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# Effect of Treatment with Negative Pressure on Wound Infection and Healing Following Open Cholecystectomy

[1]Gholam Reza, [1]Mohsen Noroozi Oliaei and [2]Akbar Hasanpour
[1]Department of Surgery, [2]Department of Pathology,
Arak University of Medical Sciences, Arak, Iran

**Abstract:** Surgical wound infection after cholecystectomy is one of the most common complications that increase morbidity and hospital costs. Wound infection control using modern methods of wound healing can reduce these complications. Negative-pressure Wound Therapy (NPWT) is a therapeutic technique using a vacuum dressing to promote healing in acute or chronic wounds by which excess fluid, debris and wound edema are removed. The aim of the present study is to investigate the effect of NPWT on the healing rate of acute infection following cholecystectomy. In this cross-sectional study, 240 patients who underwent cholecystectomy where divided into two groups based on a randomized block model. Cases of surgical wounds treated with NPWT and control wounds treated with classical treatment methods. From 31 patients who had positive cultures from the wound site, 6.45% where in case group and 93.55% where in control group ($p<0.00001$). Wound healing rate in case group where as follows: 14 patients in grade 1, 86 patients in grade 2 and 20 patients in grade 3. This rate in control group was 21, 91 and 8 patients for grade 1-3, respectively which was significantly different ($p = 0.035$). NPWT may facilitate wound healing and decrease the wound infection rate after cholecystectomy.

**Key words:** Cholecystectomy, surgicalwound infection, negative-pressure wound therapy

## INTRODUCTION

Wound infection is one of the most common causes of infection in surgical wards and is the third leading cause of hospital-acquired infection (Martone *et al*., 1995; Varela *et al*., 2010). Infection increases the patient's consent, possibility of surgical site hernia, creation of scar tissue, readmission of the patient to hospital, need to surgery for the second time, administration of broad-spectrum antibiotics and prolongation of patient's stay in hospital (Astagneau *et al*., 2001; Kirkland *et al*., 1999; Huskins *et al*., 1998). Despite the use of prophylactic antibiotics and improved surgical techniques, the rate of wound infection after open cholecystectomy is still so high that it's prevalence in open cholecystectomy is between 4.2-21% (Morran *et al*., 1978; Stone *et al*., 1976; Keighley *et al*., 1975). Using a method to be able to control wound infection could decrease the unwanted side effects of surgical site infection.

Negative-Pressure Wound Therapy (NPWT) is a method that creates a constant negative pressure, to remove excess fluid and debris from the wound, reduces the wound's edema and number of bacteria and increases the production of granulation tissue (Petzina *et al*., 2010). Considering that one of the most common surgical abdominal surgeries is cholecystectomy and surgical site infection is one of its most common side effects, researchers decided to evaluate the effect of administrating the NPWT method on surgical site wound infection and healing following open cholecystectomy.

## MATERIALS AND METHODS

In this cross-sectional analytic study, researchers studied 240 patients with acute cholecystitis who were candidate of cholecystectomy. The exclusion criteria were suffering from anemia, hypoxemia, diabetes melitus, uremia, malnutrition, impaired coagulation, vascular events in recent history, connective tissue disorders, recent COPD and pneumonia, emphysematous cholecystitis, gangrenous cholecystitis, gallbladder empyema, body mass index above 35, steroids dependency, chemotherapy, drugs containing vitamins A and C, duration of surgery >5.2 h and subcutaneous tissue bulking.

All of the patients were prepared for surgery by the same surgeon, same scrab technique and the same operation room (in which infective operation such as anorectal operation were not done at least 24 h before the patients' surgery). Open cholecystectomy was done by

**Corresponding Author:** Mohsen Noroozi Oliaei, Department of Surgery, Arak University of Medical Sciences, Arak, Iran

classic technique and kocher incision. Abdominal wall was sutured in two separate fascial layer using absorbable 1-0 chromic and non-absorbable 1-0 nylon surgical threads. The surgical site then washed using 500 cc normal saline. Using a randomized block method, the patients were devided into case (n = 120) and control (n = 120) groups. Skin was closed in control group but in case group, an orange coloured nelaton catheter (size: ch 16) was placed in abdominal subcutaneous tissue anterior to internal abdominal fascia and then connected to hemovac drain in orther to produce 60 mmHg negative pressure in the wound. Wound's skin closure was done by means of discontinuous 2-0 nylon sutures and dressed with hydrofilm wound dressing. Patients were examined every 6 h for drain maintainance of negative pressure. On the day 4 after operation, surgical site was evaluated for pain, redness, secretions, leukocyte and hematoma. For wound healing evaluation, a tissue specimen of 0.5×1 cm was taken from the middle part of the wound under local aneasthesia.

Data were analysed using paired sample t-test, Mann-Whitney U test and Chi-square test by means of SPSS statistics software, Ver. 20, IBM Company. Data were considered significant at the level of $p<0.05$.

