Timing of Surgical Fixation in Polytrauma Patients with Long Bone Fractures

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KEYWORDS

Early surgery, late surgery, postoperative pneumonia, thromboembolic events, complications, and mortality.

ABSTRACT

Background: Early versus late surgery has been a topic of considerable debate, particularly regarding its impact on postoperative outcomes. Delaying surgery may lead to complications such as pneumonia, thromboembolic events, and other adverse effects, potentially influencing patient recovery and mortality rates. On the other hand, early surgical intervention may offer benefits by reducing the possibility of such complications and improving overall recovery.

Aim: This meta-analysis study aimed to assess the influence of early (less than twenty-four hours) vs. delayed (>24 hours) surgical fixation of long bone fractures on outcomes like mortality, ARDS, and infection rates in polytrauma patients.

Methods: A search of PubMed, Embase, Cochrane Library, and Google Scholar identified studies with keywords as follows: early surgery, late surgery, postoperative pneumonia, thromboembolic events, complications, and mortality. Additional searches were done on ClinicalTrials.gov, and relevant references were reviewed.

Results: This meta-analysis, including 14 studies with 18,189 patients, was included in the analysis. Analysis of postoperative pneumonia revealed a statistically significant variance between early and late surgery groups (mean difference 0.51, ninety-five percent CI 0.39 to 0.67, Z = 4.94, P-value less than 0.0001). Nevertheless, insignificant variance was detected in postoperative thromboembolic events (mean difference 0.47, 95% CI 0.20 to 1.10, Z = 1.74, P = 0.08). Statistically significant variances have been found in complications (mean difference 0.56, 95% CI 0.43 to 0.71, Z = 4.70, P-value less than 0.001), but insignificant variances were detected in mortality at 24 hours (mean difference 0.82, 95% CI 0.68 to 1.01, Z = 1.90, P = 0.06) or 48 hours (mean difference 4.56, ninety-five percent CI 0.05 to 400.83, Z = 0.66, P = 0.51).

Conclusion: Early surgery has been related a significantly reduced frequency of postoperative pneumonia and complications, while insignificant variances have been detected in thromboembolic events or mortality at 24 or 48 hours. These findings suggest that early surgery may offer better outcomes in terms of postoperative pneumonia and complications

Introduction

The immediate injury, which frequently results in exsanguinating trauma or lethal head injuries because of the rupture of major vasculature, is responsible for almost fifty percent of all trauma-related deaths. About ten percent happen within hours following the initial trauma, 2ry to hypoxia, head injury or hypovolemic shock. The remaining forty-five percent of trauma deaths happen weeks later, as a result of acute respiratory distress syndrome, kidney failure, or a combination of several organ failures (1).

In cases who have numerous traumas, fracture fixation has been recognized as a critical component of their management. In stable patients, early definitive surgery is recognized as advantageous. Nevertheless, for cases with physiological derangements, early fracture fixation is related to severe complications throughout the clinical course (2).

The frequency of spinal column injuries in polytrauma cases may reach up to forty-six percent. Systemic injuries often happen in close proximity to vertebral injuries. It is common for head injuries to be related to cervical spine injuries, while thoracic spine injuries are related to lung contusion (thirty to sixty-four), hemopneumothorax (twenty-four to thirty-nine), and rib fractures (thirty percent). Abdominopelvic organ injuries have been demonstrated to be significantly related to lumbar spine injuries (3).

The management of polytrauma cases is a dynamic and complex process. In severe polytrauma cases, early definitive management is essential. By choosing the optimum timing for operation and promptly conducting fracture reconstruction and limb rehabilitation, pulmonary and other early complications may be significantly reduced. Nevertheless, early fracture surgery is related to severe complications in cases whose physiological functions haven’t yet stabilized, as excessive surgical intervention can result in additional injury to soft tissues and blood loss, further exacerbating the case's condition (4).

