

**ORIGINAL RESEARCH**

# Study of Evaluation of Diabetic Foot Patients Undergoing Surgical Treatment: An Institutional Based Study

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**ABSTRACT**

**Background:** Diabetic foot is one of the most mutilating and severe complications of diabetes, the prevalence of which is gradually increasing over the past decade. This study was conducted for the evaluation of diabetic foot patients undergoing surgical treatment. **Materials and Methods:** This retrospective cohort study examined 100 diabetic foot ulcer (DFU) patients who underwent surgical intervention, categorized into two groups: the Enhanced Recovery After Surgery (ERAS) group, which included 50 patients, and the non-ERAS group, also consisting of 50 patients. All surgeries were standardized and performed by the same team. **Results:** In this study there were 50 subjects in ERAS group and 50 subjects in non-ERAS group. The length of stay (LOS) was  $13.69 \pm 5.2$  in ERAS group and  $28.5 \pm 8.6$  in the non-ERAS group. The expenses were found to be less in the ERAS group while more in the non-ERAS group. **Conclusion:** The findings from the comparison of the ERAS and non-ERAS groups indicate that the implementation of the ERAS protocol may enhance the quality of medical care and effectiveness. This improvement is evidenced by increased patient satisfaction, higher scores on the activities of daily living scale, a reduction in length of stay (LOS), and a decrease in overall hospital costs.

**Keywords:** Diabetic Foot Ulcer; Enhanced Recovery After Surgery (ERAS); Diabetic Complications.

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**INTRODUCTION**

Diabetic foot is one of the most mutilating and severe complications of diabetes, the prevalence of which is gradually increasing over the past decade. The global prevalence of diabetic foot ulcer in 2019 is estimated to be 463 million, which is expected to rise to 578 million by 2030.<sup>1,2</sup> In 2015, the International Diabetes Federation estimated that diabetic foot ulcers develop in 9.1-26.1 million individuals worldwide annually. The prevalence of both type 1 and type 2 diabetes is increasing, such that in 2019, 463 million adult individuals were afflicted with diabetes worldwide.

In addition, diabetes is now becoming an increasingly common pathological condition because the lifestyle of the world population is becoming increasingly problematic. Diabetes is known to be associated with obesity and a sedentary lifestyle.<sup>3-5</sup> The prevalence of diabetes has increased dramatically over recent decades especially in developing countries, reaching global pandemic proportions.

Enhanced recovery after surgery (ERAS), also known as fast-track surgery (FTS), refers to a set of protocols

that was first developed by Danish surgeon Kehlet.<sup>6</sup> ERAS aims to reduce surgical stress and postoperative complications and accelerate recovery without limiting the effectiveness of surgery. Operating based on evidence-based optimization measures during the perioperative period, the concept of ERAS initially achieved success in colorectal surgery, resulting in early recovery without severe complications. This groundbreaking achievement advanced the revolutionary perspective that postoperative recovery may be more influenced by other factors than the specific choice of surgical technique (e.g., laparoscopic or open), such as effective pain management, early nutritional support, early mobilization, and the omission of recovery-inhibiting regimens (e.g., gastrointestinal tubes, prolonged urinary catheter drainage, and drains).<sup>7,8</sup> This study was conducted for the evaluation of diabetic foot patients undergoing surgical treatment.

## MATERIALS AND METHODS

This investigation was designed as a retrospective cohort study, focusing on patients diagnosed with diabetic foot ulcers (DFU) following surgical intervention. Informed consent was obtained in writing from all participants, ensuring the confidentiality of their identities. The study comprised a total of 100 DFU patients who had undergone surgical procedures, categorized into two groups: the Enhanced Recovery After Surgery (ERAS) group, which included 50 patients, and the non-ERAS group, also consisting of 50 patients. All surgical interventions were standardized and executed by a consistent surgical team. Various therapeutic approaches were employed, including endovascular therapy for ischemic diabetic foot, radiofrequency thermocoagulation of lumbar sympathetic ganglia (LSG) or spinal cord stimulation (SCS) for painful diabetic peripheral neuropathy (PDPN), excisional debridement for infected ulcers with necrotic tissue or diabetic foot osteomyelitis, amputation for cases of gangrene, skin grafting for delayed wound healing post-negative-pressure wound therapy (NPWT), and surgical off-loading for foot deformities. Assessment of results was done.

