

Practice Management Guidelines for the Optimal Timing of Long Bone Fracture

Stabilization in Polytrauma Patients:

The EAST Practice Management Guidelines Work Group

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Practice Management Guidelines for the Optimal Timing of Long Bone Fracture Stabilization in Polytrauma Patients

I. Statement of the Problem

The optimal timing for long bone stabilization in polytrauma patients has been debated for the last two decades. Much of the relevant literature focused on long bone fracture as a femoral fracture; however, a substantial portion of published studies include various fractures (tibia, humerus, spine, and/or pelvis). Reported benefits of early long bone stabilization in polytrauma patients include increased patient mobilization by eliminating the need for traction and decreased pulmonary morbidity (fat emboli syndrome, pneumonia, adult respiratory distress syndrome [ARDS]), late septic sequelae, hospital care costs, mortality, hospital length of stay (LOS), ICU LOS, and ventilator days. Some authors suggest that early long bone stabilization in polytrauma patients increases blood loss, fluid administration, and surgical stress, fat embolism and pulmonary complication risks, and mortality. However, others intimate that the pulmonary shunt is similar in those undergoing early or late stabilization, i.e., no worse, no better. There have been additional concerns regarding the timing of long bone stabilization in patients with brain or chest injury. Problems with early fixation of long bones in patients with brain injury include secondary brain injury as a result of hypoxemia, hypotension, and/or complexity of controlling intracranial hypertension, increased mortality, and increased fluid administration which might exacerbate cerebral edema. Early long bone stabilization in patients with pulmonary contusion, multiple rib fractures, or hemopneumothorax is also not advised since there are increased pulmonary complications (ARDS, fat embolism syndrome), especially when intramedullary nailing and reaming are used. However, others indicate that chest injury

patients with early intramedullary nailing have similar outcomes compared to later intramedullary nailing or other stabilization techniques, i.e. no worse, no better; and pulmonary contusion patients have similar PaO₂/FiO₂ and duration of mechanical ventilation, i.e. no worse, no better.

II. Process

A. Identification of References

Literature searches were conducted by committee members using Medline. The subcommittee chair also had the OVID Company perform a literature search using EMBASE. Literature survey parameters included studies written in the English language using human subjects which were published between 1980 and 1998.

Medline MESH Search

1. (femoral fracture / fractures / fracture fixation) AND (thoracic injuries): 414 articles found; only 12 with potential relevance to long bone injury based on the article title with or without abstract review
2. (fracture fixation / femoral fractures) AND (head injuries / brain injuries): 666 articles found; only 18 with potential relevance to long bone injury based on the article title with or without abstract review
3. (fractures / femoral fractures / fracture fixation) AND (multiple trauma): 378 articles found; only 59 with potential relevance to long bone injury based on the article title with or without abstract review
4. (femoral fractures / fracture fixation / fractures) AND (respiratory insufficiency / respiratory distress syndrome, adult / respiration); 158 articles found; only 34 with potential relevance to long bone injury based on

the article title with or without abstract review

Medline Title Strategy

Additional articles were sought by using the following title searches: 1. timing fixation, 2. delayed fixation, 3. early fixation, 4. early osteosynthesis, 5. immediate fixation, 6. timing fracture:, 7. timing osteosynthesis, 8. fracture: brain, 9. fracture: chest, 10. fem: multipl:, 11. fem: poly:, 12. fracture: thoracic, 13. fracture: multipl:, 14. fracture: poly:, 15. fixation multipl:, 16. fixation poly:, and 17. fracture: head.

Other Medline Literature Search Strategies

The bibliography of the relevant articles mentioned previously was reviewed to find additional potentially appropriate publications.

EMBASE Literature Search Strategies

The OVID Company used EMBASE, a medical literature database distinct from the National Library of Medicine, to perform similar 'MESH' and title searches as described above for the Medline searches. The 'MESH' strategy identified 1,462 potentially relevant articles and the title search method captured 351 such articles.

Inclusion in Evidence Tables

Articles retrieved from the above process were selected for inclusion if they met the following criteria: (a) the blunt trauma mechanism was high-energy, (b) each patient had a long bone injury, (c) each patient had a major non-long bone injury, and (d) there was an early and a late group undergoing fracture stabilization.

B. Quality of the References

The quality assessment instrument applied to the references was developed by the EAST Practice Management Guidelines Committee. Articles were classified as

Class I, II, or III according to the following definitions:

Class I: A randomized clinical trial. There were no Class I articles identified.

Class II: A prospective, noncomparative clinical study or a retrospective analysis based on reliable data.

Class III: A retrospective case series or database review.

III. Recommendations

A. Level I

There is insufficient evidence to support a standard of care on this topic.