## RESULTS

In this clinical trial, 240 patients who underwent open cholecystectomy were enrolled. Patients were randomly divided into case (n = 120) and control (n = 120) groups. In case group, NPWT method used after open cholecystectomy and in control group, current usual method of wound dressing administered after operation. From 120 patients in each group, 46 were male and 74 were female in case group. This amount was 50 male and 70 female in control group. There was no difference in patients' characteristics (age and sex) ($\chi^2 = 0.59$). The mean±SD of group ages were 51.2±10.61 and 50.5±11.48 years old for case and control groups, respectively ($p = 0.62$).

Leukocyte count in patients' blood were 7958±2072 $mL^{-1}$ in case group and 11099±3318 in control group which had no significant difference ($p<0.001$), 37 patients had post-operation surgical site pain among which 8.1% were in case group and 91.89% were in control group ($p<0.001$) while 31 patients had positive bacterial culture of surgical wound among which 6.45% were in case and 93.55% were in control group ($p<0.001$). Total 12 patients in case and 63 patients in control group had fever ($p<0.0001$). Where 80 patients had no wound erythema in case group of which 22 were in grade 1, 17 were in grade 2 and one was in grade 3. While in control group, 13 patients had no wound erythema and 19, 75 and 13 patients had grade 1-3 of wound erythema, respectively which were significantly different from case groups ($p<0.0001$).

Among all case and control group, 154 patients had no interval between surgical site wound edges. Among these patients, 114 were in case group and 40 patients were in control groups. In control group, 48 patients had wound edge interval grade 1 and 24 patients had grade 2 interval while in case group, 5 patients had wound edge interval grade 1 and one had grade 2 which was significantly less than case group ($p<0.0001$).

From 138 patients with no wound secretion, 28 were in control group and 110 were in case group. Wound secretion grading of 92 patients in control group were 38, 26 and 28 patients in grades 1-3, respectively. While 5, 3 and 2 patients in case group had wound secretion grades of 1-3, respectively which were significantly less than control group ($p<0.0001$) and 26 patients in control group and one in case group had wound hematoma ($p<0.0001$). Wound healing in case group was faster in comparison to control group ($p<0.0001$) so that in day 4 post-operation, in control group, wound healing grading consisted of 21, 91 and 8 patients in grades 1-3, respectively while these amounts were 14, 86 and 20 patients for groups 1-3, respectively ($p = 0.035$).

## DISCUSSION

The aim of this study was to evaluate the effect of NPWT method in reducing the incidence of postoperative wound infection, following open cholecystectomy. Some studies evaluated NPWT method in the treatment of chronic wounds (Gregor *et al*., 1998; Karamercan *et al*., 2008) and most of them which evaluated this method on acute surgical wounds have been done on patients tolerated sternotomy, colorectal surgery or following open bone fractures (Peinemann and Sauerland, 2011; Fujii *et al*., 2011; De Feo *et al*., 2011; Stannard *et al*., 2012; Chowdri *et al*., 2007). However, the effect of this method on wound infection control in open cholecystectomy has not been studied so far.

If subcutaneous drain is placed in the surgical wounds and is connected to the suction device, hematoma, debris, accumulated excess fluid and seroma could be drained from wound and lead to decreased wound dead space. Besides, it has clearly been shown that use of NPWT Method is effective in wound healing (Cardosi *et al*., 2006; Shaffer *et al*., 1987; Morykwas *et al*., 2006).

Based on the findings, case group treated with NPWT Method had significantly less fever, pain at the

wound site, leukocytes and lower rates of positive cultures of their wound in comparison to control group ($p<0.05$). The rate of wound healing in the case group was significantly better than control group ($p<0.05$). The efficacy of NPWT in wound healing rate was higher in women in comparison to men ($p<0.05$). This effect could probably relate to the greater amount of subcutaneous adipose tissue in women.

Karamercan *et al.* (2008) in their study on evaluating the efficacy of NPWT Method in prevention of infection of surgical site wound following colorectal operations found that this method can significantly reduce post-operation wound infection. Fujii *et al.* (2011) in a study on patients with high risk for surgical wound infection proposed that use of subcutaneous drain in high-risk patients could be useful in reducing the surgical wound infection.

In addition, the findings of De Feo *et al.* (2011) on the efficacy of NPWT in patients tolerated sternotomy demonstrated that in these patients, mortality, wound infection and patients' stay in hospital reduced significantly. Therefore, they concluded that NPWT method could be used as the first-line treatment of sternotomy wound.

## CONCLUSION

According to the results and the findings of similar studies in this field, researchers can conclude the use of NPWT Method in treating surgical site wounds following open cholecystectomy is significantly effective in reducing the rate of wound infection and also wound healing process is faster in treating with this method.

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