The timing of surgical fixation for unstable spinal column injuries is in contention.1. It has been stated that the duration of hospital stays, morbidity, and death are all reduced by the early fixation of spinal fractures. This decrease is achieved by reducing the frequency and severity of complications related to immuno-bilization, including the utilization of opiate-equivalent analgesia and the exposure to the hospital environment, which includes thrombo-embolic phenomena, respiratory failure, and infection (5).

In addition to the timing of an operation, the extent of operation is additionally critical in clinical decision-making, as the surgeon has the ability to choose from a diverse array of surgical approaches, implants, and degrees of fracture stabilization (6).

This goal of this systematic review and meta-analysis was to assess the impact of early (less than twenty-four hours) vs. delayed (more than twenty-four hours) surgical fixation of long bone fractures on outcomes like mortality, ARDS, and infection rates in polytrauma patients.

Patients and methods:

Search strategy and study analysis: We performed a systematic search across multiple databases to identify studies with keywords such as early surgery, late surgery, postoperative pneumonia, thromboembolic events, complications, and mortality. Review Manager version 5.4.1 was used to perform all data analyses. (Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014). The odds ratio for binary outcomes has been calculated utilizing a 95% confidence interval (CI). For continuous results, we computed the mean variance with a 95% confidence interval. A fixed-effect model with the Mantel-Haenszel method has been used to compute the aggregate effect, which was estimated with a 95% confidence interval when there is no proof of heterogeneity among investigations. Alternatively, the random-effects model using the method of DerSimonian and Laird was chosen. The Q statistic and I^2 test have been used to evaluate the heterogeneity among investigations, which denotes the degree of variability in the effect estimates. A $P < 0.05$ was considered statistically significant.

Inclusion criteria: For investigations to be considered, they must meet the subsequent criteria: Randomized controlled trials, observational investigations, or cohort investigations. Focused on comparing early versus late surgery for postoperative outcomes such as pneumonia, thromboembolic events, complications, and mortality. Provided sufficient data on postoperative pneumonia, thromboembolic events, complications, or mortality at 24 or 48 hours.

Exclusion criteria: Studies were excluded if data were incomplete or not accessible for analysis. Studies were not related to surgical outcomes in patients who underwent early versus late surgery. Data Extraction and Analysis: Two researchers conducted separate assessments of the titles and abstracts of all the papers generated to determine their relevance. We thoroughly examined each trial that was discovered and decided whether to include it or not. Researchers also independently extracted the data into a standardized data extraction form. The two reviewers established a consensus on decisions about the inclusion of research and data extraction. The 3rd researcher (JJS) would have the final authority to determine trial eligibility and extract data where discrepancies have been discovered**.**

Results

A total of 13 studies have been selected for the present analysis, including a total of 18,189 patients. The publication year ranged from 2004 to 2024. One study was conducted in each of the following: France, New York, Italy, Singapore, England, Sweden, and New Zealand. 2 studies were conducted in the US and Spain. Baseline characteristics of involved investigations are illustrated in

Table 1.

Author, year	year	country	Study period		Study design	Sample Size		
			from	to		Early	Late	total
Jiang Zheng, 2024	2024	French	2014	2017	Comparative study	74	179	253
Gretchen M, 2004	2004	New York			Comparative study	398	780	1178
Mari´a T, 2011	2011	US			Prospective cohort study			2250
Andor Sebestyén, 2006	2006	Spain	2003	2008				3777
Alejandro Lizaur-Utrilla, 2016	2016	Spain	2012	2014	A prospective observational study	206	625	628
P. Kelly, 2017	2017	Sweden			Observational single cohort	264	297	576
Mariconda M, 2015	2015	ITALY			Prospective	324	244	568
Orosz GM, 2004	2004	US			Prospective	398	780	1206
Poh KS, 2013	2013	Singapore			Prospective	107	135	242
Vidan, 2011	2011					790	1459	2249
Siegmeth AW, 2005	2005	England				3454	174	3628
Hapuarachchi, R.S, 2014	2014	New Zealand				61	85	146
Jiang Zheng, 2024	2024	French	2014	2017	Comparative study	74	179	253

Table2. Patient's characteristics:

As illustrated in Table 2, the mean age of the participants in the examined groups was 72.3 years, with a range of 20 to 89 years. Gender has been recorded in all four investigations, with 2589 men and 3595 women participants.