B. Level II

1. Polytrauma patients undergoing long bone stabilization within 48 hours of injury have no improvement in survival when compared to those receiving later stabilization; however, there may be some patients who will have fewer complications. There is no evidence that early stabilization has any detrimental effect. It seems preferable to perform early long bone stabilization in polytrauma patients.

2. There is no compelling evidence that early long bone stabilization in mild, moderate, or severe brain injured patients either enhances or worsens outcome. The timing of long bone stabilization should be individualized according to the patient's clinical condition.

3. There is no compelling evidence that early long bone stabilization in patients with chest injury alters outcome. It appears reasonable to individualize the timing of long bone stabilization according to the patient's clinical condition.

IV. Scientific Foundation

Since the literature describes patients with injuries to the non-long bone body region which includes brain injury, chest injury, or mixed injury (the non-fracture injury is variable), and the clinical problems are often distinct, the scientific evidence is organized accordingly. Each study selected has an early and a late group according to the timing of fracture stabilization following injury. Almost all articles describe a clearly delineated number of hours or days for the timing of stabilization. However, a few only indicate "early" or "late" intervention and are typically excluded from this evaluation (see Evidence Tables). Most investigations demonstrate similar injury severity between the early and late stabilization groups; however, it is clear that the magnitude of injury is different between the two groups in some studies. When the latter exists, those investigations are usually excluded from the final outcome analysis (see Evidence Tables). Most studies indicate that the long bone injury is a femoral fracture; however, several publications include patients with only a tibial, pelvic, humeral, or spinal fracture (see Evidence Tables). Mortality and non-mortality outcomes are evaluated to determine whether the early fracture stabilization group has a similar, beneficial, or detrimental effect relative to the late group (see Evidence Tables). An outcome between the early and late group is considered to be different in a given study when the P value is $<.05$. A few studies considered and cited in the evidence tables have such severe methodological flaws that they are not included in the final outcome analysis.¹⁻⁴

Mixed Injury Group (divergent non-long bone injuries)

Class II and III studies are combined to provide a more valid and comprehensive understanding of the data results. Polytrauma patients undergoing long bone stabilization within 48 hours of injury have no improvement in survival when compared to those receiving later stabilization,⁵⁻¹³ however, there may be a reduction in the number of days of

mechanical ventilation,^{5,7,10-13} ICU^{5-7, 10-14} or hospital LOS,^{5-8, 10, 12-14} incidence of ARDS,^{6,7,9-11,16} pulmonary complications,^{5-7, 14, 16} pneumonia,^{6,7,11} or systemic infection.^{5, 10, 11, 13} The outcome summary is presented in Table 1. In essence, polytrauma patients undergoing long bone stabilization within 48 hours of injury have no improvement in survival when compared to those receiving later stabilization; however, there may be some patients who will have fewer morbidities. There is no evidence that early stabilization has any detrimental effect.

Brain Injury Group

Class II Data: One study focuses on patients with severe traumatic brain injury⁸ while the other co-mingles those with mild, moderate, or severe traumatic brain injury.¹² Patients with mild, moderate, or severe brain injury undergoing long bone stabilization within 48 hours of injury have similar rates for mortality,^{8,12} ICU LOS,¹² mechanical ventilation requirements,¹² and total hospital LOS^{8,12} when compared to those receiving later stabilization. The outcome summary is presented in Table 2. There is no compelling evidence that early long bone stabilization in mild, moderate, or severe brain injured patients either enhances or worsens outcome.

Class III Data: Four studies address those with severe traumatic brain injury,¹⁷⁻²⁰ while three investigations evaluate those with mild, moderate, or severe brain injury.²¹⁻²³ Patients with mild, moderate, or severe brain injury undergoing long bone stabilization within 48 hours of injury have similar rates for mortality,^{17,18,20-23} ICU LOS,^{17,20-21} mechanical ventilation requirements,^{20,21} total hospital LOS,^{17,20,21} CNS outcome,^{10,11,13} and adverse CNS event,^{18,20,21,23} ARDS,²³ pulmonary complications,²³ pneumonia,²⁰ and systemic infection rate,²³ when compared to those receiving later stabilization. The outcome summary is

presented in Table 3. These data support the Class II Data study findings.

Chest Injury Group

Class II Data: Patients with chest injury undergoing long bone stabilization within 48 hours of injury have similar rates for mortality,^{7,8,12} ARDS,⁷ mechanical ventilation requirements,^{7,12} ICU LOS,^{7,12} and total hospital LOS,^{7,8,12} when compared to those receiving later stabilization. The outcome summary is presented in Table 4. There is no compelling evidence that early long bone stabilization in patients with chest injury either enhances or worsens outcome.

Class III Data: Patients with chest injury undergoing long bone stabilization within 48 hours of injury may have a worse ARDS rate,^{11,15} however, the mortality,^{11,24} pulmonary complication,^{24,25} and pneumonia¹¹ rates, ventilator days,^{11,24} and ICU LOS^{11,24} are similar when compared to those receiving later stabilization. The outcome summary is presented in Table V. These data support the Class II Data study findings.

