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Early Versus Delayed Drain Removal and Its Effect on Surgical Recovery and Complication Rates

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Abstract: Background: There is some controversy over whether or not the time of postoperative drain removal is optimal in orthopedic surgery, and whether it will affect patient recovery and postoperative complications. **Objective**: To compare the outcomes of early and late removal of drains on the surgical healing and rates of postoperative complications. **Methods:** A comparative prospective observational study was conducted at Department of General Surgery, MTI, GOMAL Medical College, D.I.Khan from 1st February, 2024 to 31st December, 2024. A total of 100 patients were included and randomized equally to early and delayed drain removal groups and underwent orthopedic procedures requiring closed-suction drains. Demographic, clinical, recovery, and postoperative complication information was gathered. Independent sample t-test was used to analyse continuous variables, Chi-square and Fisher's exact test were used for categorical variables, and multivariable logistic regression was used to identify the predictors of postoperative complications. **Results:** There were no significant differences in baseline characteristics. Patients who had early removal of the drain had significantly lower pain scores, quicker mobilization, lower drain output, shorter hospital stays, and less analgesic requirement ($p<0.05$). Overall postoperative complication rate was significantly lower in the early drain removal group (22% vs. 42%, $p=0.031$), but no significant differences in any individual complications were seen, such as surgical site infection, seroma, hematoma, wound dehiscence, and reoperation. Postoperative complications were predicted independently from delayed removal of the drains, smoking, and diabetes mellitus. **Conclusion:** Early drain removal appears to be a safe and effective postoperative strategy that enhances recovery without increasing major complications in orthopedic patients.

Keywords: Early removal; Delayed removal; Orthopedic surgery; Surgical recovery; Surgical site infection

INTRODUCTION

Surgical drains are routinely used following elective or emergency surgery to drain blood, serous fluid, and inflammatory exudate, thereby reducing dead space and the likelihood of hematoma and seroma formation.[1] Even though the use of drains is widespread, there is still some controversy regarding the best time to remove them.[2] While the current practice is to keep drains in place until output falls into a set range, extended drainage times can lead to greater patient discomfort, delayed mobilization, extended hospital stays, and risk of retrograde

bacterial contamination.[3] There are over 310 million major surgical procedures performed worldwide each year, and 5-15% of the patients suffer from complications after surgery, making optimization of perioperative care a major healthcare priority.[4]

Recent data has shown that early removal of drains may be beneficial to enhance recovery after surgery (ERAS) with decreased postoperative pain, quicker hospital discharge, increased patient satisfaction, and earlier mobilization without increasing the risk of complications in carefully selected patients.[5] However, there are concerns about the potential for seroma or hematoma, wound infection, or re-intervention after early removal of the drain.[6] Inconsistent findings have been reported in published studies as a result of the diversity in surgical techniques, patient characteristics, and institutional practices, indicating that there is no universally accepted guideline for the management of drains.[1, 7]

In the era of evidence-based perioperative care and cost-effective surgical practice, the question of the best time to remove a drain assumes greater significance.[8] There are few local data available to compare early with delayed drain removal in surgical populations, especially in resource-limited healthcare environments.[9-11] It will be important to assess postoperative recovery in addition to assessing complication rates to supply evidence for the development of standardized drain management protocols, which will improve patient outcomes and minimize healthcare utilization, and enable the implementation of better recovery pathways. This present study was designed to verify that early removal of the drain has an impact on the recovery process of a surgical procedure and on the rate of postoperative complications, compared to delayed drain removal.

Materials and Methods

This study was a comparative prospective observational study to compare early or delayed removal of a closed suction drain on postoperative surgical recovery and complication rates in patients undergoing orthopedic surgical procedures that required a closed suction drain. The study was conducted Department of General Surgery, MTI, GOMAL Medical College, D.I.Khan from 1st February, 2024 to 31st December, 2024.

