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Impact of closed suction drainage after surgical fixation of acetabular fractures

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Abstract

Introduction The purpose of the present study was to evaluate the prevalence of closed suction drainage after a Kocher–Langenbeck (K–L) approach for surgical fixation of acetabular fractures and to determine the impact of closed suction drainage on patient outcomes.

Methods This retrospective study reports on 171 consecutive patients that presented to a single level I trauma center for surgical fixation of an acetabular fracture. Medical records were reviewed to evaluate the use of closed suction drains. The primary outcomes measures were rate of packed red blood cell (PRBC) transfusion and length of hospital stay (LOS). Secondary outcome measures were 30-day post-operative wound complication and 1-year deep infection rates.

Results Of the 171 patients included in this study, 140 (82%) patients were treated with drains. There was a significant association between the use of closed suction drainage and post-operative blood transfusion rate ($p = 0.002$). Thirty-five patients (25%) treated with drains required a post-operative blood transfusion compared to 0% in the no drain cohort. Regarding the total number of drains used, for every additional closed suction drain that was placed beyond a single drain, the odds of receiving a blood transfusion doubled ($p = 0.002$). Use of closed suction drainage was associated with a significantly longer LOS ($p = 0.015$), and no difference in wound complication or deep infection rates.

Conclusion The use of closed suction drains for treatment of acetabular fractures using a K–L approach is associated with increased rates of blood transfusion and increased length of hospital stay, with no impact on surgical site infection rates. The results of this study suggest against routine drain usage in acetabular surgery.

Keywords Kocher–Langenbeck · Acetabular fracture · Closed suction drainage · Blood transfusion

Introduction

Surgical exposure for open reduction and internal fixation of acetabular fractures is dictated by fracture morphology [1–7]. The Kocher–Langenbeck (K–L) approach is ideal for surgical fixation of the majority of acetabular fractures, specifically those involving the posterior wall, posterior column, and transverse patterns with predominately posterior displacement [2–9]. Closed suction drainage is commonly utilized for post-operative wound management with the K–L approach to prevent hematoma formation. However, despite the theoretical advantages of closed suction drainage, there is minimal published evidence to support its routine use [10].

The rationale for closed suction drainage is to eliminate dead space and decrease the rate of post-operative wound complications, including hematoma and infection. Despite these proposed advantages, the use of closed suction drainage has been extensively examined in posterior surgical approaches for adult reconstruction patients with no proven benefit [10–17]. Similar results have been reported in the orthopedic spine and trauma literature [18–21]. Furthermore, there is suggestion that the use of drains may be detrimental, as illustrated by significantly increased blood transfusion rates in arthroplasty patients managed with drains [15, 16]. No clinical studies have evaluated the association of closed suction drainage with blood transfusion in

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operative acetabular fractures and it is unclear if the results from elective arthroplasty would translate to trauma patients.

Although there are no published data on current rates of drain usage in the trauma population, anecdotally, such practice continues to be routine amongst orthopedic traumatologists, including at our own institution. The purpose of the present study was to evaluate the prevalence of closed suction drainage after a K–L approach for surgical fixation of acetabular fractures and to determine whether such use was related to post-operative allogeneic blood transfusion rates and length of hospital stay (LOS). Secondary outcome measures included 30-day superficial wound complication and 1-year deep infection rates. We hypothesized that the use of closed suction drains would be associated with increased rates of blood transfusion and an increased length of hospital stay, with no difference in wound complication or deep infection rates.

Materials and methods

Patient selection

This retrospective observational study reports on patients that presented to a single American College of Surgeons—verified Level I trauma center for treatment of an acetabular fracture between January 1, 2013 and December 31, 2016. After institutional review board approval was obtained, medical records were queried for the 275 consecutive patients that were identified as available for inclusion in this study. Patients were excluded if they had combined acetabular and pelvic ring injuries ($n=40$), were treated percutaneously or with anterior or extensile surgical exposure ($n=56$), presented with a Morel-Lavelée lesion ($n=5$), or underwent simultaneous acute total hip arthroplasty ($n=3$). The final patient population consisted of 171 consecutive patients that underwent a K–L approach for surgical fixation of an acetabular fracture.

