



Research Article

Fracture Healing in Elderly Distal Radius Fracture with Type II Diabetes Mellitus

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Abstract

Introduction: It is hypothesized that elderly patients with type II diabetes mellitus are at a higher risk for delayed union of distal radius fracture and this risk is specific to patients with comorbidity of diabetes mellitus. The purpose of this study is to compare the fracture healing time duration in elderly, diabetic distal radius fracture with those of non-diabetic control group.

Material and methods: Elderly distal radius fracture with type II diabetes mellitus in 22 patients were retrospectively reviewed. Patients were individually matched to controls, who were treated by the author from the same institute with respect to age, gender, fracture type. Radiographs were reviewed to determine fracture healing. Univariate and multivariate regression were used to identify factors associated with time to radiographic fracture union.

Results: In 4 (18.2%) of diabetic group A and 20 (90.9%) non diabetic group B patients exhibited a radiologically visible callus formation at 4 weeks. While no callus formation was visible in 18 (81.8%), 2 (9.1%) accordingly. The mean average time to fracture healing 66 ± 19 days was visualized in group A of type II diabetes mellitus patients versus 46 ± 12 days in group B, non-diabetic control group ($P > 0.001$). Linear regression analysis revealed that group A patients were associated with longer time for fracture healing ($P = 0.02$). The age ($P = 0.29$), sex ($P = 0.31$) was not associated with increased fracture healing time duration. No differences were detected between both the groups A and B in terms of treatment approach ($P = 0.61$).

Conclusion: The fracture healing time duration in elderly diabetic distal radius fracture group was categorically prolonged than non-diabetic control group.

Keywords: Distal Radius Fracture; Diabetes Mellitus; Fracture Healing; Osteoporotic Fracture; Elderly Diabetic Patient

Introduction

Increasing prevalence of type II diabetes mellitus has been demonstrated over the globe, corresponding to doubling of the numbering in coming 30 years [1]. It is also postulated, that

diabetics may have an increased tendency to fall. Thus, increasing low energy distal radius fractures in elderly [2]. It is very much necessary to gain better understanding of pathophysiology of diabetic bone metabolism [3]. The bone mineral density is reduced with a defective bone formation in diabetics [4]. Hence it appears that the reduced bone quality is possibly due to an imbalance between organic and inorganic matrix surrounding the osteogenic cell pool [5]. With all these distortions the fracture healing is getting delayed with disturbed remodeling of bony callus [6]. The goal of this present retrospective study is to assess and compare the fracture healing time duration of distal radius fracture in elderly diabetic patients to similar control group of non-diabetic patients.

Material and Methods

In this retrospective study 22 elderly patients of unilateral, closed, fragility distal radius fracture with type II diabetes mellitus treated at District Hospital Sindhudurg have been included (Group A). Fragility fracture was defined as those resulting in elderly a fall from standing height or less. In control group of non-diabetics, elderly patients, the data were recorded with similar age, height, weight, haemoglobin and fracture type with no other comorbidities are identified and included (Group B).

The patients with history of diabetes, its duration and complications, with their details of medications, regularity of treatment were also recorded. Group A consisted of 22 patients with type II diabetes mellitus included 15 (68.2%) men and 7 (31.8%) women. The non-diabetic group B had 22 control patients with 17 (77.3%) men and 5 (22.7%) women (Table 1). The mean age for group A was 66 years (64 ± 12 , range 60 to 88) and group B (62 ± 11 , range 60 to 86) respectively. With regard to age, sex, treatment type, fracture complexity was taken in to consideration that could affect the fracture healing. Patients below 60 years of age, high energy trauma fracture and multiple traumas were excluded. All patients were treated conservatively with above elbow cast with forearm in supination, wrist in volar flexion and ulnar deviation with change of cast to below elbow with wrist in neutral position at the end of second week.

Initial radiography studied by orthopaedic surgeon and radiologist at the retrospective evaluation of each patient was reviewed and classified according to Frykmen (Table 2) [7]. The X-rays of both the group were held with an identical technique. The X-rays were taken for every patient immediately after trauma, after reduction, then at subsequent follow up 2,4,6,8,10,12 weeks. Follow up radiography were reviewed to determine time to radiographic union, defined as external bridging of callus across fracture lines in at least three cortices. All radiographs obtained by trained X-ray technicians in radiology department of this institute using a standardized protocol. All identifying information including the signs of acuity were excluded so as not to influence the reviewer's assessment of fracture healing. The assessment of fracture healing radiologically is done as follows [8].