V. Summary

For the past couple of decades, there has been a debate regarding the optimal timing of long bone fracture stabilization in polytrauma patients who may or may not have a brain or chest injury. Mixed injury group: Polytrauma patients undergoing long bone stabilization

within 48 hours of injury have no improvement in survival when compared to those receiving later stabilization; however, there may be some patients who will have fewer morbidities. There is no evidence that early stabilization has any detrimental effect. It seems preferable to perform early long bone stabilization in polytrauma patients. Brain

injury group: There is no compelling evidence that early long bone stabilization in mild, moderate, or severe brain injured patients either enhances or worsens outcome. It appears

reasonable to individualize the timing of long bone stabilization according to the patient's clinical condition. Chest injury group: There is no compelling evidence that early long bone stabilization in patients with chest injury either enhances or worsens outcome. It appears reasonable to individualize the timing of long bone stabilization according to the patient's clinical condition.

VI. Future Investigation

Since there are no Data Class I studies and only 6 (27.3%) of the 22 relevant studies are Data Class II, there is a clear need for large, randomized studies. The following factors should be considered in the design of any future investigation:

Inclusion criteria: Patients should have similar long bone injury, most likely a femoral fracture; there should be a non-long bone injury Abbreviated Injury Scale (AIS) ≥ 2 (possibly AIS ≥ 3); a consecutive patient cohort should be used, with clear exclusion criteria for those not entering the study.

Patient characteristics: Grade of fracture (open [III vs. I/II] vs. closed); location of fracture (proximal, shaft, distal); method of initial long bone stabilization (intramedullary nail [with or without reaming], external fixation, plates and screws); degree of hemodynamic instability in first six hours (grade by blood loss, base deficit, hypotension, etc.); degree of brain injury (mild, moderate, or severe) (grade by best Glasgow Coma Scale [GCS] score in first 6 hours and brain AIS); degree of chest injury (grade by lowest PaO₂/FiO₂ in first 6 hours and chest AIS).

Subgroups according to timing of long bone stabilization: (1) ≤ 24 hours vs. 25-48 hours vs. >48 hours OR (2) ≤ 48 hours vs. >48 hours.

Delineation of relevant outcome variables: Mortality rate (hospital vs. 30-day); non-mortality

outcomes: strict criteria for outcome variable definitions, e.g., pneumonia, ARDS; a priori ranking as to the importance of the various outcome variables; variables to be considered include ARDS, non-ARDS pulmonary complications, ventilator days, pneumonia, systemic infections, multiple organ failure, hospital and/or professional costs, ICU LOS, total hospital LOS, intraoperative complications (hypotension, hypoxemia), adverse CNS events, and CNS outcome.

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Table 1. Mixed Injury Group; Class II and III Data Outcome Summary (12 Studies)

	Early Group vs. Late Group			
	PATIENTS (N = 1,227)	BETTER	SAME	BENEFIT
Mortality	869 (70.8%)	0 (.0%)	869 (100%)	none
ARDS	516 (42.1%)	238 (46.1%)	278 (53.9%)	potential
Pulmonary complications	473 (38.5%)	317 (67.0%)	156 (33.0%)	potential
Ventilator days	486 (39.6%)	96 (19.8%)	390 (80.2%)	potential
ICU LOS*	706 (57.5%)	96 (13.6%)	610 (86.4%)	potential
Total LOS*	927 (75.6%)	454 (49.0%)	473 (51.0%)	potential
Pneumonia	195 (15.9%)	83 (42.6%)	112 (57.4%)	potential
Systemic infection	325 (26.5%)	172 (52.9%)	153 (47.1%)	potential

Multiple organ failure	56 (4.6%)	0 (.0%)	56 (100%)	none
Hospital cost	83 (6.8%)	0 (.0%)	83 (100%)	none

LOS = length of stay.

Table 2. Brain Injury Group; Class II Data Outcome Summary (2 Studies)

	Early Group vs. Late Group			
	PATIENTS (N = 192)	BETTER	SAME	BENEFIT
Mortality	192 (100%)	0 (.0%)	192 (100%)	none
Ventilator days	105 (54.7%)	0 (.0%)	105 (100%)	none
ICU LOS*	105 (54.7%)	0 (.0%)	105 (100%)	none
Total LOS*	192 (100%)	0 (.0%)	192 (100%)	none

LOS = length of stay.