The sample size was estimated using OpenEpi Version 3.01, the comparison of two independent proportions. The calculation was based on the previously reported postoperative complication rate of 21% in the delayed drain removal group and 10% in the early drain removal group with a 95% confidence level, 80% study power and an equal allocation ratio (1:1).[9] The minimum number of patients calculated was 86 in each group. In order to make up for possible dropouts and incomplete follow-up, the number of patients was raised to 100 which was divided as 50 in early Drain removal and 50 in delayed Drain removal. A non-probability consecutive sampling technique was used. Patients aged 18 years or older of both sexes undergoing elective and emergency orthopedic surgeries, where a closed suction drain was necessary, were included in the study. Those patients who gave informed consent and attended the prescribed postoperative follow-up were included. Patients with active surgical site infection at the time of surgery, pathological fractures due to malignancy, polytrauma requiring multiple staged surgeries, revision orthopedic surgeries, immunocompromised patients and those with uncontrolled diabetes mellitus, chronic renal failure, chronic liver disease, long-term corticosteroid or immunosuppressive therapy, and those lost to follow-up or with incomplete clinical information were excluded.

All eligible patients admitted to the Orthopedic Ward and Trauma Centre were approached to participate after getting the approval from the Institutional Research and Ethics Committee. Written informed consent was sought prior to enrolment. Demographic data such as age, gender, BMI, smoking, comorbidities, and mechanism of injury, diagnosis and surgical procedure type was obtained on a structured proforma. All surgeries were carried out following normal departmental protocols with a closed suction drain placed when necessary as indicated by the operating surgeon.

Patients were divided into two groups depending on when the drain was removed. In the early drain removal group, the drain was removed within 24–48 hours after surgery, while in the delayed drain removal group, the drain was removed after 48 hours or by the treating surgeon's routine practice based on the drain output and clinical assessment. Parameters of postoperative recovery, such as pain score, time to mobilization, duration of hospital stay, drain output and the requirement for analgesics were recorded. Patients were followed each day until ready for discharge and again at follow-up for the occurrence of surgical site infection, seroma, hematoma, wound dehiscence and reoperation and for other postoperative complications. The principal investigator documented all clinical information on a standardized data collection form and ensured confidentiality was maintained.

Data collected were entered and analyzed by the Statistical Package for the Social Sciences (SPSS) version 26.0. Age, drain output, pain score, time to mobilization, and duration of hospital stay were analyzed as continuous variables and presented as the mean ± SD; gender, diagnosis, type of surgery,

surgical site infection, seroma, hematoma, wound dehiscence, and reoperation data were presented as frequencies and percentages. Comparisons between the two groups of continuous variables were made using the independent sample t-test and categorical variables using the Chi-square test and Fisher's exact test as appropriate. After controlling for potential confounding factors, independent risk factors for post-operative complications were determined by a multivariable logistic regression analysis. A p-value of <0.05 was deemed statistically significant.

Results

A total of 100 patients were included in the study, with equal numbers in the early drain removal and delayed drain removal groups. The baseline demographic and clinical features such as age, body mass index, gender distribution, smoking status, diabetes mellitus and hypertension, were well matched in both groups with no significant difference between them (Table 1).

The distribution of surgical characteristics was also similar between the two groups. Majority patients had undergone procedures related to trauma and majority of surgeries were on the lower limb. There was no significant difference between the groups with respect to the type of surgery or the site of surgery, indicating similar surgical experiences between the two groups (Table 2).

Significant difference in the postoperative recovery between the early drain removal and delayed drain removal groups was found in terms of drain output, postoperative pain score, mobilization time, hospital stay and consumption of analgesics (Table 3).

There was no statistically significant difference in the incidence of certain individual postoperative complications (surgical site infection, seroma, hematoma, wound dehiscence, and reoperation); however, the overall rate of postoperative complications was significantly lower in the early drain removal group (Table 4).
Multivariable logistic regression analysis revealed that delayed drain removal, smoking and diabetes mellitus were independently associated with postoperative complications, while there was no significant association between age, gender and BMI with adverse postoperative outcomes (Table 5).