Criteria 1: Formation of callus and sclerotic border

Criteria 2: Evaluation of fracture gap

- Stage 1 Fracture gap unchanged
- Stage 2 Fracture gap no longer detectable

Criteria 3: Signs of consolidation

- Stage 1 No signs of Consolidation
- Stage 2 Proof of beginning of consolidation
- Stage 3 Consolidation

The date of first radiograph that met the radiological criteria of union was recorded as the date of radiological union. Fracture healing time duration was defined as the difference between the date of fracture and date of union. Radiographs were reviewed by the medical officers without the knowledge of the patient's medical history.

Time to fracture union calculated for several sub groups specifically patients age, sex was tabulated and patients were stratified by fracture severity. Time to union were also determined separately for patients with type II diabetes mellitus group A and for non-diabetes group B (group A, n=22, group B, n =22). The two patients' groups, group A diabetic and group B non-diabetic were compared for homogeneity in gender, side of fracture, uniform treatment modality, haemoglobin, fracture severity, height, weight of patients and other comorbidities which are, likely to affect fracture healing.

In group A 16 (72.7%) patients were on oral hypoglycaemic drugs and 6 (27.3%) on insulin therapy. 7 (31.8%) patients were on oral anti diabetic treatment for more than 11 years, 5 (22.7%) for 5 to 8 years and 4 (18.2%) started treatment 1 to 3 years before this fracture.

To ensure that both groups were comparable with regard to timing of radiographic follow up. The mean average dates of follow up radiographs were obtained and compared. All patients' X-rays were obtained immediately after reduction. The first follow up X-rays were taken at 12 ± 6 days versus 13 ± 7 days in control group ($p = 0.06$). The second and third radiographs were obtained at 18 ± 9 ; 43 ± 11 and in control group 20 ± 8 ; 41 ± 13 ($p = 0.62$) respectively. The fourth and fifth radiographs were obtained at an average of 56 ± 14 , 72 ± 16 days and in control group 54 ± 16 , 68 ± 18 days, ($p = 0.74$) respectively.

This study was approved by Institute review board.

Statistical analysis was performed using chi – square test for non-parametric data and independent t-tests for parametric data as well as linear regression with level of significance 0.05. The regression model was used to determine the association between both group A and B days to healing of fracture adjustment for age, sex, fracture severity and diabetes mellitus comorbidity.

Sr. No.	Age in Years	Group A Type II Diabetes Mellitus Group (n = 22)		Group B Control Group (n = 22)	
		Male	Female	Male	Female
1	60 - 70	6 (40.0%)	3 (42.9%)	7 (41.2%)	2 (40.0%)
2	71 - 80	5 (33.3%)	2 (28.6%)	3 (17.6%)	1 (20.0%)
3	81 - 90	3 (20.0%)	1 (14.3%)	5 (29.4%)	1 (20.0%)
4	91 - 100	1 (6.7%)	1 (14.3%)	1 (5.9%)	1 (20.0%)
5	Above 100	0 (0.0%)	0 (0.0%)	1 (5.9%)	0 (0.0%)
	Total	15 (68.2%)	7 (31.8%)	17 (77.3%)	5 (22.7%)

Table 1: Base line demographic characteristics data in group A and B.

Frykman Type	Group A Type II Diabetes Mellitus (n = 22)		Group B Control Group (n = 22)	
	Men	Women	Men	Women
1	0 (0.0%)	0 (0.0%)	1 (5.9%)	0 (0.0%)
2	1 (6.7%)	1 (14.3%)	0 (0.0%)	1 (20.0%)
3	0 (0.0%)	2 (28.6%)	1 (5.9%)	0 (0.0%)
4	3 (20.0%)	0 (0.0%)	3 (17.6%)	0 (0.0%)
5	1 (6.7%)	1 (14.3%)	1 (5.9%)	0 (0.0%)
6	3 (20.0%)	0 (0.0%)	2 (11.8%)	1 (20.0%)
7	3 (20.0%)	1 (14.3%)	4 (23.5%)	1 (20.0%)
8	4 (26.7%)	2 (28.6%)	5 (29.4%)	2 (40.0%)

Table 2: Frykman classification for diabetes mellitus group A and control groups B.

