



EFFECT OF SMOKING ON FRACTURE HEALING IN TIBIAL DIAPHYSEAL FRACTURES – A PROSPECTIVE STUDY

Orthopaedics

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ABSTRACT

Background: Cigarette smoking and its strong association with cardiovascular and respiratory disease have been well documented. There is growing evidence that smoking delays or inhibits bone healing after surgery or trauma. Tibial fractures are difficult to manage, mainly due to coexistence of covering tissue problem and poor blood supply. The negative effects of smoking on tibial shaft fracture healing have been observed in few clinical investigations. The present study aimed to evaluate whether smokers are at a higher risk of delayed and non-union following closed tibial diaphyseal fractures. **Methods:** 120 patients were enrolled and divided into 2 groups - Group 1 (G1) consisted of patients who had never smoked and Group 2 (G2) consisted of patients who have smoked 100 cigarettes in their lifetime and currently smoke cigarettes every day or some days. (According to WHO smoker / current smoker criteria). All patients will be treated with CRIF with ILN Tibia. Both the groups received same perioperative care. The patients were followed up at every 6 weeks till 6 months with X ray of AP and lateral view. **Results:** At the end of 6 months follow up we found 23.33% union, 60% delayed union, 16.67% non-union and 16.67% infection in smokers and 83.33% union, 6.67% nonunion, 10% delayed union and 6.67% infection in non-smokers respectively. Rate of nonunion, delayed union and infection is high in group 2 compared to group 1. Mean days of union in smoker group is (127 days) longer compared to non-smokers group (102 days). **Conclusion:** Smokers healed their fractures more slowly compared to nonsmokers. Smokers are at a higher risk of delayed and non-union. Rate of infection is high in smokers compared to non-smokers. The results highlight the need for orthopedic surgeons to encourage their patients to enter a smoking cessation programs.

KEYWORDS

Smoking, Closed diaphyseal tibial fractures, Union, Delayed union, Non-union

INTRODUCTION

Cigarette smoking and its strong association with cardiovascular and respiratory disease have been well documented. In recent years there has been increasing interest in possible adverse effects of nicotine consumption on soft tissue and bone healing following injury.¹ Smoking is probably the most wide spread addiction in the world.² It affects almost all the systems in the body, from the functioning of organs to the efficiency of the body's immune system. Experimental studies have suggested that nicotine may impair wound healing and bone healing. Adverse effects on bone healing have been noted in patients after spinal fusion with higher pseudarthrosis rate in smokers. The World Health Organization (WHO) estimates that there are about 1.1 billion smokers in the world. Tobacco use in Indian society is increasing.³

In the literature, smoking has been recognized as a detrimental factor to diaphyseal bone healing and increases time to union.⁴ Due to its subcutaneous anatomical location and poor blood supply, tibia is vulnerable to direct blow in high energy trauma. The diaphysis is at high risk from twisting injuries because it is thinner distally.⁵

Distal tibia fractures are one of the most demanding and difficult to manage injuries in orthopaedic traumatology. Complications are also common like possible wound problems, osteomyelitis, malunion, nonunion, pintract infections and hardware failure.⁶

Despite improvements in surgical technique and equipment over the past decade, an increasing percentage of patients experience impaired fracture healing due to the complexity of the healing process.⁷ There is growing evidence that smoking delays or inhibits bone healing after surgery or trauma. Multiple studies have shown a significant difference in the healing time of bone between groups of smokers and non-smokers.⁸

Overall a number of studies in the medical literature have investigated the effects of smoking on bone healing, however predominantly this information is dispersed across multiple surgical specialties. There are only few studies over effect of smoking over closed tibia fractures.

The present study aims to evaluate whether smokers are at a higher risk for surgical failure, infection, delayed union, nonunion following closed tibial diaphyseal fractures.

METHODOLOGY OBJECTIVES

- To study the effect of smoking on healing of closed diaphyseal tibial fractures
- To study duration of union of closed diaphyseal tibial fractures treated by closed reduction and internal fixation by interlocking nail in smokers and non-smokers.

Inclusion criteria:

- Smokers who have smoked 100 cigarettes in their lifetime and who currently smokes cigarettes every day or some days.
- Male and female patients aged between 18 to 40 years with tibial diaphyseal fracture.
- Closed fractures and type 1 open as per Gustilo and Anderson classification.
- The fractures which can be treated by closed intramedullary nailing.
- No associated co morbidities.