## RESULTS

In this study there were 50 subjects in ERAS group and 50 subjects in Non-ERAS group.

Table 1 presents the distribution of subjects between two groups in the study: the ERAS (Enhanced Recovery After Surgery) group and the Non-ERAS group. Each group comprises 50 subjects, accounting

for 50% of the total study population, which consists of 100 participants.

Table 2 provides detailed results from a retrospective cohort study examining the impact of ERAS on patients with diabetic foot ulcers. The table lists both primary and secondary outcomes, reported as mean values with standard deviations for each metric across the two groups.

The primary outcomes include the length of stay (LOS) in the hospital, wound healing time, patient satisfaction, and expenses measured in Chinese Yuan (CNY). The ERAS group showed a significantly shorter average hospital stay ( $13.69 \pm 5.2$  days) compared to the Non-ERAS group ( $28.5 \pm 8.6$  days). Wound healing time was similar between the groups, with the ERAS group averaging  $25.51 \pm 9.25$  days and the Non-ERAS group  $25.99 \pm 10.2$  days. Patient satisfaction scores were slightly higher in the Non-ERAS group ( $90.2 \pm 5.67$ ) compared to the ERAS group ( $91.57 \pm 1.23$ ). Notably, the ERAS group incurred lower expenses ( $7102.27 \pm 25008.85$  CNY) compared to the Non-ERAS group ( $10289.75 \pm 31055.29$  CNY).

The secondary outcomes include measures of anxiety symptoms (APAIS), nutritional status (PG-SGA), and pain levels (NRS). The ERAS group reported lower anxiety scores ( $6.71 \pm 3.7$ ) than the Non-ERAS group ( $12.58 \pm 8.9$ ). Nutritional status was slightly better in the ERAS group ( $8.14 \pm 2.14$ ) compared to the Non-ERAS group ( $8.78 \pm 3.15$ ). Pain levels were similar between the groups, with the ERAS group scoring  $5.21 \pm 1.48$  and the Non-ERAS group scoring  $5.01 \pm 3.18$ .

**Table 1: Group-wise distribution of subjects**

Group	Number of subjects	Percentage
ERAS group	50	50%
Non-ERAS group	50	50%
Total	100	100%

**Table 2: A retrospective cohort study on enhanced recovery after surgery (ERAS) in patients with diabetic foot ulcer**

	ERAS group	Non-ERAS group
<b>PRIMARY OUTCOMES</b>		
The length of stay (LOS) (days), $\bar{x} \pm s$	$13.69 \pm 5.2$	$28.5 \pm 8.6$
Wound healing time(days), $\bar{x} \pm s$	$25.51 \pm 9.25$	$25.99 \pm 10.2$
Patient satisfaction, $\bar{x} \pm s$	$91.57 \pm 1.23$	$90.2 \pm 5.67$
Expenses (CNY), $\bar{x} \pm s$	$7102.27 \pm 25008.85$	$10289.75 \pm 31055.29$
<b>SECONDARY OUTCOMES</b>		
Anxiety symptoms (APAIS), $\bar{x} \pm s$	$6.71 \pm 3.7$	$12.58 \pm 8.9$
Nutritional status (PG-SGA), $\bar{x} \pm s$	$8.14 \pm 2.14$	$8.78 \pm 3.15$
Pain (NRS), $\bar{x} \pm s$	$5.21 \pm 1.48$	$5.01 \pm 3.18$

$\bar{x} \pm s$ : Mean  $\pm$  SD

## DISCUSSION

The prevalence of diabetes mellitus (DM) is rapidly spreading at an alarming rate worldwide.<sup>9</sup> DM is known to damage multiple organs, including the heart, kidney, eye, and nerves, leading to complications such

as heart attack, stroke, blindness, kidney failure, and lower limb amputation. Diabetic foot ulcer (DFU) is a frequent complication that occurs in approximately 6.3% of patients with DM globally.<sup>10</sup> The high incidence of DFU and the associated mortality and

morbidity are the most common reasons for hospitalization of diabetes patients. Early in the course of DM, patients experience serious foot sensitivity symptoms such as pain and tingling, while later stages of the disease course are characterized by negative symptoms such as numbness and weakness of the toes.