Results

In non-diabetic group 20 (90.9%) and 4 (18.2%) of diabetic group patients exhibited a radiologically visible callus formation at 4 weeks. While no callus formation was visible in 2 (9.1%), 18 (81.8%) accordingly. In comparison to non-diabetic patients, a fisher's exact test showed no statistical significance ($p = 0.052$), which suggests a delayed callus formation in diabetics.

The mean average time to fracture healing of 66 ± 19 days was visualized in group A of type II diabetes mellitus patients versus 46 ± 12 days in group B, non-diabetic control group ($p > 0.001$). It is evident that there was a longer time duration to radiographic fracture union associated with type II diabetic mellitus group A patients (Table 3).

The Frykmen fracture type 7 and 8 had average longer fracture time than type 1,2,3,4,5,6. (65 ± 17 versus 58 ± 15 days, $p = 0.019$), whereas there was no effect of age ($p = 0.25$), sex ($p = 0.51$) on time to radiographic union. There was marginal difference detected in fracture healing time in group A of type II diabetics mellitus patients on oral hypoglycaemic drugs and insulin (63 ± 14 versus 61 ± 12 , $p = 0.72$). No difference was detected in group A patients who had acceptable reductions compared with loss of reduction radiologically (62 ± 15 versus 59 ± 13 , $p = 0.66$). In control group B fracture healing time duration was much less compared with group A patients. This did not differ according to age ($p = 0.36$), sex ($p = 0.39$). Linear regression analysis revealed that group A patients were associated with longer time fracture healing ($p = 0.02$). The age ($p = 0.29$), sex ($p = 0.31$) was not associated with increased fracture healing time duration. Multivariable regression analysis revealed that group A patients associated with increased fracture healing time duration when controlling for age, sex ($p = 0.03$).

	Group A Type II Diabetes Mellitus (n = 22) Days to Union		Group B Control Group (n = 22) Days to Union		p-value
Age in years	Male	Female	Male	Female	
60 - 70	68 ± 16	66 ± 14	42 ± 10	44 ± 12	0.16
71 - 80	65 ± 14	63 ± 11	40 ± 12	42 ± 11	0.14
81 - 90	62 ± 17	61 ± 16	39 ± 14	41 ± 13	0.09
91 - 100	67 ± 18	68 ± 12	42 ± 15	47 ± 14	0.12
Above 100		43 ± 17			0.18
Frykman Type					
1	64 ± 13	63 ± 10	40 ± 9	46 ± 14	0.23
2	62 ± 10	64 ± 16	42 ± 11	44 ± 12	0.19
3	59 ± 13	63 ± 14	40 ± 8	42 ± 9	0.2
4	68 ± 15	69 ± 13	44 ± 12	43 ± 8	0.16
5	64 ± 17	65 ± 15	47 ± 14	48 ± 10	0.17
6	69 ± 18	70 ± 17	48 ± 15	49 ± 13	0.26
7	72 ± 19	74 ± 18	51 ± 12	45 ± 12	0.08
8	74 ± 18	72 ± 17	46 ± 11	47 ± 10	0.05

Table 3: Age, sex and severity of fracture, as per Frykman classification type for Fracture healing time duration in type II diabetes mellitus and control group.

Discussion

In this study it is depicted very categorically that the diabetic patient group of distal radius fractures in elderly was associated with longer fracture healing time duration compared to non-diabetic control group. This diabetic group patients exhibited a delayed callus formation with a tendency of prolonged remodeling of bone in comparison with non-diabetic control group.

Diabetic fracture is a significant comorbidity which is characterized by micro architectural changes that decrease bone quality [9]. Meta analysis reports show a consistent pattern of increase risk of fracture [10]. Diabetes mellitus is associated with a reduction of bone strength that, result in high risk of fracture [11]. The osseous tissue experience alternation in quality, composition and biomechanical properties and these lead to fracture healing impairment [12]. It is also observed that in diabetic fracture healing there is a trend towards decrease callus vascular volume and significantly increased callus adiposity [13]. There is further delay in reaching peak bone volume, with significant decrease in woven bone [14]. The presence of increased adiposity found in fracture callus with elevated marrow adiposity is confirmed by many other studies [15].

