Early intramedullary nailing of lower extremity fracture and respiratory function in polytraumatized patients with a chest injury

A retrospective study of 61 patients

Lauri E Handolin, Jarkko T Pajarinen, Jan E S Lassus and Ilkka T A Tulikoura

Department of Orthopedics and Traumatology, Helsinki University Central Hospital, Topeliuksenkatu 5, FI-00260 Helsinki, Finland
Correspondence LEH: lauri.handolin@hus.fi
Submitted 03-05-07. Accepted 03-12-01

Background The optimal treatment of diaphyseal fractures of the lower extremities in patients who also have serious chest injuries is not known.

Patients and methods We retrospectively evaluated the effect of an early intramedullary nailing (IMN) of femur or tibia fractures on respiratory function in 61 consecutive polytraumatized patients with unilateral or bilateral pulmonary contusion (thoracic AIS ≥ 3) admitted to our trauma intensive care unit between January 2000 and June 2001. 27 patients had a diaphyseal fracture of at least one long bone of the lower extremity, which was treated with IMN within 24 hours of admission.

Results We found no difference between patients with or without a lower extremity fracture regarding the length of ventilator treatment, oxygenation ratio (PaO_2/FiO_2) or in the incidence of acute respiratory distress syndrome (ARDS), pneumonia, multi-organ failure or mortality.

Interpretation In this retrospective study, IMN of a long bone fracture in a patient with multiple injuries and with a coexisting pulmonary contusion did not impair pulmonary function or outcome.

A lower extremity diaphyseal fracture, which is a relatively common finding in polytraumatized patients with high-energy blunt injuries, is usually not life threatening *per se*. However, these injuries, and timing of the treatment, may be important factors in the development of pulmonary complications (Bone et al. 1989, 1994, Behrman et al. 1990, Pape et al. 1993a, b).

The optimal treatment and the timing of diaphyseal fractures of lower extremities in patients with a concomitant serious chest injury is not known. Several reports have suggested that early operative fixation (EOF) does not increase pulmonary morbidity in chest trauma patients (Riska et al. 1976, van Os et al. 1994, Boulanger et al. 1997, Carlson et al. 1998, Dunham et al. 2001). Pelias et al. (1992) found that a long bone fracture per se predisposes patients with a blunt chest injury to increased pulmonary dysfunction, regardless of EOF. Reynolds et al. (1995) demonstrated that pulmonary complications were related to the severity of the trauma, rather than to the timing of the fracture fixation. It has also been suggested that lower extremity fractures should rather be externally fixated in the primary phase in polytraumatized patients (Nowotarski et al. 2000).

In this retrospective study, we evaluated the joint effect of a lower extremity diaphyseal fracture and an early IMN on respiratory function in a series of 61 polytraumatized patients with serious chest injury.

Patients and methods

We analyzed all polytraumatized patients (n = 61) with pulmonary contusion and a need for mechanical ventilation who were treated at our department between January 2000 and June 2001 (Table 1).

The outcome variables analyzed included days in mechanical ventilator, oxygenation ratio (PaO_2/FiO_2) with maximum PEEP (positive end expiratory pressure) during the first 72 hours and at the time of extubation, pulmonary complications (ARDS, fat embolism, pulmonary embolism, pneumonia), septicemia, multi-organ failure (MOF) and mortality.

Pulmonary contusion was diagnosed by thoracic CT scans. Brain injury was considered to be severe if the patient was unconscious at the scene of the accident. Hypovolemic shock was defined as metabolic acidosis (BE < 4.5 and HCO_3 < 20) and a systolic blood pressure < 90 mmHg. IMN was defined as being early if performed within 24 h. Operation time was determined to cover the whole period spent in the operating theatre.

ARDS was defined as decreased oxygenation ratio prolonged later than 72 hours after the trauma (PaO_2/FiO_2 ratio < 200 mmHg and PEEP > 6 cm H_2O) with concomitant bilateral diffuse changes on the chest radiograph without other signs of pneumonia. Pneumonia was defined as elevated CRP, positive bronchial culture and discrete infiltrate on chest radiograph. Fat embolism syndrome was defined as PaO_2/FiO_2 ratio < 200 mmHg and platelet count < 4 × 10^9/L with petechiae without pneumonia or other defined cause for ARDS. Pulmonary embolism was excluded by a chest spiral-CT scan in cases of clinical suspicion. The diagnostic criterion for MOF was a Sequential Organ Failure Assessment (SOFA) score of 8 or more. The criterion for cardiac contusion was elevated tnt (troponin-T > 0.1 μg/L) in the absence of myocardial infarction.