Table 1. Baseline demographic and clinical characteristics of the study participants (n=100)

Variable	Early Drain Removal (n=50) Mean ± SD/n(%)	Delayed Drain Removal (n=50) Mean ± SD/n(%)	p-value
Age (years)	41.8 ± 13.2	43.5 ± 12.6	0.512
BMI (kg/m²)	25.7 ± 3.8	26.2 ± 4.1	0.534
Male	34 (68.0%)	32 (64.0%)	0.673
Female	16 (32.0%)	18 (36.0%)	
Smokers	15 (30.0%)	17 (34.0%)	0.668
Diabetes Mellitus	9 (18.0%)	11 (22.0%)	0.617
Hypertension	12 (24.0%)	10 (20.0%)	0.629

Table 2. Surgical characteristics of the study participants

Variable	Early (n=50)	Delayed (n=50)	p-value
Trauma surgery	36 (72.0%)	34 (68.0%)	0.664
Elective surgery	14 (28.0%)	16 (32.0%)	
Lower limb surgery	30 (60.0%)	28 (56.0%)	0.683
Upper limb surgery	20 (40.0%)	22 (44.0%)	

Table 3. Comparison of postoperative recovery outcomes

Variable	Early (n=50) Mean ± SD	Delayed (n=50) Mean ± SD	p-value
Drain output (mL)	145.8 ± 38.6	162.7 ± 42.3	0.038*
Pain score (VAS)	3.5 ± 1.1	4.6 ± 1.2	<0.001*
Time to mobilization (hours)	22.4 ± 5.8	34.8 ± 8.5	<0.001*
Duration of hospital stay (days)	4.6 ± 1.2	6.3 ± 1.6	<0.001*
Analgesic requirement (days), Mean ± SD	3.2 ± 1.0	4.5 ± 1.4	<0.001*
**Statistically significant*			

Table 4. Comparison of postoperative complications

Variable	Early (n=50)	Delayed (n=50)	p-value
Surgical site infection	4 (8.0%)	9 (18.0%)	0.134
Seroma	5 (10.0%)	4 (8.0%)	0.728
Hematoma	2 (4.0%)	5 (10.0%)	0.436
Wound dehiscence	2 (4.0%)	4 (8.0%)	0.678
Reoperation	1 (2.0%)	3 (6.0%)	0.617
Any postoperative complication	11 (22.0%)	21 (42.0%)	0.031*
**Statistically significant*			

Table 5. Multivariable logistic regression analysis for predictors of postoperative complications

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Delayed drain removal	2.84	1.18–6.82	0.020*
Age (>50 years)	1.42	0.63–3.24	0.395
Male gender	1.11	0.49–2.52	0.804
BMI ≥30 kg/m²	1.76	0.74–4.18	0.201
Smoking	2.18	1.01–4.71	0.047*
Diabetes mellitus	2.54	1.06–6.11	0.036*
**Statistically significant*			

DISCUSSION

Early drain removal was found to be a factor associated with better postoperative recovery in the present study with significantly lower pain scores, earlier mobilization, shorter hospital stay, lesser analgesic requirement and lesser overall postoperative complications in comparison with delayed drain removal. The results of this study align with the increasing evidence that drainage removal should proceed early in surgery and be based on a protocol rather than on individual surgeon preference.

In the present study, the patients in the early drain removal group had a significantly shorter hospital stay as compared to patients undergoing delayed drain removal. The findings are consistent with the systematic review and meta-analysis conducted by Shima et al., in 2021, which showed that early removal of drains was associated with a significant decrease in hospital length of stay without an increase in surgical site infection, but with a nonsignificant increase in seroma after breast surgery.[12] Similarly, a 2025 meta-analysis showed that early removal of the drains after pancreatoduodenectomy had a beneficial effect on postoperative recovery, decreased hospitalization and health-care costs.[13]

Our results also showed that early removal of the drains resulted in significantly less postoperative pain and earlier mobilization of patients. This is in line with the Enhanced Recovery after Surgery (ERAS) principles, which focus on reducing unnecessary postoperative interventions, thereby promoting early ambulation and functional recovery. In 2025, a recent narrative review found that early, criteria-based drain removal has been proven in numerous surgical subspecialties to improve postoperative recovery, reduce pain and shorten hospital stays.[1]