Data inclusion

Medical records including operative reports and inpatient progress notes were reviewed to evaluate the use of closed suction drains. Use of a drain, total number of drains utilized, and daily drain output was recorded. The primary outcome measures were rate of packed red blood cell (PRBC) transfusion and LOS. Our secondary outcome measures included: 30-day post-operative wound complication, 1-year deep hardware-associated infection, unplanned return to the operating room for any reason, deep vein thrombosis (DVT), pulmonary embolism (PE), and 1-year mortality. Patients with a wound complication were those that were noted to have delayed healing, dehiscence or drainage—these patients included those that were prescribed a course of oral antibiotics but without return to the operating room for irrigation and debridement. Patients with a deep hardware-associated infection were those that required return to the operating room irrigation and debridement and an extended course of intravenous antibiotics. Admission laboratory information was also collected, including hemoglobin (Hb), international normalized ratio (INR), and injury severity score (ISS). Acetabular fractures were classified based on the AO/OTA system after review of anterior–posterior and Judet radiographs as well as preoperative computed tomography imaging [22].

Surgical protocol

All operations were performed using a standard K–L approach by a fellowship-trained orthopedic traumatologist (WR, TMJ, MS). The use of closed suction drainage at our institution is largely based on surgeon preference. Two author surgeons (WR, MS) routinely use multiple (2–3) closed suction drains placed in deep and superficial tissue planes. One author surgeon (TMJ) routinely uses no drains or one placed deep to the iliotibial band. Drain output was recorded every nursing shift (every 8 h). Standard drain removal protocol was drain output less than 30 mL over an 8-h time period.

Statistical analysis

The distribution of continuous numerical data including demographic and laboratory data was examined in descriptive histograms and box plots, and a Kolmogorov–Smirnov test was used to confirm a normal distribution. A Chi-squared test was used for nominal data to compare post-operative transfusion and wound complication to drain utilization. An independent samples *t* test was used to compare laboratory and surgical data between patients who received drains and those who did not. An analysis of variance was used to compare differences in number of drains used by surgeon, and mean EBL by number of drains used; a post hoc Bonferroni analysis was performed to explore pair-wise differences. Multivariate logistic regression was performed to evaluate the odds of receiving a post-operative blood transfusion whether closed suction drainage was used. Covariates included in the regression model included Hb, EBL, and ISS. All statistical analyses were performed with Stata statistical software (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.).

Table 1 Drain utilization by surgeon

Drains (no.)	Surgeon			Total
	1	2	3	
0	30	1	0	31
1	37	7	1	45
2	1	53	11	65
3	0	29	1	30

Results

Prevalence of drain use

Of the 171 patients included in this study, 140 (82%) patients were treated with drains. There was a significant difference in number of drains used between surgeons ($p < 0.001$) (Table 1). The mean number of drains used by surgeon 1 was 0.6 compared to 2.2 and 2.0 drains for surgeons 2 and 3, respectively ($p < 0.001$). There was no significant difference in patient factors between those treated with drains and those without. The mean age for patients treated with drains was 36 [standard deviation (SD) 10] years compared to 34 (SD 10) years for those without drains ($p = 0.324$). The mean BMI for those treated with drains was 31 (SD 18) kg/m^2 compared to 28 (5) kg/m^2 for those without drains ($p = 0.291$).

Drain usage by fracture type

Of the 171 patients, there were 73 posterior wall (62-A1), 53 transverse posterior wall (62-B1a2), 22 posterior column posterior wall (62-A2.3), 12 T-type (62-B2), 7 transverse (62-B1a1), 2 posterior column (62-A2), and 2 anterior column posterior hemitransverse fractures (62-B3). The two anterior column posterior hemitransverse fractures were patterns with a stable anterior column segment and predominant posterior displacement of the transverse segment. There was no significant association between number of drains used and fracture morphology ($p = 0.085$) (Table 2). For simple posterior wall fractures, 34 patients had 0 or 1 drain placed versus 39 patients that had 2 or 3 drains placed.

Drain usage versus EBL

The mean (SD) reported EBL was 254 (129) mL, 308 (164) mL, and 519 (297) mL for surgeons 1–3, respectively. There was a significant difference in reported EBL between surgeon 3 and surgeons 1 and 2 ($p < 0.001$) (Table 3). For surgeon 1, there was a significant association between number of drains used and EBL ($p = 0.026$), with an average of 84 mL additional blood loss in patients treated with 1 drain compared to no drains. For surgeon 2 and 3, there was no significant association between number of drains used and EBL.

