



## DIABETES AND ITS IMPACT ON ORTHOPAEDIC TRAUMA SURGERY

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### ARTICLE INFO

#### Article History:

Received 5<sup>th</sup> October, 2016

Received in revised form 7<sup>th</sup>  
November, 2016

Accepted 16<sup>th</sup> December, 2016

Published online 28<sup>th</sup> January, 2017

#### Key words:

Diabetes, Surgery, Outcomes,  
Trauma, Complications.

### ABSTRACT

Worldwide there were over 285 million people suffering from diabetes in 2010 and the number is going to double by the year 2030. Orthopaedic specialist shall come across various trauma patients with diabetes mellitus in their daily practice. Diabetes has bad effect on end organs which results in poor surgical outcome. The aim of the present review is to outline the effect of diabetes mellitus on orthopaedic trauma surgery. The patients with poorly controlled diabetes mellitus have problems with bone and soft tissue healing while those with good control of blood sugar have functional outcome similar to those without diabetes mellitus. The adverse outcomes include impaired wound healing, pseudarthrosis, surgical site infection and implant failure. In addition to trauma management the orthopaedic surgeons should engage endocrinologists in optimising blood sugar

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## INTRODUCTION

Trauma induces hyperglycaemia due to secretion of catabolic hormones (Kerby *et al*, 2012). The catabolic state results in increased risk of morbidity and mortality. Blood glucose levels greater than 200 mg/dl is highly predictive of infection and mortality in trauma patients (Laird *et al*, 2004). Tight control of blood sugar levels are practised in critically ill patients but it lacks evidence in terms of improvement in rate of mortality (Treggiari *et al*, 2008). The diabetic patients utilize bed days in excess of 45% in comparison to other orthopaedic patients (Dhatariya *et al*, 2012; Frisch *et al*, 2010). Many a times the patients are diagnosed to be suffering from diabetes mellitus at the time of admission itself. In a study of 1166 orthopaedic patients, 385 patients were diagnosed to have hyperglycaemia and 45% among them were finally labelled as diabetics (Cohen *et al*, 2002). The purpose of the present study is to review the pathophysiology of diabetes mellitus and its impact on orthopaedic trauma surgery.

### Pathophysiology

Diabetes mellitus (DM) is classified into two types: type 1 and type 2. Type 1 includes the patients who had dysfunction of pancreatic insulin secreting cells secondary to antibodies. Type 2 patients include patients with insulin resistance. The glucose metabolism is hence grossly affected in them. Various theories had been postulated like genetic predisposition, old age, elevated body mass index and ethnicity.

Both types of diabetes mellitus result in hyperglycaemia. In type 1 DM, the deficiency of insulin leads to decreased uptake of glucose into peripheral cells of liver and skeletal muscles, while in type 2 DM, the peripheral cells become resistant to entry of glucose. The stresses of surgery, infection and trauma results in release of counter regulatory hormones like glucagon, epinephrine, cortisol and growth hormone. This leads to deranged carbohydrate metabolism. The hyperglycaemia leading to medical condition results in higher mortality rates as compared to euglycemic patients (Umpierrez *et al*, 2002). The treating surgeon must be aware of these problems as the final outcome is affected by it.

### Complications Associated Diabetes Mellitus

The complications of diabetes mellitus are divided into two categories: microvascular and macrovascular (table 1). These complications may not directly affect the outcome but they play a significant role indirectly. Cardiovascular complications like myocardial infarction, stroke and hypertension are more likely in diabetics than euglycaemic individuals. The microvascular complications like retinopathy results in higher incidence of falls due to decreased visibility. Similarly neuropathy has issues with balancing resulting in trauma. There are wound healing problems due to decreased blood supply in the peripheral parts of the body. Vitamin D deficiency also coexists in many cases of diabetes mellitus which result in weakened bones and higher chances of fractures with trivial fall.

**Table 1** Diabetes related complications affecting orthopaedic trauma patients

- Impaired visual acuity.
- Peripheral nerve involvement.
- Retinopathy
- Body balancing problem
- Gait disturbance
- Decreased proprioception
- Increased chances of surgical wound infection
- Peripheral vascular disease
- Chronic anaemia.
- End stage renal disease.
- Delayed bone and soft tissue healing

Diabetic patients may have normal flow velocities in the peripheral vessels but the pattern of flow which is triphasic is certainly disturbed. The mean pressure is decreased in the peripheral vessels as compared to the normal population but clinically it does not affect the day to day activities unless there is trauma. In injury to the limbs the decreased blood supply manifests in terms of delayed fracture healing, morbidity and higher chances of wound complications as mentioned earlier also. The stress of surgery further compromises on this aspect and the patients experience more complications as compared to euglycaemics (Chew *et al*, 1995).