The rates of individual complications (surgical site infection, seroma, hematoma, wound dehiscence, and reoperation) were not significantly different between the two groups for our study, but the total postoperative complication rate was significantly lower in the early drain removal group. This was also reported by Wu et al. (2023) who reported reduced overall postoperative morbidity, including fewer pancreatic fistulas and decreased hospital length of stay (LOS) in the early removal of the drain group without increased incidence of clinically significant fistulas after pancreatoduodenectomy.[9]
Early removal of the drain did not show a significant difference in the incidence of surgical site infection. A similar finding was shown by Seidelman et al, (2023) in their systematic review; the removal of drains did not affect surgical site infections despite the earlier discharge from hospital.[14] Similarly, early removal of drains in a study by Zu et al. 2024 showed a pattern of fewer wound infections.[15]

One of the major issues with early drain removal is the potential for seroma. In the current study, the incidence of seroma was similar between the groups, suggesting that earlier removal of the drain did not significantly affect this complication. Similar findings were reported by Chua C, et al. (2022), who observed that drain output and postoperative day alone were poor indicators for determining drain removal and concluded that early drain removal did not significantly increase seroma formation in most surgical patients.[16]
In the present study, there were also no significant differences between the groups in the amount of hematoma, wound dehiscence or reoperation rate.

These observations support the study, which found that early drainage removal did not lead to an increase in re-operation or major postoperative complications, but could result in decreased postoperative morbidity and hospital length of stay in patients who were suitably selected.[9]

In our study, the use of multivariable logistic regression identified delayed drain removal, smoking and diabetes mellitus as independent risk factors for postoperative complications. The risk factors are comparable to those reported in the past. Patients who require longer drain placement have been reported to have higher complication rates by Neville et al. (2023), and more recent evidence-based reviews have indicated that patient comorbidities significantly affect postoperative outcomes more than the length of drain placement.[17]

The findings are confirmed by study by Zhange et al., 2022 that showed that early removal of drains significantly lowered the overall complication rate, infection rate, reoperation rate, readmission rate, and length of hospital stay compared to delayed removal.[18] These results highlight the clinical advantages of implementing evidence-based early removal of drains.

However, not every study has shown a definite advantage for early drain removal. In a randomized trial of melanoma patients who received lymph node dissection, Broman et al. (2021) reported similar early complication rates between early complete removal of the drain and progressive removal of the drain, but shorter hospital stays in the early removal group.[19] These differences could be attributed to different surgical techniques, patient populations, drain management protocols and definitions of postoperative complications.

In summary, the results of the present study are supported by most of the existing evidence which suggests that early removal of drains does not increase the clinically relevant complication rate in appropriately selected patients while improving postoperative recovery. Therefore, the implementation of the standardized removal of the drain procedure could enhance patient comfort, facilitate earlier mobility, shorten hospitalisation and optimise healthcare resource use, without compromising surgical safety.

Limitations

There were many limitations to this study. First, it was carried out in a single tertiary care center that may have restricted generalisability of findings, and had a relatively small sample size. Secondly, a consecutive sampling technique was used for enrollment, which may have led to selection bias. Third, the follow-up period was short, so that late complications and long term functional outcomes could not be evaluated. Fourth, the different fracture morphology, surgical approaches, and surgeon preference might have affected postoperative recovery and drain management. Lastly, no evaluation of microbiological assessment of drain colonization or patient-reported quality-of-life measures was evaluated.

CONCLUSION

Early removal of drains after orthopedic surgery resulted in better postoperative recovery, as evidenced by decreased pain, earlier mobilization, shorter hospital stay, and less overall postoperative complication rates when compared to delayed drain removal. Individual complications including surgical site infection, seroma, hematoma, wound dehiscence and reoperation were similar in the two groups. The only independent factors associated with postoperative complications were delayed removal of the drains, smoking and diabetes mellitus. The results indicate that early removal of drains is a safe and effective approach for selected orthopedic patients and could be associated with improved outcomes and decreased health care utilization. These results suggest a need for larger multicenter randomized studies to confirm the results and create standardized protocols for removing the drain.

