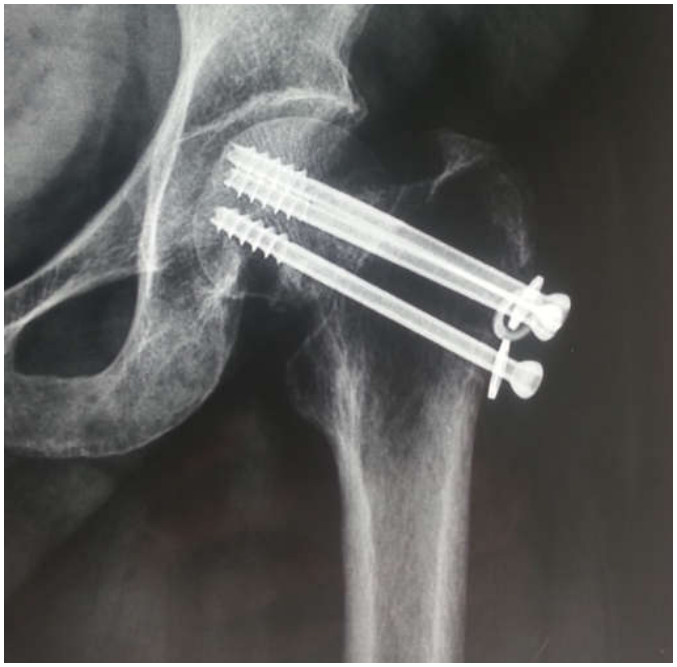

Fig. 4. Severe linear and varus collapse at 6 months follow-up

Fig. 5. Implant and fixation failure

The patients who had fracture union in three months were all Garden's type 1. Incidence of Non-union was found to be 5 out of the total 40 patients at 12 months follow-up. Moderate to severe linear collapse was seen in 21 cases and 18 cases were found to have moderate to severe varus collapse out of a total 28 cases with displaced fractures. All of the patients with undisplaced fractures had either none or only mild linear and varus collapse (Tables 2 & 3). Avascular necrosis was seen in none of the cases till 12 months of follow-up.

DISCUSSION

The main aim of any treatment modality used in patients with femoral neck fractures who are accepted as young based on physiological age is the improvement of the fracture outcome by preserving the femoral head and prevention of non-union and avascular necrosis. This retrospective review revealed satisfactory outcome of the used surgical modality in management of young intracapsular fractures as evident by the low complication rate. Our study series shows that the essential determinants for successful management were the type of fracture in terms of displacement and the acceptability of osteosynthesis. Similar inferences were arrived at by Seyfettinoglu *et al*. (2011) and Zlodowski *et al.* (2008) in their studies. Displaced fractures in our study had a higher complication rate as elaborated in Tables 2 & 3 when compared to undisplaced ones. A few common complications of this fracture fixation include non-union (Fig. 3), avascular necrosis, linear & varus collapse (Fig. 4) and implant failure (Fig. 5). In the present study the rate of non-union was found to be 12.5% (5 out of 40). This incidence was around 7% in separate studies by both Seyfettinoglu *et al.* (2011) and Lo Irene *et al*. (2011). All Undisplaced fractures showed union in our study which was similar to the findings of Seyfettinoglu and Lo Irene. On the contrary a non-union rate of 3% was reported by both Stromquist (1984) and Stappert (1987) in their respective studies. Displacement of fracture was a major influence in predicting the outcome and rate of complications with high rates of non-union and collapse (both linear and varus collapse).

In case of a femoral neck fracture, the intra-osseous cervical vessels are disrupted; femoral head nutrition is then dependent on the retinacular vessels and those functioning vessels in the ligamentum teres that remain intactas described by Truetta (1953). The femoral head in majority of the cases of displaced femoral neck fractures therefore becomes avascular, either partially or totally. Revascularization then occurs through the remaining blood supply by the process of creeping substitution as shown by Catto (1965) and Phemister (1930). Revascularization also takes place from the metaphyseal region because of vascular ingrowth across the fracture site. But this revascularization across a fracture is usually slow and rarely is it complete. Studies by Ray in 1964 demonstrated that a bone graft can be made to revascularize within hours and concluded that there is an entity similar to lumen-to-lumen connection of existing blood vessels. This suggests the importance of emergent reduction and stable fixation construct in the management of transcervical fracture of the neck of femur.

Zlodowski *et al.* (2008) in a large multicentric analytical study have shown that shortening and varus collapse have a significant impact on physical function. The incidence of limping and the need for a walking aid significantly increased as the femoral neck shortened. Our study shows that around $2/3^{rd}$ of displaced fractures tend to show collapse after fixation. A very high incidence of linear and varus collapse is also associated with unacceptable osteosynthesis which includes both reduction and type of fixation. A large correlation was also found between linear collapse and varus collapse (Pearson's correlation coefficient 0.8) suggesting the interaction between these two determinants. Zlodowski *et al.* also suggested a relation between these two but claimed that linear collapse was the single largest predictor of the physical outcome. Thus it is safe to conclude that fractures that heal in a

shortened position need not necessarily have a satisfactory outcome. A major part of reason for the observed decline in function is thought to be due to the changes in abductor moment due to the shortening of femoral neck but whether it is wholly responsible is debatable. Another possible explanation may be the screws backing out alongside the shortening causing local irritation. A further possibility is a non-anatomical reduction leading to mal-alignment between the femoral head and the acetabulum causing further impairment in function. The preferred method of three screw fixation is in the inverted triangle configuration as evident by the works of Blair *et al*. (1994) and Lindequist *et al.* (1993 & 1995). Here the most important screw happens to be the inferior screw or the calcar screw which controls inferior displacement of the head of femur by having the shaft of the screw rest on the calcar. This has also been purported to reduce the occurrence of later fractures at the level of the lesser trochanter. Successful use of three screw fixation has been reported in various studies. Selvan *et al.* (2004) showed that three screws that are parallel to each other, forming an equilateral triangle in femoral head, are biomechanically the most stable configuration.

A review of pertinent literature points to the fact that Injury-Surgery interval is an important factor determining the final outcome. Swiontkowski *et al*. (1987) reported that early fixation, ideal placement and the opening of the capsule of the hip joint are the three most important factors for a successful outcome and surgical intervention should be done within 12 hours. In our series 16 patients were operated within 12 hours of injury and there was only one case of non-union (Table 4). Out of those operated after 12 hours of injury 4 ended up with a non-union but this difference and the analysis of mean time to union in these two groups was not statistically significant. A large series by Upadhyay *et al*. (2004) and a meta-analysis of literature by Damany *et al*. (2005) also showed that there was no relationship between time to surgery from injury and union time.

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