Author, year	Age (year)						Sex					
	Early			Late			Early			Late		
	mean	SD	total	mean	SD	total	male	female	total	male	female	total
Jiang Zheng, 2024	40.3	23.1	253	41.8	23.1	253	47	27	253	137	42	253
Gretchen M, 2004	82	9.2	398	82	8.6	780	82	316	398	147	633	780
Mari´a T, 2011	83.9	7.3	2250	84	6.6	2250	410	1840	2250	1582	668	2250
Andor Sebestyén, 2006	40.3	23.1	253	41.8	23.1	253	47	27	253	137	42	253

Postoperative pneumonia

4 studies reported (**postoperative pneumonia**), and all may be utilized. A significant heterogeneity has been observed. Consequently, a random-effect model was used for analysis (I^2 = 90%, P < 0.00001). The combined mean variance and 95% CIs was 0.51 (0.39 to 0.67). The combined findings show a statistically significant distinction between groups with regard to **postoperative pneumonia** (Z = 4.94, P < 0.0001).

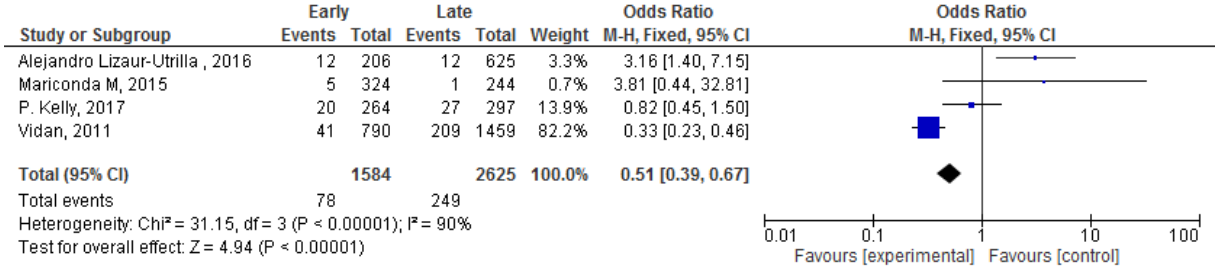

Figure 1. Forest plot of postoperative pneumonia illustrates statistically significant variance among early and late groups.

Postoperative thromboembolic events:

3 studies reported (**postoperative thromboembolic events**), and all may be utilized. A non-significant heterogeneity has been identified. Consequently, a random-effect model has been used for the analysis (I^2 = 0%, P-value equal to 0.74). The combined mean variance and 95% confidence intervals were 0.47 (0.20 to 1.10). The combined outcome indicates that there is a statistically insignificant distinction among the groups in terms of **postoperative thromboembolic events** (Z = 1.74, P-value equal to 0.08).