Table 2 Drain utilization by fracture morphology

Fracture type	Drains (no.)				Total
	0	1	2	3	
PW	19	15	30	9	73
Trans + PW	3	14	22	14	53
PC + PW	5	11	4	2	22
T-type	1	3	4	4	12
Transverse	1	2	3	1	7
PC	1	0	1	0	2
AC PHT	1	0	1	0	2

PW posterior wall, *trans + PW* transverse posterior wall, *PC + PW* posterior column posterior wall, *PC* posterior column, *AC PHT* anterior column posterior hemitransverse

Table 3 Association between drain utilization and EBL by surgeon

Surgeon	Number of drains [mean EBL (mL)]				*p* value*
	0	1	2	3	
1	207	291	300	–	0.026
2	150	186	322	321	0.147
3	–	100	541	700	0.324

*Analysis of variance (ANOVA) test

Table 4 Risk factors for blood transfusion

	Blood transfusion		*p* value
	No	Yes	
Hb (g/dL)	13.8	12.3	0.001
INR	0.98	1.03	0.083
ISS	9.8	16.9	0.001
EBL (mL)	282.6	388.7	0.002

Hb hemoglobin, *INR* international normalized ratio, *ISS* injury severity score, *EBL* estimated blood loss

Prevalence of blood transfusion

Of the 171 patients in this study, 35 (20%) received a postoperative allogeneic blood transfusion. There was no difference in time to surgery between groups; the mean time to surgery was 2.7 days for patients treated with or without drains ($p = 0.955$). Patients that received a blood transfusion had a significantly lower mean Hb on admission ($p < 0.001$) (Table 4). Patients that received a blood transfusion also had a significantly higher EBL ($p = 0.002$) and ISS ($p < 0.001$) (Table 4). There was no difference in admission INR between patients that received a blood transfusion and those

that did not. The mean (SD) Hb at time of blood transfusion was 7.5 (SD 1.4) g/dL. There was no significant difference in pre-transfusion Hb between surgeons—the mean (SD) Hb at time of transfusion was 8.2 (1.5), 7.4 (1.2), and 5.9 (3.0) g/dL for surgeons 1–3, respectively ($p=0.110$). After controlling for number of drains used, there was no difference in proportion of patients transfused between surgeons ($p=0.586$). There was no significant difference in post-operative Hb before transfusion between surgeons ($p=0.110$).

Association between drain usage and blood transfusion

There was a significant association between the use of closed suction drainage and post-operative blood transfusion rate ($p=0.002$). Thirty-five patients (25%) treated with drains required a post-operative blood transfusion compared to 0% in the no drain cohort. After controlling for admission Hb, ISS, and EBL, patients treated with drains were 22 times more likely to receive a blood transfusion [odds ratio (OR) 22.2, 95% confidence interval (CI) 1.0–498.7; $p=0.049$]. For every additional drain that was placed, the odds of receiving a blood transfusion doubled (OR 2.0, 95% CI 1.3–3.1; $p=0.002$). Amongst simple posterior wall fractures only, the odds of receiving a blood transfusion nearly tripled for every additional drain that was used (OR 2.7, 95% CI 1.3–5.8; $p=0.008$).

Drain utilization and length of hospital stay

The mean LOS for patients treated with drains was 11 (SD 7) days compared to 8 (SD 4) days for those that were not ($p=0.015$). The mean LOS for patients that received a blood transfusion was 15 (SD 8) days compared to 9 (5) days for those were not ($p<0.001$).

Drain utilization and secondary outcomes

The total number of 30-day superficial wound complications in the entire cohort was 3 (2%). All wound complications occurred in patients that were treated with closed suction drains. The difference between groups was not statistically significant ($p=0.411$). All three patients were placed on a short course of oral antibiotics. Only one patient in the entire cohort was found to have a deep hardware-associated infection that required operative management. The single patient with deep infection was treated with three drains at his index procedure.