Table 1. Characteristics of 61 patients with a unilaeral or bilateral pulmonary contusion. Values are number and percentages or mean (range)

	Total (n = 61)		Fracture + IMN (n = 27)		No fracture (n = 34)	
Age [a]	38	(13–77)	39	(15–77)	38	(13–75)
Male sex	40	66	19	70	21	62
Mode of injury						
Car accident	25	41	10	37	15	44
Motorcycle accident	4	7	3	11	1	3
Pedestrian/vehicle	7	12	4	15	3	9
Falling	15	25	6	22	9	27
Crush injury	3	5	1	4	2	6
Miscellaneous	7	12	3	11	4	12
Injury severity score [a]	31	(18–56)	27	(18–48)	34	(18–56)
Lower extremity fracture						
Femur	22	36	22	81	0	0
Tibia	12	20	12	44	0	0
Thoracal injury						
Unilateral costal fracture	26	43	9	33	17	50
Bilateral costal fracture	12	20	7	26	5	15
Serial costal fracture	28	46	13	48	15	44
Flail chest	5	8	2	7	3	9
Cardiac contusion	17	28	6	22	11	32
Pulmonary contusion						
Unilateral	40	66	19	70	21	62
Bilateral	21	34	8	30	13	38
Severe head injury	14	23	8	30	6	18
Hypovolemic shock at adm	13	21	7	26	6	18
Duration (min) [a]	114	(15–240)	79	(15–210)	155	(60–420)

[a] mean (range)

Statistics

When numerical variables were compared, the statistical analysis included a comparison of calculated means with 95% confidence intervals between the groups. Values excluding the number 0 were considered to be statistically significant. For categorized variables, odds ratios with 95% confidence intervals were calculated. Values excluding the number 1 were considered to be statistically significant. P-values were calculated with Pearson Chi-square and likelihood ratio, and values < 0.05 were considered to be statistically significant.

Results (Table 2)

The average length of ventilator treatment in patients with IMN was 7.2 days, and 5.8 days in patients without IMN. This difference was not statistically significant (difference of means –1.3 days, 95% CI: –4.5 to 1.8, p = 0.40). 32 of the 61 patients had pulmonary shunting (PaO_2/FiO_2 ratio

< 200 mmHg) during the first 72 hours, but no significant difference between the groups was observed (odds ratio 0.5, 95% CI: 0.12–1.5, p = 0.2). This was also the case both with minimum PaO_2/FiO_2 ratio in the first 72 hours (difference of means –28, 95% CI: –98 to 41, p = 0.4) and PaO_2/FiO_2 ratio at the time of extubation (difference of means –3.6, 95% CI: –63 to 56, p = 0.9). ARDS, pneumonia and MOF were observed in 3, 13 and 6 patients, respectively, without any correlation to IMN. Only 1 patient had fat embolism syndrome (no lower extremity fracture), and pulmonary embolism was not observed in our series. 9 patients had sepsis during the ICU period. Mortality in the initial phase, for various reasons, was 7% (4 patients).

Table 2. Respiratory function and complications in 61 patients with pulmonary contusion. Values are number and percentages or mean (range)

	Fracture + IMN (n = 27)		No fracture (n = 34)	
Within 72 hours of injury				
Lowest PaO_2/FiO_2 ratio [a]	247	(85–534)	215	(42–589)
PaO_2/FiO_2 <200 mmHg	17	63	15	44
Days in ventilator [a]	7.2	(0–36)	5.8	(0–15)
PaO_2/FiO_2 ratio at extubation [a]	326	(117–587)	322	(168–639)
ARDS	1	4	2	6
Pneumonia	7	26	6	18
Fat embolism syndrome	0	0	1	3
Pulmonary embolism	0	0	0	0
Multi-organ failure	1	4	5	15
Sepsis	5	19	4	12
Mortality	1	4	3	9

[a] mean (range)

Discussion

Pulmonary contusion, caused by a blunt chest trauma, is considered to be one of the most important risk factors for the eventual development of ARDS (Charash et al. 1994). A systemic post-injury inflammatory response (SIR) may, together with additional stress factors such as IMN, predispose polytraumatized patients to post-traumatic pulmonary complications (Cohn and Zieg 1996, Giannoudis et al. 1998).

In this study, the inclusion criterion was pulmonary contusion, not high ISS or severe polytrauma per se. The idea behind this study was not to compare early nailing to late nailing, but to find out whether there was any evidence that a combination of diaphyseal lower extremity fracture and early IMN might compromise pulmonary function compared to patients having a similar thoracic injury pattern but no femoral or tibial fracture. It is not possible to evaluate the effect of early IMN alone by this study protocol, but it is possible to evaluate the joint effect of fracture and early nailing.