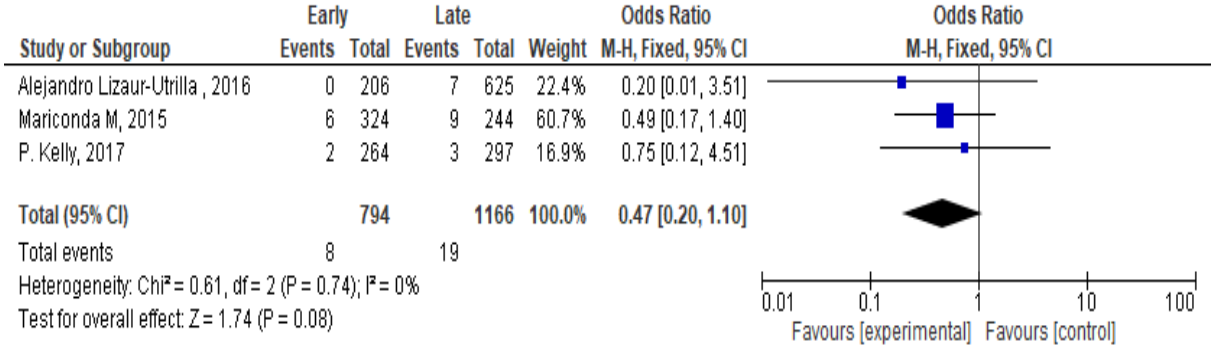

Figure 2. Forest plot of postoperative thromboembolic events demonstrates a statistically insignificant difference between early and late surgery groups.

Complications:
4 studies reported (complications), and all may be utilized. A non-significant heterogeneity has been identified. Consequently, a random-effect model was used for the analysis (I^2 = 0%, P-value equal to 0.46). The combined mean variance and 95% confidence intervals were 0.56 (0.43 to 0.71). The combined outcome indicates a statistically significant distinction among the groups in terms of **complications** (Z = 4.70, P-value less than 0.001).

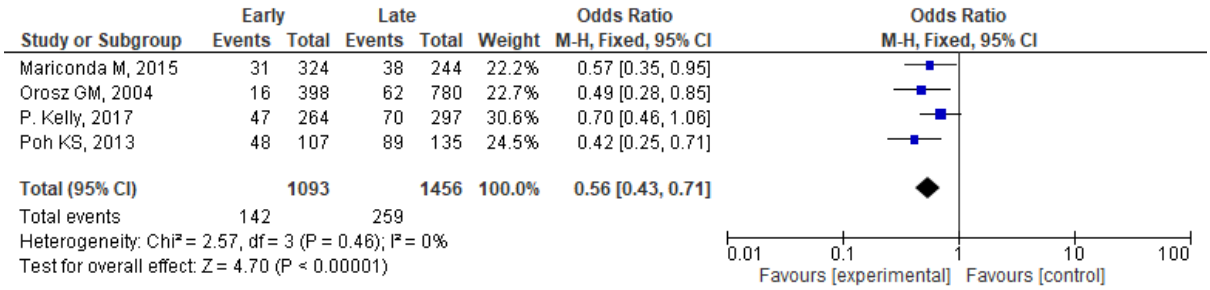

Figure 3. Forest plot of duration of complications statistically significant variance among early and late groups.

Mortality 24 h

1 study reported (**mortality 24 h**), and all can be used. The combined mean variance and ninety-five percent confidence intervals were 0.39 (0.13 to 1.12). The combined outcome indicates that there is a statistically insignificant distinction among the groups in terms of (**Mortality** 24 h) (Z = 1.76, P-value equal to 0.08).

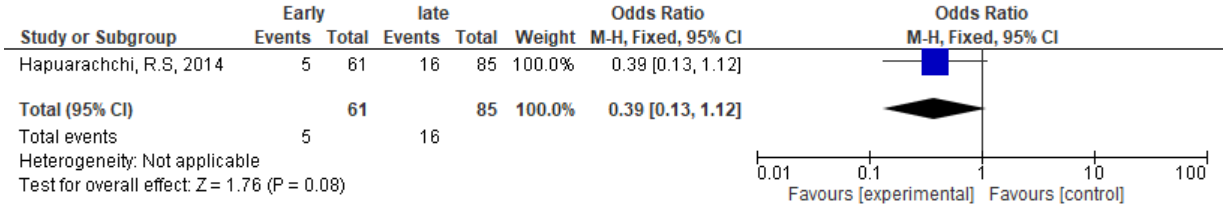

Figure 4. Forest plot of Mortality 24 h illustrates a statistically insignificant variance among early and late groups.