BIBLIOGRAPHY

1. Salib, M., et al., Optimizing surgical drain removal: a narrative review of timing, criteria, and evidence-based practices. Cureus, 2025. 17(10).
2. Rekavari, S.G. and C. Mahakalkar, Prophylactic intra-abdominal drains in major elective surgeries: a comprehensive review. Cureus, 2024. 16(2).
3. Nobles, K., et al., Mobilization in neurocritical care: challenges and opportunities. Current Neurology and Neuroscience Reports, 2025. 25(1): p. 13.
4. Javed, H., et al., Challenges and solutions in postoperative complications: a narrative review in general surgery. Cureus, 2023. 15(12).
5. Mithany, R.H., et al., Revolutionizing surgical care: the power of enhanced recovery after surgery (ERAS). Cureus, 2023. 15(11).
6. Wahid, A., et al., THE IMPACT OF TRANEXAMIC ACID ON HEMATOMA AND SEROMA FORMATION IN BREAST CONSERVATION SURGERY. Journal of Medical Sciences, 2026. 34(2): p. 93-97.
7. Eleftheriou, M., et al., Risk factors as criteria for drain use in gastrectomy: A prospective study. Molecular and Clinical Oncology, 2025. 23(2): p. 75.
8. Assolari, F., et al., Advanced practice nursing in

surgery: A scoping review of roles, responsibilities, and educational programs. International nursing review, 2025. 72(3): p. e13045.
9. Wu, A.G.R., et al., Early vs late drain removal after pancreatic resection—a systematic review and meta-analysis. Langenbeck's Archives of Surgery, 2023. 408(1): p. 317.
10. Goldaracena, N., et al., Early removal of drains and lines after liver transplantation to reduce the length of hospital stay and enhance recovery–A systematic review of the literature and expert panel recommendations. Clinical Transplantation, 2022. 36(10): p. e14687.
11. Pankaj, D., et al., Comparison of Conventional and Enhanced Recovery after Surgery Protocols in Emergency Colorectal Surgery: A Prospective Comparative Study from a Tertiary Care Center. Indian Journal of Colo-Rectal Surgery, 2026: p. 10.4103.
12. Shima, H., et al., An optimal timing for removing a drain after breast surgery: a systematic review and meta-analysis. Journal of Surgical Research, 2021. 267: p. 267-273.
13. Bai, G., et al., Prophylactic abdominal drainage for pancreatic surgery. Cochrane Database of Systematic Reviews, 2025(5).
14. Seidelman, J.L., C.R. Mantyh, and D.J. Anderson, Surgical site infection prevention: a review. Jama, 2023. 329(3): p. 244-252.
15. Zhu, S., et al., Early drain removal versus routine drain removal after pancreaticoduodenectomy and/or distal pancreatectomy: a meta-analysis and systematic review. Digestive Diseases and Sciences, 2024. 69(9): p. 3450-3465.
16. Chua, C., et al., Final 24-hour drain output and postoperative day are poor indicators for appropriate drain removal. Plastic and Reconstructive Surgery–Global Open, 2022. 10(4): p. e4160.
17. Neville, J. and B. Aldeiri, Drain placement in paediatric complicated appendicitis: a systematic review and meta-analysis. Pediatric Surgery International, 2023. 39(1): p. 171.
18. Zhang, P., et al., Effect of total laparoscopic versus open pancreaticoduodenectomy on short-term and oncological outcomes: a single-institution comparative study. Langenbeck's Archives of Surgery, 2022. 407(7): p. 2789-2799.
19. Broman, K.K., et al., Surveillance of sentinel node-positive melanoma patients who receive adjuvant therapy without undergoing completion lymph node dissection. Annals of surgical oncology, 2021. 28(12): p. 6978-6985.