Table 3. Brain Injury Group; Class III Data Outcome Summary (7 Studies)

	Early Group vs. Late Group				BENEFIT
	PATIENTS (N = 336)	BETTER	SAME	WORSE	
Mortality	314 (93.5%)	58 (18.5%)	222 (70.7%)	34 (10.8%)	likely none
ARDS	72 (21.4%)	0 (.0%)	72 (100%)	0 (.0%)	none
Pulmonary complications	72 (21.4%)	0 (.0%)	72 (100%)	0 (.0%)	none
Ventilator days	50 (14.9%)	0 (.0%)	50 (100%)	0 (.0%)	none
ICU LOS*	108 (32.1%)	0 (.0%)	50 (46.3%)	58 (53.7%)	potential harm
Total LOS*	108 (32.1%)	0 (.0%)	108 (100%)	0 (.0%)	none
Adverse CNS events	144 (42.9%)	0 (.0%)	144 (100%)	0 (.0%)	none
CNS outcome	191 (56.8%)	0 (.0%)	191 (100%)	0 (.0%)	none

LOS = length of stay.

Table 4. Chest Injury Group; Class II Data Outcome Summary (4 Studies)

	Early Group vs. Late Group				BENEFIT
	PATIENTS	BETTER	SAME	WORSE	
	(N = 283)				
Mortality	283	0	283	0	none
	(100%)	(.0%)	(100%)	(.0%)	
ARDS	82	0	82	0	none
	(28.9%)	(.0%)	(100%)	(.0%)	
Ventilator	187	0	187	0	none
days	(66.1%)	(.0%)	(100%)	(.0%)	
ICU LOS	187	0	187	0	none
	(66.1%)	(.0%)	(100%)	(.0%)	
Total LOS	283	0	283	0	none
	(100%)	(.0%)	(100%)	(.0%)	

LOS = length of stay.

Table 5. Chest Injury Group; Class III Data Outcome Summary (4 Studies)

Early Group vs. Late Group					
	PATIENTS	BETTER	SAME	WORSE	BENEFIT
	(N = 274)				
Mortality	132 (48.2%)	0 (.0%)	132 (100%)	0 (.0%)	none
ARDS	133 (48.5%)	0 (.0%)	83 (62.4%)	50 (37.6%)	potential harm
Pulmonary complications	141 (51.5%)	59 (41.8%)	82 (58.2%)	0 (.0%)	potential benefit
Ventilator days	132 (48.2%)	0 (.0%)	132 (100%)	0 (.0%)	none
ICU LOS*	132 (48.2%)	0 (.0%)	132 (100%)	0 (.0%)	none
Multiple organ failure	50 (18.2%)	0 (.0%)	50 (100%)	0 (.0%)	none
Pneumonia	50 (18.2%)	0 (.0%)	50 (100%)	0 (.0%)	none

LOS = length of stay.

EVIDENTIARY TABLE

Must Be Polytrauma and Have An Early and Late Fixation Group

MIXED INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)			
Author	Patient Traits	Outcomes	Data Class Findings
Bone et al. ⁶	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 83; ISS: EG-31.8, LG-31.3	mortality: EG-4.3%, LG-2.7%, P=1.0; ARDS: EG-2.2%, LG-16.2%, P=.04; FES: EG-.0%, LG-5.4%, P=.2; ICULOS: EG-2.8, LG-7.6, P>.05; totalLOS: EG-17.3, LG-26.6, P>.05 ; costs: EG-19,854, LG-32,915, P>.05; pneumonia: EG-2.2%, LG-16.2%, P=.04; pulmonary complications: EG-4.3%, LG-45.9%, P<.001	II EG same outcome as LG: mortality; FES; ICU LOS; total LOS; costs EG better outcome than LG: ARDS; pneumonia; pulmonary complications EG worse outcome than LG: NR
Johnson et al. ¹⁰	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 132; ISS: EG-38.2, LG-38.0	mortality: EG-2.4%, LG-12.2%, P=.05; ARDS: EG-7%, LG-39%, P=<.001; infection: EG-4.8%, LG-24.5%, P=<.001; orthopedic.infection: EG-20.5%, LG-8.2%, P=.08; ventilator days: EG-4.9, LG-11.1, P>.05; ICULOS: EG-4.9, LG-11.1, P>.05; totalLOS: EG-31.6, LG-38.3, P>.05; ARDS a ISS, severe head injury, and late fixation	II EG same outcome as LG: mortality; orthopedic infections; ventilator days; ICU LOS; total LOS EG better outcome than LG: ARDS; infections EG worse outcome than LG: NR