Half of our patients had remarkably reduced oxygenation ratio (PaO_2/FiO_2 < 200 mmHg) within 72 hours of the injury, indicating that blunt trauma per se may cause clinically significant disturbances in pulmonary function during the first days after trauma. However, we did not observe any statistically significant differences between the two groups, indicating that there were no obvious immediate harmful effects of fracture and IMN. In addition to early-phase adverse effects, blunt trauma and lower extremity diaphyseal fracture treated with IMN may compromise pulmonary function during a later intensive care period. In this study the two groups had a similar incidence of later phase complications, indicating that fracture and IMN did not increase that risk.

Although patients without a lower extremity fracture had a higher ISS, presumably caused by a higher incidence of severe abdominal injuries, the thoracic injury pattern was similar. This may, of course, have had an influence on the results. It should also be acknowledged that in larger series, some differences in outcome variables may have become statistically significant. These injuries and their complications are quite rare, but still multifactorial, which means that randomized trials face considerable methodological difficulties. Also, the results achieved with modern intensive care treatment need to be further discussed.

We conclude that in patients with pulmonary contusion, it appears that early intramedullary nailing of lower extremity diaphyseal fractures is not associated with deterioration of pulmonary function.

No competing interests declared.

Behrman S W, Fabian T C, Kudsk K A, Taylor J C. Improved outcome with femur fractures: early vs. delayed fixation. J Trauma 1990; 30 (7): 792-7.

Bone L B, Johnson K D, Weigelt J, Scheinberg R. Early versus delayed stabilization of femoral fractures. A prospective randomized Study. J Bone Joint Surg (Am) 1989; 71 (3): 336-40.

Bone L B, McNamara K, Shine B, Border J. Mortality in multiple trauma patients with fractures. J Trauma 1994; 37 (2): 262-4.

Boulanger B R, Stephen D, Brenneman F D. Thoracic trauma and early intramedullary nailing of femur fractures: are we doing harm? J Trauma 1997; 43 (1): 24-8.

Carlson D W, Rodman G H Jr., Kaehr D, Hage J, Misinski M. Femur fractures in chest- injured patients: is reaming contraindicated? J Orthop Trauma 1998; 12 (3): 164-8.

Charash W E, Fabian T C, Croce M A. Delayed surgical fixation of femur fractures is a risk factor for pulmonary failure independent of thoracic trauma. J Trauma 1994; 37 (4): 667-72.

Cohn S M, Zieg P M. Experimental pulmonary contusion: review of the literature and description of a new porcine model. J Trauma 1996; 41 (3): 565-71.

Dunham C M, Bosse M J, Clancy T V, Cole F J Jr., Coles M J, Knuth T, Luchette F A, Ostrum R, Plaiser B, Poka A, Simon R J. The EAST Practice Management Guidelines Work Group. Practice management guidelines for the optimal timing of long-bone fracture stabilization in polytrauma patients: the EAST Practice Management Guidelines Work Group. J Trauma 2001; 50 (5): 958-67.

Giannoudis P V, Smith R M, Banks R E, Windsor A C, Dickson R A, Guillou P J. Stimulation of inflammatory markers after blunt trauma. Br J Surg 1998; 85 (7): 986-90.

Nowotarski P J, Turen C H, Brumback R J, Scarboro J M. Conversion of external fixation to intramedullary nailing for fractures of the shaft of the femur in multiply injured patients. J Bone Joint Surg (Am) 2000; 82 (6): 781-8.

Pape H C, Regel G, Dwenger A, Sturm J A, Tscherne H. Influence of thoracic trauma and primary femoral intramedullary nailing on the incidence of ARDS in multiple trauma patients. Injury (Suppl 3) 1993a; 24: 82-103.

Pape H C, Auf'm'Kolk M, Paffrath T, Regel G, Sturm J A, Tsherne H. Primary intramedullary femur fixation in multiple trauma patients with associated lung contusion – a cause of posttraumatic ARDS? J Trauma 1993b; 34 (4): 540-7.

Pelias M E, Townsend M C, Flancbaum L. Long bone fractures predispose to pulmonary dysfunction in blunt chest trauma despite early operative fixation. Surgery 1992; 111 (5): 576-9.

Reynolds M A, Richardson J D, Spain D A, Seligson D, Wilson M A, Miller F B. Is the timing of fracture fixation important for the patient with multiple trauma? Ann Surg 1995; 222 (4): 470-8.

Riska E B, von Bonsdorff H, Häkkinen S, Jaroma H, Kiviluoto O, Paavilainen T. Prevention of fat embolism by early internal fixation of fractures in patients with multiple injuries. Injury 1976; 8 (2): 110-6.

van Os J P, Roumen R M, Schoots F J, Heystraten F M, Goris R J. Is early osteosynthesis safe in multiple trauma patients with severe thoracic trauma and pulmonary contusion? J Trauma 1994; 36 (4): 495-8.