Mortality 48 h:
1 study reported (mortality 48 h), and all can be used. The combined mean variance and 95% CIs were 0.46 (0.29 to 0.73). The combined outcome shows statistically significant variance among groups with regard to mortality (48 h) (Z = 3.35, P-value less than 0.001).

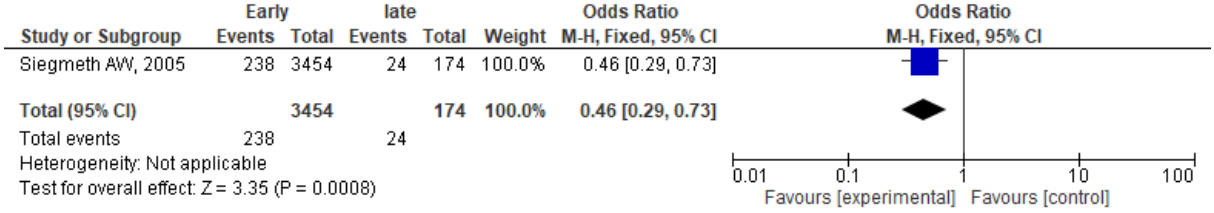

Figure 5. Forest plot of mortality at 48 h illustrates statistically significant variance among early and late groups.

Discussion

Concerning outcomes, the combined results demonstrated statistically significant variance among groups regarding postoperative pneumonia (Z = 4.94, P = value less than 0.0001).
Similarly, in accordance with Vidán et al. (7), who assessed the influence of surgical delay on hospital consequences regarding the cause of delay. They reported that regarding analysis of each postoperative complication according to delay categories, it revealed an increase in the rate of pneumonia among cases for whom operation was delayed for more than 5 days.
Additionally, this systematic review and meta-analysis are in line with with Kelly-Pettersson et al. (8), who conducted a study to examine the impact of waiting time to operation on the probability of serious adverse events in cases with hip fractures throughout their hospital stay, as well as to investigate the extent to which the risk elevated over time. They determined that the possibility of postoperative pneumonia and pressure ulcers is reduced when the operation is performed at an early stage.
The combined results demonstrated no statistically significant difference between groups regarding postoperative thromboembolic events (Z = 1.74, P = 0.08).
The combined findings were also consistent with Chen et al. (9) who compared and assessed the clinical results of cases with proximal femoral fractures with ard to of the benefits of early against delayed operation. They stated that early operation has been related to fewer complications prior to surgery compared to delayed operation (OR = 0.52; 95% CI: 0.35–0.76), particularly in the context of postoperative thromboembolic events (OR = 0.61; 95% CI: 0.39–0.96) as documented.
Additionally, the present findings are in line with the objectives of Lizaur-Utrilla et al. (10), who aimed to prospectively evaluate the effect of surgery timing on deaths and morbidity at one year, as well as to determine whether early surgery within two days of admission can be considered a reliable indicator of the quality of medical care. They discovered that ASA >2, Charlson >2, and anticoagulant therapy were significantly related to a delay for an operation of over two days. There was no significant association between delayed surgery for more than two days and medical complications.
Additionally, Kelly-Pettersson et al. (8) provide support for these findings, revealing that 397 severe adverse events were experienced by 119 cases (20.6%) throughout their hospital stay. The odds ratio of serious adverse events (SAEs) raised by 12% for every ten hours of waiting time to operation (odds ratio 1.12 [ninety-five percent confidence interval 1.02–1.23]). The most prevalent SAEs were deaths, cardiac and circulatory conditions, postoperative hemorrhage requiring significant transfusions, and respiratory infections.
The combined results demonstrated statistically significant variance among groups with regard to complications (Z = 4.70, P = value less than 0.001).
Furthermore, this systematic review and meta-analysis were consistent with the findings of Poh & Lingaraj et al. (11), who conducted an assessment of the risk factors and following surgery associated with hip fractures. They stated the mean length of hospitalization was 14.6 days. At least one complication was experienced by 56.8% of the 242 cases who had surgical treatment following a mean of 3.6 days. The most prevalent conditions were acute urinary retention (39.3percent) and urinary tract infection (24.0 percent). Cases with complications and their risk factors after a hip fracture operation grade III or greater had a

2.3-fold greater risk of developing complications compared to those with lower-grade comorbidity. Conversely, cases with delayed operations (more than forty-eight hours following presentation) had a 1.8-fold greater possibility of progressing complications compared to those without delayed operations. Four cases died in hospital: two from myocardial infarction and two from upper gastrointestinal bleeding.