MIXED INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)				
Author	Patient Traits	Outcomes	Data Class	Findings
Goris et al. ⁹	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 58; ISS: EG-37.7, LG-54.6; major chest injury: EG-23.9%, LG-75.0%, P=.002	mortality: EG-2.2%, LG-41.7%, P<.001; ARDS: EG-17.4%, LG-75.0%, P<.001; ventilator days (survivors): EG-2.5, LG-10	III	Study is not useful.
Goris et al. ⁹	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 23; HTI-ISS ≥50	mortality: EG-8%, LG-50%, P=.05; ARDS: EG-15%, LG-80%, P=.003; ventilator days (survivors): EG-2.5, LG-10	III	<u>EG same outcome as LG:</u> mortality <u>EG better outcome than LG:</u> ARDS <u>EG worse outcome than LG:</u> NR
Talucci ¹⁶	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 100; ISS: EG-23.2, LG-12.4, P<.001	mortality: NR; ARDS: EG-7%, LG-5%, P=1.0; <u>FES</u> : EG-.0%, LG-11%, P=.01; <u>pulmonary complications</u> (hypoxemia): EG-23%, LG-14%, P=0.3	II	<u>EG same outcome as LG:</u> ARDS, pulmonary complications <u>EG better outcome than LG:</u> FES <u>EG worse outcome than LG:</u> NR

MIXED INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)				
Author	Patient Traits	Outcomes	Data Class	Findings
Fakhry ⁸	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 277; ISS: EG-23, LG-22, P>.05	<u>mortality</u> : EG-3.8%, LG-1.5%, P>.05; <u>total LOS</u> : EG-18.4, LG-29.4, P<.001	II	<u>EG same outcome as LG</u> : mortality <u>EG better outcome than LG</u> : total LOS <u>EG worse outcome than LG</u> : NR
Bone ¹	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 1,582; ISS ≥18	<u>mortality</u> : EG-11.9%, LG-19.3%, P<.001; same mortality (≅60%) in the 121 with ISS >45 (7.6% of all patients)	III	Study is not useful.
Riska ⁴	all femoral fractures - no; time of early fixation "early"; injury severity	<u>mortality</u> : ; <u>non-mortality</u> :	III	Study is not useful.

MIXED INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)			
Author	Patient Traits	Outcomes	Data Class Findings
Behrman ¹⁴	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 137; ISS: >15	mortality: none reported; pulmonary complications (↑ shunt): EG-28.3%, LG-50.5%, P<.05; <u>ICULLOS</u> (ISS 16-35, n=104): EG = LG; <u>ICULLOS</u> (ISS >35, n=33): EG-3, LG-8, P<.05; <u>totalLOS</u> : EG-17.7, LG-25.8, P<.05	III EG same outcome as LG: ICU LOS (ISS 16-35, n=104) EG better outcome than LG: pulmonary complications; ICU LOS (ISS >35, n=33); total LOS EG worse outcome than LG: NR
Reynolds et al. ¹²	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 105; ISS: EG-27, LG-34, P<.05; brain AIS: EG-1.96, LG-2.36, P<.05	mortality: EG-4.2%, LG-.0%, P>.05; <u>mechanical ventilation</u> : EG-42%, LG-67%, P=.01; <u>ventilator days</u> : EG-7.1, LG-7.1, P=1.0; <u>ICULLOS</u> : EG-10.6, LG-9.4, P>.05; <u>totalLOS</u> : EG-14.6, LG-21.9, P=NR; total LOS greater compared to group <24 hours; however, authors indicate "increased total LOS was related to greater degree of critical injury"	II EG same outcome as LG: mortality; ventilator days; ICU LOS; total LOS EG better outcome than LG: none that are not related to injury severity EG worse outcome than LG: NR

MIXED INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)				
Author	Patient Traits	Outcomes	Data Class	Findings
Beckman et al. ⁵	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 97; ISS: EG-33, LG-31, P>.05	mortality: EG-5.3%, LG-2.8%, P>.05; pulmonary complications (PE, FES, ARDS): EG-.0%, LG-19%, P<.05; infection: EG-21%, LG-37%, P>.05; ventilator days: EG-0, LG-0, P>.05; ICU LOS: EG-3, LG-4, P>>.05; total LOS: EG-20, LG-25, P>.05	III	EG same outcome as LG: mortality; infections; ventilator days; ICU LOS; total LOS EG better outcome than LG: pulmonary complications EG worse outcome than LG: NR
Seibel et al. ¹³	all femoral fractures - no; time of early fixation ≤48 hrs. ("immediate"); total patients 40; ISS: EG-36, LG-37, P>.05	mortality: NR, assume none; bacteremia: EG-5%, LG-40%, P=.02; ventilator days: EG-3.4, LG-9.7, P=.006; ICU LOS: EG-7.5, LG-15, P=.01; total LOS: EG-23, LG-45, P<.05	II	EG same outcome as LG: mortality EG better outcome than LG: bacteremia; ventilator days; ICU LOS; total LOS EG worse outcome than LG: NR
Riska et al. ³	all femoral fractures - no; time of early fixation early; injury severity: none described	mortality: ; non-mortality:	III	Study is not useful.