With the progression of the disease, patients usually show mixed pain sensitivity and dullness, along with decreased limb sensation and motor function, which lead to imbalance and unsteadiness and increase the likelihood of falls.<sup>11,12</sup> In addition, because of the increasing morbidity, DFU is a leading cause of non-traumatic amputation and is associated with an increased risk of death.<sup>13</sup> This study was conducted for the assessment of patients undergoing surgical treatment for diabetic foot.

In this study there were 50 subjects in ERAS group and 50 subjects in non-ERAS group. The length of stay (LOS) was  $13.69 \pm 5.2$  in ERAS group and  $28.5 \pm 8.6$  in the non-ERAS group. The expenses were found to be less in the ERAS group while more in the non-ERAS group. Aragón-Sánchez, F.J. et al (2008)<sup>14</sup> analysed the factors that determine the outcomes of surgical treatment of osteomyelitis of the foot in diabetic patients given early surgical treatment within 12 h of admission and treated with prioritisation of foot-sparing surgery and avoidance of amputation. A consecutive series of 185 diabetic patients with foot osteomyelitis and histopathological confirmation of bone involvement were followed until healing, amputation or death. Probing to bone was positive in 175 cases (94.5%) and radiological signs of osteomyelitis were found in 157 cases (84.8%). *Staphylococcus aureus* was the organism isolated in the majority of cultures (51.3%), and in 35 cases (36.8%) it proved to be methicillin-resistant. The surgical treatment performed included 91 conservative surgical procedures, which were defined as those where no amputation of any part of the foot was undertaken (49.1%). A total of 94 patients received some degree of amputation, consisting of 79 foot-level (minor) amputations (42.4%) and 15 major amputations (8%). Five patients died during the perioperative period (2.7%). Histopathological analysis revealed 94 cases (50.8%) of acute osteomyelitis, 43 cases (23.2%) of chronic osteomyelitis, 45 cases (24.3%) of acute exacerbation of chronic osteomyelitis and three remaining cases (1.6%) designated as 'other'. The risks of failure in the case of conservative surgery were exposed bone, the presence of ischaemia and necrotising soft tissue infection. Conservative surgery without local or high-level amputation is successful in almost half of the cases of diabetic foot osteomyelitis. Prospective trials should be undertaken to determine the relative roles of conservative surgery versus other approaches. Al-Rubeaan K et al (2015).<sup>15</sup> reported the overall prevalence of diabetic foot complications to be 3.3%. The prevalence of foot complications increased with

age and diabetes duration predominantly amongst the male patients. Diabetic foot is more commonly seen among type 2 patients, although it is more prevalent among type 1 diabetic patients. The Univariate analysis showed Charcot joints, peripheral vascular disease (PVD), neuropathy, diabetes duration  $\geq 10$  years, insulin use, retinopathy, nephropathy, age  $\geq 45$  years, cerebral vascular disease (CVD), poor glycaemic control, coronary artery disease (CAD), male gender, smoking, and hypertension to be significant risk factors with odds ratio and 95% CI at 42.53 (18.16–99.62), 14.47 (8.99–23.31), 12.06 (10.54–13.80), 7.22 (6.10–8.55), 4.69 (4.28–5.14), 4.45 (4.05–4.89), 2.88 (2.43–3.40), 2.81 (2.31–3.43), 2.24 (1.98–2.45), 2.02 (1.84–2.22), 1.54 (1.29–1.83), and 1.51 (1.38–1.65), respectively. Risk factors for diabetic foot complications are highly prevalent; they have put these complications at a higher rate and warrant primary and secondary prevention programs to minimize morbidity and mortality in addition to economic impact of the complications. Other measurements, such as decompression of lower extremity nerves, should be considered among diabetic patients.

## CONCLUSION

The findings from the comparison of the ERAS and non-ERAS groups indicate that the implementation of the ERAS protocol may enhance the quality of medical care and effectiveness.

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