Additionally, in line with Orosz et al. (12), who investigated the correlation between the timing of surgical repair of a hip fracture and other results. They found that the outcomes remained consistent when the cohort consisted only of cases who were medically stable at admission and consequently eligible for early surgery, with the exception of the fact that early operation has been related to fewer major complications (odds ratio, 0.26; ninety-five percent CI, 0.07-0.95).

Similarly, our findings are consistent with Mariconda et al. (13) who assessed the complications and death rates in elderly cases at four and twelve months following surgical management of a hip fracture, with the objective of identifying the factors that can predict the result. Following controlling for confounding variables, they discovered that the probability of early and delayed general complications was determined by comorbidities and poor cognitive status, correspondingly (p-value less than 0.001). The length of hospital stay was primarily predicted by operational delay (p less than 0.001), and it was directly correlated with in-hospital (p-value equal to 0.017) and four-month complications (p-value equal to 0.008). Additionally, the study identified a decrease in the probability of complications among cases who had operations earlier.

The combined results demonstrated a statistically insignificant variance among groups with regard to mortality 24 h ($Z = 1.9$, $P = 0.06$) and demonstrated a statistically insignificant variance between groups regarding mortality 48 h ($Z = 0.66$, $P = 0.51$).

Additionally, the present findings are consistent with the objectives of Sebestyén et al. (14) who aimed to examine the correlation between death that occurs within thirty days of injury and the delay in surgical treatment in cases aged sixty or more who have a femoral neck fracture. They stated that all three groups (12–24 h, 24–48 h, and over 48 h) exhibited a trend toward greater death risks, as determined by multiple regression analysis. However, this trend was statistically insignificant ($OR_{12–24h}=1.301$, $CI_{12–24h}$: 0.945–1.791, $p= 0.106$; $OR_{24–48h}=1.384$, $CI_{24–48h}$: 0.932–2.056, $p=0.108$; $OR_{>48h}=1.246$, $CI_{>48h}$: 0.950–1.635, $p=0.113$).

Additionally, this systematic review and meta-analysis, in line with with Hapuarachchi et al. (15), who reported the surgical results of this population, aims to determine whether medical optimization happens throughout the duration of admission prior to operation and to comprehend the potential impact of surgical timing on operative results utilizing the orthopedic POSSUM scoring system. They stated that there was a statistically insignificant variation in the mortality rate in the following twenty-four hours.

Additionally, the present results are supported by the results of Siegmeth et al. (16), who conducted a prospective study to examine the impact of surgical delay on the case's ability to return home and the duration of their hospital stay in a large consecutive group of cases. They discovered that the hours of delay upon the destination did not affect the discharge and death rate when adjusted for the ASA, mental score, and pre-fracture mobility score, as indicated by a logistic regression analysis.

Conclusion

This systematic review and meta-analysis assessed the influence of early (less than twenty-four hours) vs. delayed (>24 hours) surgical fixation of long bone fractures on outcomes like mortality, ARDS, and infection rates in polytrauma patients. Accordingly, a statistically significant variance has been found among groups regarding (postoperative pneumonia), (postoperative thromboembolic events), and (complications). Meanwhile, there was a statistically insignificant variance among groups (mortality 24 h) and (mortality 48 h). These findings suggest that early surgery may offer better outcomes in terms of postoperative pneumonia and complications.

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