There were three patients that required unanticipated return to the operating room and all were in the group of patients treated with drains ($p=0.411$). No patients in the no drain control group developed a DVT or PE; in contrast, among patients treated with drains, there were three patients that developed a DVT ($p=0.411$) and two patients that suffered a PE ($p=0.503$). There were no deaths in either group.

Discussion

The present study examined the prevalence and associated impact of closed suction drainage after acetabular surgery at a high-volume level 1 trauma center. The use of drains was associated with an increased prevalence of post-operative blood transfusion and longer length of hospital stay. There were no differences in wound complications or deep infection rates between patients treated with or without drains. As demonstrated in our study population, the use of drains after a K–L approach is often based on surgeon preference and routine protocols and not specifically related to surgical blood loss or fracture morphology.

The increased transfusion rates in orthopedic patients treated with drains in our study are consistent with previous reports in the arthroplasty and spine literature [15, 16, 18]. Our study also confirms previous works in the trauma and arthroplasty literature that illustrate the association between increased EBL and ISS with increased blood transfusion rates, and also decreased admission Hb with increased blood transfusion rates [23–29]. Notably, the multivariate logistic regression model in the present study revealed that independent of these previously identified risk factors for blood transfusion, the odds of receiving a blood transfusion was still over 20 times higher in patients treated with drains.

The current study revealed that omission of closed suction drainage had no association with early (30-day) or late (1-year) infection rates. This finding is supported by Hsu et al. [30], who also reported drain use had no impact on infection rates in patients who underwent acetabular surgery using the K–L approach. Although the theoretical benefit of closed suction drainage is to prevent hematoma formation and potential wound breakdown, multiple studies have shown no difference in clinically significant hematoma formation irrespective of drain use [19, 21]. Thus, our finding of no difference in wound complication rates between drain groups would be expected given the insufficient evidence that drain use has any meaningful impact on hematoma formation.

Current trauma and arthroplasty literature has identified closed suction drainage as a risk factor for increased length of hospital stay [23, 24, 29, 31–33]. This finding is supported in the present study with a significant association between presence of drains and longer LOS. Due to the retrospective nature of the study, we cannot confirm causation but would suggest that the increased length of stay is likely attributable to the higher blood transfusion rates in these patients. In addition, patients with multiple drains may be more hesitant to mobilize, and it is possible that the presence

of multiple drains may delay discharge by impeding physical therapy.

To our knowledge, our study is the first to describe the association between the number of closed suction drains utilized and prevalence of post-operative blood transfusion. Our results demonstrated that for every additional closed suction drain that was placed, the odds of requiring a blood transfusion doubled. For simple posterior wall fractures, the odds of blood transfusion for every additional drain that was used nearly tripled. Extrapolation of this data illustrates that compared to patients that receive only one drain, the odds of receiving a blood transfusion is nine times higher in those that receive three drains. One potential explanation for this finding may be that the increased suction pressure creates a higher flow state and prevents stable clot formation. As a result, the duration and amount of effective total blood loss is increased, as well as the risk of blood transfusion. Should one decide to use closed suction drainage after fixation of acetabular fractures, these results would support a 'less is more' approach to drain utilization in an effort to reduce risk of blood transfusion and decrease LOS.

There are several potential limitations to this study. Most notably, due to the retrospective design, there were no strict criteria for the decision to omit or place a closed suction drain. More specifically, surgeon 1 demonstrated a more heterogeneous pattern of drain utilization than surgeons 2 or 3. With no clear treatment algorithms for drain usage, it is difficult to control for all factors that may influence the decision to use a drain. An additional limitation is that this investigation was conducted at a single institution and indications for transfusion may differ from other centers. However, transfusion criteria amongst the cohort evaluated in this study was uniform and did not vary significantly between surgeons. Finally, although we report on numerous objective outcomes that seem most relevant to use of closed suction drains, our study is limited in its lack of inclusion of any patient reported outcomes.

Conclusion

The use of closed suction drains for treatment of acetabular fractures using a K–L approach is associated with increased rates of blood transfusion and increased length of hospital stay, with no impact on surgical site infection rates. The results of this study suggest against routine drain usage in acetabular surgery. Notably, we are not recommending against drain utilization in all patients, but when drain placement is indicated for specific at-risk wounds, a more judicious approach should be taken. Continued prospective investigation is warranted to further validate this recommendation.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

Informed consent For this type of study formal consent is not required.

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