#### **Treating high blood sugar levels**

The general consensus is that the hyperglycemia should be controlled but hypoglycaemia is to be avoided. The studies had shown good results in terms of functional outcome in trauma patients. The patients should preferably be shifted on insulin prior to surgery. The guidelines are as fasting blood sugar levels below 140 mg/dl and random blood sugar levels below 180 mg/dl in patients not admitted in intensive care unit (ICU) and fasting blood sugar levels below 150 mg/dl in ICU patients (Jacobi *et al*, 2012). Many patients are diagnosed as case of diabetes mellitus on admission to the hospital.

#### **Effect of Diabetes on Bone Healing In Trauma Patients**

Diabetes causes alteration in bone healing and results in delayed healing of the wound and bone. In a study on rat models it was seen that the bone mineralisation and crystal mineralisation was decreased in tibial metaphysis in diabetic rats. The decreased mineralisation leads to diminished stiffness and rotational strength at the fracture callus. High blood sugar levels inhibit chondrocyte production and enchondral ossification. There is decrease in cytokine production and neovascularisation at the site of callus formation. However there is minimal impact on bone healing in cases where the blood sugar levels were adequately controlled.

#### **Diabetes and trauma care**

Hyperglycaemia secondary to stress in trauma patients is associated with high incidence of postoperative infection (Karunakar *et al*, 2010). In a study by Karunakar *et al* it was concluded that a blood glucose levels greater than 220 mg% is associated with 25% increase in the incidence of wound complications, urinary tract infection. The wound infection rate specifically was increased by seven folds in patients who had perioperative blood glucose levels greater than 220 mg/dl.

In another study by Richards *et al*, the patients admitted in intensive care unit with orthopaedic trauma were evaluated for association of hyperglycaemia and surgical site infection in non-diabetic patients. They found significant relationship

between hyperglycaemia and surgical site infection. In their study they also had found that even non critically ill patients with orthopaedic trauma had higher incidence of infection experiencing hyperglycaemia.

The diabetic patient experience slower recovery as compared to their counterparts and more likely to used assistive devices (Norris *et al*, 2011). The perioperative complications like cardiac events and bed sores were also more likely in them (Norris *et al*, 2011). In spite of higher complications rate and other problems, the functional outcome in diabetics is comparable to non diabetics at the end of one year (Deschamps *et al*, 2013). Diabetics often had biomechanical abnormalities to problems at ankle joint. These abnormalities further increase with associated peripheral neuropathy. These alterations lead to frequent falls and hence are more prone to injuries (Deschamps *et al*, 2013).

The incidence of fragility fractures like hip are increased in diabetic patients (Lipscombe *et al*, 2007). In another major study of hip fractures in diabetic patients, they had more pain, higher chances of using assistive devices in comparison to non diabetics. The complication rate was comparable in first year however the complications were more at the end of second year (Ekstrom *et al*, 2013). Diabetics experience more pain in the post operative period but had similar activity level and ambulatory status at long term follow up (Ekstrom *et al*, 2013).

## **CONCLUSION**

Diabetes is associated with bad outcome in orthopaedic trauma surgery. The key message for trauma surgeons is that the blood sugar levels should be optimised preoperatively, perioperatively and in the post operative period (table 2).

**Table 2** Key messages for orthopaedic trauma team

- Blood sugar control in the preoperative period
- Look for associated cardiovascular problems
- Identify anaemia and treat accordingly
- Thorough distal vascular assessment
- Thorough assessment of the vascular system preoperatively
- Target for fasting blood sugar levels below 140 mg/dL and random blood sugar levels below 180mg/dL.
- Avoid hypoglycemia
- Glucose levels greater than 200 mg/dl is associated with higher complications rate

High rates of surgical site infection and complications like myocardial infarction and pulmonary embolism are experienced in cases with uncontrolled diabetes mellitus. They tend to experience more pain and have longer hospital stays. Over the years of research, it has been found that the diabetes per se does lead to bad outcome but the higher blood sugar levels have a negative impact on the final outcome. The patients with optimal blood sugar levels generally have similar end results in comparison to non diabetics.

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