Exclusion criteria:

- Patients who are not willing to provide written informed consent for research or surgery.
- Aged less than 18 years and more than 40 years.
- Poly trauma patients.
- Metaphyseal and articulate fractures.
- Patients with ipsilateral fractures in the same lower extremity.
- Pathological fractures.
- Type 2 and Type 3 open fractures as per Gustilo and Anderson classification.
- Associated co morbidities such as diabetes, thyroid disorders, peripheral vascular diseases, Chronic illness, metabolic bone diseases, chronic steroid and NSAIDs use, malnutrition and anaemia.

Sample Size Estimation

Estimated to be 29, rounded off to 30, considering proportion (P1) of union in nonsmokers as 80% and proportion (P2) of union in smokers as 39.90%. power of 95%, alpha error of 5%

$$d = P1 - P2 = 40.1$$

$$n = \frac{2Pq(Z\alpha + Z\beta)^2}{d^2}$$

$$P = \frac{P1 + P2}{2} \quad q = 100 - p$$

$$Z\alpha = 1.96 \text{ at } 5\% \alpha \text{ error}$$

$$Z\beta = 1.282 \text{ at } 10\% \beta \text{ error}$$

Methodology:

After obtaining written informed consent and institutional ethical committee clearance, 120 patients who sustained tibial diaphyseal fractures satisfying inclusion and exclusion criteria's were enrolled and divided into two groups:

Group 1 (G1) consisted of patients who had never smoked.

Group 2 (G2) consisted of patients who were either currently smoking or had a smoking history.

Blanket treatment for all subjects was given with T. vitamin D3 60000 IU weekly once for 8 weeks and T. calcium 500mg OD for 2 months. All patients will be treated with CRIF with ILN Tibia.

After initial assessment, adequate resuscitative measures, analgesic administration, the limb was immobilized in the form of above knee plaster of paris posterior slab. Limb elevation over a pillow was given to all patients. Antibiotics were administered for open fractures. Routine investigations, X Rays were done according to the guidelines for both the groups. All patients underwent Intramedullary interlocking nailing under spinal anaesthesia after the patients were fit for surgery according to standard protocols and principles. Adequate analgesia and antibiotics cover was given post operatively. Patients were advised for full weight bearing between 8 weeks to 16 weeks postoperatively after clinical and radiological examination for fracture union. Patients were advised for follow-up on 4th, 8th, 14th and 24th weeks after discharge and at every 6 weeks till 6 months. Patients were assessed clinically and radiologically for fracture union, non-union and delayed union and infections at each follow up.

Clinical outcome: Fracture union was defined as ability of the patient to have full pain free weight bearing on the injured extremity.

Radiological outcome: Visible bridging of at least three cortices on the anteroposterior and lateral radiographs.

Delayed fracture union: Defined as pain with weight bearing and the absence of visible bony consolidation on X-ray after 4 months.

Non-union: Defined as pain with weight bearing and the absence of visible bony consolidation on X-ray between 6 to 8 months (Rockwood & Greens Fractures in adults)

STATISTICAL METHODS

Data obtained was coded and entered into Microsoft Excel spreadsheet. The categorical data was expressed as rate and percentage. The continuous data was expressed as mean $\pm$ S.D. Chi-square and independent t test was used to find the association between categorical data. A 'p' value of less than or equal to 0.05 was considered as statistically significant.

The Statistical software namely SPSS 22.0, and R environment ver.3.2.2 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS

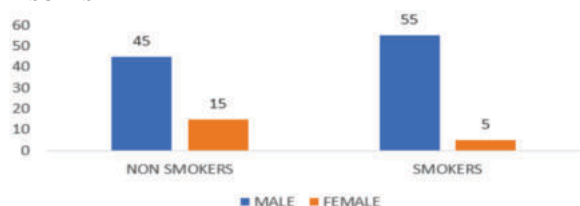


Chart 1: Percentage of male and females.

In nonsmokers group there were 15 female (25%) and 45 male (75%) and in smokers group 55 male (91.6%) and 5 female (8.4%) respectively.

Table 1: Types of fracture

Types of fracture	Smokers	%	Non-smokers	%	Total	%
Closed	46	76.67	54	90.00	100	46
Open	14	23.33	6	10.00	20	14
Total	60	100.00	60	100.00	120	60

Chi-square = 3.8400 P = 0.0500*

In this study, closed tibial fracture is most common, accounting for 90% and 76.67% of fracture in group 1 and 2 respectively.