MIXED INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)				
Author	Patient Traits	Outcomes	Data Class	Findings
Pape et al. ¹¹	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 56; ISS: EG-22, LG-26, P>.05; AIS head: EG-1.7, LG-2.5, P<.05; GCS: EG-14.8, LG-9.1, P>.05	mortality: EG-<5%, LG-<5%, P>.05; ARDS: EG-<10%, LG-<10%, P>.05; infections: EG-9%, LG-17%, P=0.4; MOF: EG-3%, LG-4%, P>.05; pneumonia: EG-3%, LG-22%, P=.07; ventilator days: EG-5, LG-11, P<.05; ICU LOS: EG-8, LG-18, P<.05	III	EG same outcome as LG: mortality; ARDS; infections; MOF; pneumonia EG better outcome than LG: ventilator days; ICU LOS EG worse outcome than LG: NR
Charash et al. ⁷	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 56; ISS: EG-25, LG-24, P>.05	mortality: EG-4%, LG-13%, P=0.4; ARDS: EG-0%, LG-13%, P=0.1; pulmonary complications: EG-14%, LG-38%, P=0.1; pneumonia: EG-10%, LG-38%, P=.07; ventilator days: EG-2.2, LG-5.8, P>.05; ICU LOS: EG-4.5, LG-8.4, P>.05; total LOS: EG-18, LG-28, P>.05	II	EG same outcome as LG: mortality; ARDS; pulmonary complications; pneumonia; ventilator days; ICU LOS; total LOS EG better outcome than LG: NR EG worse outcome than LG: NR

MIXED INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)				
Author	Patient Traits	Outcomes	Data Class	Findings
Boulangier et al. ¹⁵	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 66; ISS: EG-26, LG-31, P>.05	<u>ARDS</u> : EG-2%, LG-11%, P>.05	III	<u>EG same outcome as LG</u> : ARDS <u>EG better outcome than LG</u> : NR <u>EG worse outcome than LG</u> : NR
Friedl et al. ²	all femoral fractures - no; time of early fixation 1-4 days; total patients 55; ISS: EG-21, LG-42, P<.05	<u>mortality</u> : EG-13%, LG-0%, P=0.13; <u>ARDS</u> : EG-25%, LG-0%, P=.01; <u>ARDS (excluding patients transferred with ARDS)</u> : EG-8%, LG-0%, P>.05	III	Study is not useful.

EVIDENTIARY TABLE

Must Be Polytrauma and Have An Early and Late Fixation Group

BRAIN INJURY PATIENT GROUP (E=early; L=late; G=group); NR=not reported)			
Author	Patient Traits	Outcomes	Data Class Findings
Fakhry et al. ⁸	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 87; ISS ≥15 and brain AIS ≥3	mortality: EG-8.5%, LG-3.6%, P=0.7; totalLOS : EG-27, LG-31, P>.05	II all have severe brain injury EG same outcome as LG: mortality, total LOS EG better outcome than LG: NR EG worse outcome than LG: NR
Kotwica et al. ²²	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 100; ISS: Not given; GCS 10-15: EG-47%, LG-49%, P>.05; femur/ pelvic fracture: EG-47%, LG-27%, P=.03; "massive brain injury": EG-33%, LG-31%, P>.05	mortality: EG-14%, LG-23%, P=0.3; FES : EG-0%, LG-6%, P=0.1; GCS III/IV (90 days) : EG-27%, LG-21%, P=0.5	III severe brain injury mixed with moderate and mild EG same outcome as LG: mortality, FES, GCS EG better outcome than LG: NR EG worse outcome than LG: NR

BRAIN INJURY PATIENT GROUP (E=early; L=late; G=group); NR=not reported)			
Author	Patient Traits	Outcomes	Data Class Findings
Martens et al. ¹⁸	all femoral fractures - no; time of early fixation early; total patients 22; ISS: EG-37, LG-35, P>.05; GCS: EG-8, LG-8, P>.05	<u>CNS complications</u> : EG-38%, LG-0%, P=.05; EG with CNS complications (n=5): ISS-49, GCS-6; EG without CNS complications (n=8): ISS-29, GCS-10	III most have severe brain injury <u>EG same outcome as LG</u> : CNS complications <u>EG better outcome than LG</u> : NR <u>EG worse outcome than LG</u> : NR
Jaicks et al. ²¹	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 33; ISS: EG-25, LG-27, P>.05; GCS: EG-11.6, LG-10.8, P>.05; brain AIS: EG-3.3, LG-3.1, P>.05; femur fractures: EG-53%, LG-36%, P=0.3	<u>mortality</u> : EG-11%, LG-0%, P>.05; <u>ventilator days</u> : EG-6.4, LG-6.5, P>.05; <u>ICU LOS</u> : EG-7.1, LG-8.9, P>.05; <u>total LOS</u> : EG-22, LG-27, P>.05; <u>OR hypotension</u> : EG-16%, LG-7%, P>.05; <u>OR hypoxia</u> : EG-11%, LG-7%, P>.05; <u>CNS complications</u> : EG-16%, LG-15%, P>.05; <u>discharge GCS</u> : EG-13.5, LG-15, P>.05;	III severe brain injury mixed with moderate and mild <u>EG same outcome as LG</u> : mortality, ventilator days, ICU LOS, total LOS, operative complications, CNS complications, discharge GCS <u>EG better outcome than LG</u> : NR <u>EG worse outcome than LG</u> : NR