Thus, in type II diabetes mellitus fracture healing impairment is caused by the event of fate switch, from osteoblast to adipocyte [16]. More over reduced immuno histochemical indice of cell proliferation in diabetic callus further support the decreased number of osteoblasts as part of the mechanism for impaired fracture healing [17]. Several studies report protein expression levels of several growth factors closely related to osseous healing such as PDGF, IGF-1, VEGF and TGF β 1, BMP have been decreased [18]. In addition, deficient micro vascular invasion and elevated chondrocyte apoptosis in diabetic fracture callus suggest compromised cartilage to bone transition, thus explaining delayed fracture healing [19]. Various studies of biomarkers of bone formation and resorption during diabetic fracture healing confirmed diminished bone formation and increased bone resorption [20]. This support the idea of bone regeneration and remodeling is impaired in type II diabetes mellitus, particularly by altering the bone turn over process [21].

Fracture healing in type II diabetes patients is prolonged by 87% [22]. Also, there is a 3,4-fold higher risk of complications like delayed union and non-union [23]. But in this current study the fracture healing was prolonged in (82%) and there were no non unions in diabetic distal radius fracture group.

The oral antidiabetic drugs have been associated with alternations in skeletal properties which can be detrimental for the fracture healing process [24]. Insulin reverses impaired fracture healing. Experiments on insulin suggest it hastens fracture healing with direct effect on repair process. But in this retrospective study of diabetic patients on oral hypoglycaemic drugs and on insulin no osseous proven adverse effects were seen radiologically during fracture healing [25].

Interestingly the fracture morphology did not offer radiologically recognizable influence in fracture healing. Furthermore, no differences were found in fracture gap or signs of consolidation. A direct comparison of influence of anti-diabetic medication on fracture healing could not be done in this study as patients have received different anti diabetic drug treatment. Taking all this in to account as more evidence is unveiled about the detrimental effects of many anti diabetic drugs acting adversely on skeletal homeostasis. Further research should be focused more on proving their effect on osseous tissue. So that safest antidiabetic drug can be chosen in the treatment of distal radius fractures with type II diabetes mellitus [26].

In this study, elderly distal radius fractures are only chosen, because they are the most common injury seen very frequently in our casualty room. This ensures enough number of patients for a meaningful statistical analysis. More over the radiological fracture healing of distal radius fracture with specific radiographic parameters tool can be demonstrated on plain X-rays without any need for further imaging modalities. Another very important fact that this fragility distal radius fracture, is a strong predictor of subsequent fracture, offer an unique opportunity to initiate treatment for osteoporosis [27]. The fracture healing time duration is associated with multiple factors in diabetes mellitus which are fragmentarily investigated so far [28]. How ever it also depends on the duration of diabetes and much more so with its complications [29]. The results of this study as regards, the fracture healing time are in agreement with these reports.

Limitations

There are several limitations in this study report. The definition of fracture union continues to be controversial since long time. Hence in this study radiographic union of fracture which is more objective is selected. The timing of follow up radiographs even though was done at similar intervals for both groups, it is difficult to determine with precision the exact time of bony healing. It is accepted in this study that the date radiographic union as the date of fracture union. But it is possible that the fracture might have healed several days before the follow up visit X-ray date. Another limitation of this study is the relative rarity of non-union of distal radius fracture, which was chosen in this report. An additional limitation was that the osteoporosis status was not known in the control group of patients. Last being the small number of patient cohort. Despite all the known negative consequences on fracture healing and the mechanisms involved in type II diabetes mellitus induced skeletal impairment are not fully understood [30]. Further investigations are a must to elucidate the pathophysiology of diabetic bone fracture and to develop successful strategies to treat this growing medical, socio economical global issue.

Conclusion

Fragility distal radius fracture in elderly with type II diabetes mellitus categorically displayed impaired, prolonged fracture healing. An intensified multidisciplinary approach treatment schedule is necessary to achieve osteosynthesis. The success of therapy depends on the complex treatment of underlying disease of type II diabetes mellitus.

Conflict of Interest

The authors have no conflict of interest to declare.

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