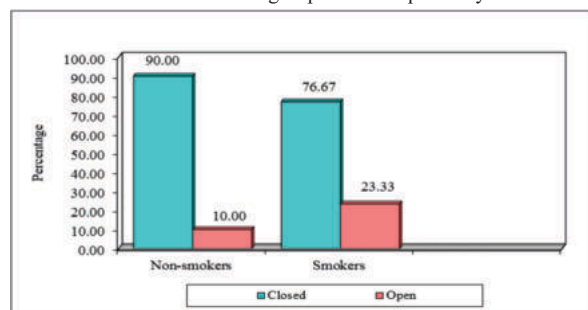


Chart 2: Types of fracture

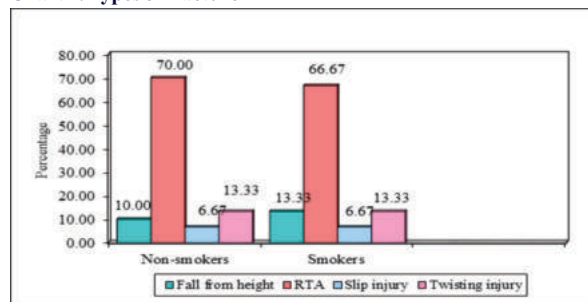


Chart 3: Mode of injury

In this study, road traffic accidents were the most common mode of injury causing tibial shaft fractures in 70% of group 1 and 66.67% of group 2 patients respectively.

Table 2: Outcome

Outcome	Non Smokers Group 1	%	Smokers Group 2	%	Total	%
Union	50	83.33	14	23.33	64	53.33
Non-union	4	6.67	10	16.67	14	11.67
Delayed union	6	10.00	36	60.00	42	35.00
Total	60	100.00	60	100.00	60	100.00

Chi-square = 44.2502 P = 0.0001*

In this study, in smokers' group 36 cases (60%) showed delayed union, 10 case (16.67%) showed non-union and 14 cases (23.33%) showed union. In non-smokers group, 50 cases (83.33%) showed union, 4 case (6.67%) showed non-union and 6 cases (10%) showed delayed union. Smokers group showed high rate of delayed union and non-union and less union compared to non-smokers group.

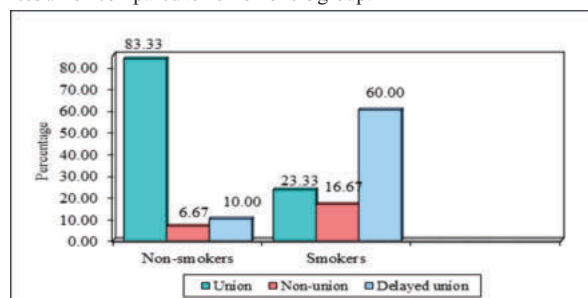


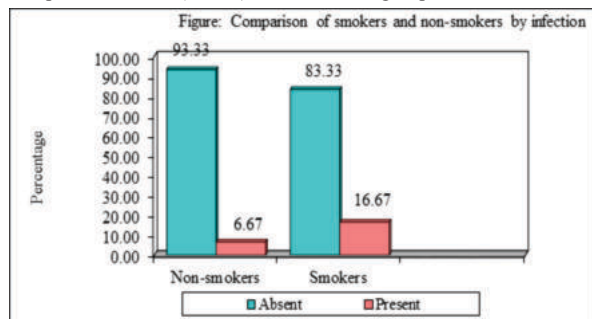
Chart 4: Outcome

Table 3: Rate of infection

Infection	Non-smokers	%	Smokers	%	Total	%
Absent	56	93.33	50	83.33	106	88.33
Present	4	6.67	10	16.67	14	11.67
Total	60	100.00	60	100.00	120	100.00

Chi-square =2.9110 P = 0.0880

In this study, in smokers group 10 cases (16.67 %) showed infection compared to 4 cases (6.67%) in non smokers group.

**Chart 5: Rate of infection**

DISCUSSION

The mean age in our study is 32.03+- 4.70 and 34.23+-4.03 in smokers and nonsmokers' group respectively. Our results were comparable to other studies done by Schmitz et al⁹ and Adams et al¹ which showed similar results. Majority of our patient sustained a right sided fracture. Out of 60 patients 36 cases (60%) and 32 cases (53.3%) were right sided in group 1 and group 2 respectively. In our study, road traffic accidents were the most common mode of injury causing tibial shaft fractures accounting 70 % of group 1 and 40 % of group 2 patients respectively. Our study was comparable to study done by Court-Brown¹⁰. In another study by Lawrence B Bone¹¹ et al also showed similar results.

Infection rates were higher in smokers. In our study we found 16.67% infection in smokers and 6.67% infection in nonsmokers' group. Our results were comparable to study done by Adams C et al¹ where infections among smokers was 15% and infections among non-smokers was 10%.