BRAIN INJURY PATIENT GROUP (E=early; L=late; G=group); NR=not reported)			
Author	Patient Traits	Outcomes	Findings
Hofman and Goris ¹⁷	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 58; ISS: EG-44, LG-36, P<.01; GCS: EG-4.6, LG-4.7, P>.05; major fractures: EG-100%, LG-53%, P<.01	mortality: EG-13%, LG-47%, P<.02; ICU LOS: EG-19, LG-9, P=.05; total LOS: same for EG & LG; GCS: same for EG & LG, P=.07	III all have severe brain injury EG same outcome as LG: total LOS, GCS EG better outcome than LG: mortality EG worse outcome than LG: ICU LOS EG worse outcome than LG: NR

BRAIN INJURY PATIENT GROUP (E=early; L=late; G=group); NR=not reported)			
Author	Patient Traits	Outcomes	Data Class Findings
Pooler et al. ²³	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 72; ISS: EG-28, LG-34, P=.06; GCS: EG-12, LG-10, P>.05	mortality: EG-4%, LG-0%, P=.2; CNS complications : EG-7%, LG-23%, P=.06; ARDS : EG-4%, LG-8%, P>.05; pulmonary complications : EG-42%, LG-58%, P=.2; FES : EG-2%, LG-4%, P>>.05; systemic infections : same for EG & LG; mechanical ventilation : same % for EG & LG	III severe brain injury mixed with moderate and mild <u>EG same outcome as LG</u> : mortality, CNS complications, ARDS, pulmonary complications, FES, infections, need for mechanical ventilation <u>EG better outcome than LG</u> : NR <u>EG worse outcome than LG</u> : NR
Bone et al. ¹	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 384; all patients had GCS 3-8 and a major fracture	mortality : EG-20%, LG-41%, P<.001	III all have severe brain injury Study is not useful.

BRAIN INJURY PATIENT GROUP (E=early; L=late; G=group); NR=not reported)			
Reynolds et al. ¹²	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 105; ISS: EG-27, LG-34, P<.05; GCS: EG-13.7, LG-8.6, P<.05; brain AIS: EG-1.96, LG-2.36, P<.05	mortality: EG-4.2%, LG-.0%, P>.05; CNS complications: EG-4%, LG-0%, P>.05; mechanical ventilation: EG-42%, LG-67%, P=.01; ventilator days: EG-7.1, LG-7.1, P=1.0; ICU LOS: EG-10.6, LG-9.4, P>.05; total LOS: EG-14.6, LG-21.9, NS; total LOS greater compared to group <24 hours; however, authors indicate "increased total LOS was related to greater degree of critical injury"	II severe brain injury mixed with moderate and mild EG same outcome as LG: mortality; ventilator days; ICU LOS; total LOS EG better outcome than LG: none that are not related to injury severity EG worse outcome than LG: NR

BRAIN INJURY PATIENT GROUP (E=early; L=late; G=group); NR=not reported)			
Author	Patient Traits	Outcomes	Data Class Findings
Sanker et al. ¹⁹	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 34; GCS 4-8	mortality: EG-59%, LG-12%, P<.01	III all have severe brain injury <u>EG same outcome as LG: NR</u> <u>EG better outcome than LG: NR</u> <u>EG worse outcome than LG: mortality</u>
Starr et al. ²⁰	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 32; GCS >8: n=15; ISS: EG-23, LG-30, P>.05; GCS: EG-14.9, LG-13, P>.05; head CT score: EG-2.0, LG-2.2, P>.05; GCS ≤8: n=17; ISS: EG-32, LG-34, P>.05; GCS: EG-6.2, LG-5.6, P>.05; head CT score: EG-2.0, LG-2.6, P>.05	GCS >8: no significant difference (P>.05) between early and late group for mortality, CNS complications, pneumonia, ventilator days, ICU LOS, and totalLOS; GCS ≤8: no significant difference (P>.05) between early and late group for mortality, CNS complications, pneumonia, ventilator days, ICU LOS, and totalLOS	III results segregated by severe and non-severe brain injury <u>EG same outcome as LG: mortality, CNS complications, pneumonia, ventilator days, ICU LOS, total LOS</u> <u>EG better outcome than LG: NR</u> <u>EG worse outcome than LG: NR</u>