Similarly, studies done by Harvey et al¹² and Anoop et al¹³ showed that infections among smokers was 16% and 14.5% and infections among non-smokers was 13% and 1.4% respectively.

The development of infection following a closed tibial fracture is rare even though the smoking group shows higher rate compared to nonsmokers in spite of good fixation. Renan C et al¹⁴ in their study showed current smokers were more than twice as likely to develop an infection compared to nonsmokers. Nicotine and CO are the principal substances predisposing to wound infection. CO restricts the flow of oxygen to the tissues by the inhibition of binding sites for Hb. Nicotine causes vasoconstriction by increasing the production of thromboxane A2 and catecholamines, and by decreasing the secretion of prostaglandin. Other components of cigarettes induce a reduced deformability of erythrocyte, which is associated with lesions of the endothelium that block repair processes. This maintains hypoxia and bacterial growth.

In our study we found that mean days for union was 102 in group 1 and 127 in group 2. Adams CI et al¹, Ristiniemi J et al¹⁵, Schmitz MA et al⁹, W-Dahl A et al¹⁶ showed smokers took significantly longer time to heal. In our study, in smokers' group 36 cases (60%) showed delayed union, 10 case (16.67%) showed nonunion and 14 cases (23.33%) showed union. In nonsmokers' group, 50 cases (83.33%) showed union, 4 case (6.67%) showed nonunion and 6 cases (10%) showed delayed union. Smokers group showed high rate of delayed union and nonunion and less union compared to nonsmokers' group. Smoking places the patient at risk for increased time to union and complications. Researchers generally agree that smoking is associated with higher rates of tibial non-unions.

Renan C et al¹⁴ in their study showed current and previous smokers were 37% and 32% less likely to achieve union than non-smokers.

Schmitz et al⁹ in their study found that smokers are at risk of non-union compared to non-smokers and median time to heal in smoker was significantly longer compare to non-smokers group. In a study conducted by Anoop et al, out of that 75 unions and 75 nonunion. 72.4% in nonunion groups are smokers and 27.6% in union groups are smokers. Harvey et al¹²(2002) in there study showed Smokers had a union rate of 84% and nonsmokers had a union rate of 94%.

W-Dahl A, Toksvig-Larsen S et al¹⁶ study also noted that smokers were more likely to have delayed healing. They defined delayed healing as > 16 weeks in external fixation. Hoogendoorn and van der Werken et al¹⁷ showed smokers had a significantly higher incidence of osteitis (27% compared to 9%) and a significantly longer time till union, i.e., a mean time of 33 compared to 26 weeks in nonsmokers.

According to Moghaddam et al⁷, the risk of delayed non-union was significantly higher in the current and previous smokers' group than in the nonsmokers group. Current and previous smokers required more time to heal, were absent longer from work, and had a significantly poorer functional outcome.

After smoking a single cigarette, vasoconstriction occurred for 90 minutes, decreasing the blood flow by 24%. Smoking a second cigarette had an additive effect, decreasing the flow by a further 29%, while a smoking habit of one pack per day induced a hypoxic state for a 24-hour period. Animal studies showed that CO present in cigarette impairs the oxygenation of tissues by binding Hb and displacing molecules of oxygen. As a result, smoking one pack of cigarettes per day might cause a permanent tissue hypoxia. Nicotine is also known to affect angiogenesis of bone grafts in animals. A 50-year follow-up study of 34000 British male doctors (started in 1951) reported the severe impact of the number of years when smoking on health and eventual mortality.

The patient should be made aware that there is a biologically plausible relationship between tobacco smokes and delayed healing. Smoking decreases oxygenation in tissues, serum concentrations of important growth factors, collagen synthesis, bone mineralization, and general healing of tibia fractures and open fractures. Smoking cessation appears to improve clinical outcomes, however, may be limited by persisting damage.

The present study evaluates the risk of smoking in patients with closed tibial and type I open fractures treated with intramedullary fixation. Our results indicate an increase in the rate of non-union, delayed union, infection in smoking patients which was statistically significant.

CONCLUSION

Tibial diaphyseal fractures are commonly seen in physically active young people. Road traffic accidents is the major cause of these fractures. Closed intramedullary interlocking nailing is effective mode of treatment in closed and type I open tibial fractures. Smokers are at a higher risk of delayed and non-union following closed and type I open tibial diaphyseal fractures. Smoking places the patient at risk for increased time to union. Smokers healed their fractures more slowly compared to nonsmokers. Rate of infection is high in smokers compared to nonsmokers following closed tibial diaphyseal fractures. Smoking has negative effect in terms of the risk & treatment of fractures.

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