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EVIDENTIARY TABLE

Must Be Polytrauma and Have An Early and Late Fixation Group

CHEST INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)			
Author	Patient Traits	Outcomes	Data Class Findings
Pelias et al. ²⁴	all femoral fractures - no; time of early fixation ≤48 hrs.; total patients 82; ISS: EG-25, LG-27, P>.05	mortality: EG-17%, LG-18%, P>.05; pulmonary complications: EG-28%, LG-29%, P>.05; ventilator days: EG-5, LG-5, P>.05; ICU LOS: EG-7, LG-7, P>.05	III EG same outcome as LG: mortality, pulmonary complications, ventilator days, ICU LOS EG better outcome than LG: NR EG worse outcome than LG: NR
Pape et al. ¹¹	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 50; ISS: EG-33, LG-32, P>.05; chest AIS: EG-3.3, LG-3.4, P>.05	mortality: EG-21%, LG-4%, P=.09; ARDS: EG-33%, LG-8%, P=.03; infections: EG-13%, LG-19%, P>.05; MOF: EG-8%, LG-0%, P>.05; pneumonia: EG-21%, LG-12%, P>.05; ventilator days: EG-10, LG-13, P>.05; ICU LOS: EG-11, LG-17, P>.05	III EG same outcome as LG: mortality, infections, MOF, pneumonia, ventilator days, ICU LOS EG better outcome than LG: NR EG worse outcome than LG: ARDS

CHEST INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)			
Author	Patient Traits	Outcomes	Data Class Findings
Fakhry et al. ⁸	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 96; EG and LG have femur fracture and chest AIS ≥3	mortality: EG-5%, LG-0%, P>.05; total LOS: EG-18, LG-29, P>.05	II EG same outcome as LG: mortality, total LOS EG better outcome than LG: NR EG worse outcome than LG: NR
Reynolds et al. ¹²	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 105; ISS: EG-27, LG-34, P<.05; chest AIS: EG-2.02, LG-2.07 P>.05; head AIS: EG-1.96, LG-2.36, P<.05; chest injuries: EG-42%, LG-61%, P=.04; LG has "higher incidence of major pulmonary injuries"	mortality: EG-4.2%, LG-.0%, P>.05; mechanical ventilation: EG-42%, LG-67%, P=.01; ventilator days: EG-7.1, LG-7.1, P=1.0; ICU LOS: EG-10.6, LG-9.4, P>.05; total LOS: EG-14.6, LG-21.9, P=NR; total LOS greater compared to group <24 hrs.; however, authors indicate "increased total LOS was related to greater degree of critical injury"	II EG same outcome as LG: mortality; ventilator days; ICU LOS; total LOS EG better outcome than LG: none that are not related to injury severity EG worse outcome than LG: NR

CHEST INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)			
Author	Patient Traits	Outcomes	Findings
Charash et al. ⁷	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 82; ISS: EG-27, LG-29, P>.05; chest AIS: EG-3.3, LG-3.4, P>.05; bilateral pulmonary contusions: EG-9%, LG-28%, P=.04; endotracheal intubation during resuscitation: EG-24%, LG-71%, P=.01; ISS >28: EG-17%, LG-82%, P<.01	mortality: EG-4%, LG-8%, P>.05; ARDS: EG-4%, LG-8%, P>.05; pulmonary complications: EG-16%, LG-56%, P<.01; pneumonia: EG-14%, LG-48%, P<.01; ventilator days: EG-6, LG-10, P>.05; ICU LOS: EG-9, LG-13, P>.05; total LOS: EG-20, LG-25, P>.05	II EG same outcome as LG: mortality, ARDS, ventilator days, ICU LOS, total LOS EG better outcome than LG: none that are not related to injury severity EG worse outcome than LG: NR

CHEST INJURY PATIENT GROUP (E=early; L=late; G=group; NR=not reported)			
Author	Patient Traits	Outcomes	Findings
Ziran et al. ²⁵	all femoral fractures - no; time of early fixation - groups <24 hrs, <48 hrs, <72 hrs, <5 days, or >5 days; total patients 59; patients with chest AIS ≥3 and extremity AIS ≥3	<u>pulmonary complications</u> : increased with delays in fracture fixation, odds ratio 3.2, P<.03	III EG same outcome as LG: NR EG better outcome than LG: pulmonary complications EG worse outcome than LG: NR
Boulangier et al. ¹⁵	all femoral fractures - yes; time of early fixation ≤48 hrs.; total patients 83; ISS: EG-30, LG-39, P>.05; chest AIS: EG-3.3, LG-3.7, P>.05	ARDS: EG-4%, LG-20%, P>.05	III EG same outcome as LG: ARDS EG better outcome than LG: NR EG worse outcome than LG: NR