

The Effect of Trauma Team Approach on the Management of Hemodynamically Unstable Pelvic Bone Fracture: Retrospective Comparative study

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Purpose: The major pelvic trauma results in high mortality with associated fatal other injuries. During early stage of resuscitation, multidisciplinary approach is essential to improve the survival and outcomes. This study aims to report the effect and positive outcome of the trauma team approach on the management of hemodynamically unstable pelvic bone fracture.

Methods: This retrospective review included all patients with hemodynamically unstable pelvic bone fracture admitted between March 2007 and December 2015. Patients were divided into group A, which comprised those admitted before the trauma team approach was started, and group B, which comprised those admitted after the approach was started. The advanced trauma life support protocol was followed for all patient. The comparisons between the two groups were based on medical records. Study variables included demographics, initial vital sign, injury severity score, fracture type, and injury mechanism. We analyzed the outcomes in each group with respect to the time interval for doctors' arrival, total length of stay in the emergency department (ED), time interval for computed tomography evaluation, 24-hour mortality, time interval for definitive fixation, and definitive fixation in the time-window of opportunity.

Results: Fifty-three patients met the inclusion criteria. No statistically significant differences in demographic data existed between the two groups. The time interval for doctors' arrival (min, 63.09 ± 50.48 vs 21.48 ± 17.75 ; $p=0.038$) and total length of stay in the ED (min, 269.33 ± 105.96 vs 115.49 ± 56.24 ; $p=0.023$) were significantly improved. The 24-hour mortality was not significantly different between the two groups. ($\%$, 14.3 vs 12.0; $p=1.000$) However, the time interval for definitive fixation and definitive fixation in the time-window of opportunity showed better results.

Conclusion: The trauma team approach has positive effects, which include initial resuscitation through multidisciplinary approach and shortening the time interval to definitive fixation, on the management of hemodynamically unstable pelvic bone fracture. [J Trauma Inj 2016; 29: 139-145]

Key Words: Pelvis, Trauma, Fracture

I. Introduction

Pelvic bone fractures are present in more than 3% of all fracture patients and 25% of all polytraumatized patients.(1,2) They are usually caused by high-

energy external force and frequently combined with associated injuries involving the abdomen, chest, or brain. The mortality of hemodynamically unstable pelvic bone fracture has been reported to be as low as 5-10% and as high as 50% to 60%.(3-5) Without

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optimal initial resuscitation for those patients at the early stage, hemorrhage shock can lead to death. To improve the survival of these patients and achieve favorable outcome, prompt initial hemorrhage control and multidisciplinary approach for the assessment of associated injuries are essential.(6)

Recently, a number of articles have suggested a protocol that focuses on multidisciplinary approach for the management of patients with hemodynamic instability due to pelvic bone fracture. Clinical practice guidelines of pelvic trauma in almost every trauma center and university hospital in Korea are generally individualized according to their facilities and medical faculties.(7,8) These health institutions organize a specialist trauma team, which is composed of experienced clinicians, involving multiple departments to provide rapid care and early decisions at the resuscitation stage.(9,10) A number of previous studies about outcome of trauma team reported overall positive improvement despite different results in total length of stay in the emergency department (ED) and 24-hour mortality.(11-13) There are still few hospitals that manage these patients in a single department.

A specialized trauma team was set-up on March 2014, and trauma urgent treatment processing system (UTPS) was implemented. In the following year, a focused training center for trauma supported by government fund was established and a specialized trauma surgery department was set-up. Prior to the establishment of the trauma team, initial resuscitation for hemodynamically unstable pelvic bone fracture patient was started by a clinician from the ED. A respective department resident was then called to attend the patient for further management. Other departments were not completely coordinated at the initial management stage; instead, they took a concertation after admission was decided. Resuscitation and early decision making were mainly performed by a junior resident on duty. This treatment pathway is common in general university hospitals in Korea, which cannot react quickly to rapidly changing medical situations. No published study has compared trauma team approach with department management for hemodynamically unstable pelvic bone fracture.

Therefore, the purpose of this study was to evaluate the positive effect of trauma team approach on the management of hemodynamically unstable pelvic ring injury. We also reviewed the factors that affect the outcome to suggest a suitable improvement direction for the treatment pathway of severely traumatized patients.

II. Materials and Methods

1. Patients and Methods

This university hospital was designated as a focused training center for trauma on March 2014, and specialized trauma team and trauma UTPS were then actively initiated. The medical records of hemodynamically unstable pelvic bone fracture patients were divided into two groups according to their admission period. Group A comprised patients admitted from March 2007 to February 2014 before the trauma team approach was started, and group B comprised those admitted from March 2014 to December 2015 after the approach was started.

There was no specialized trauma medical record database system. Therefore, we reviewed and assembled the patient medical records retrospectively, who were performed surgical treatment, who were taken pelvic bone or abdomen CT scan in emergency department, who were expired in emergency department by trauma, who underwent emergency angiography and embolization and who was diagnosed with pelvic bone fracture in emergency department.

The inclusion criteria for this study were patients above 18 years of age with pelvic bone fracture and who had initial resuscitation according to ATLS protocol at this hospital. Patients who presented with hemodynamic instability were also included. Hemodynamic instability was defined as the presence of one or more following criteria: persistent systolic blood pressure <90 mmHg or mean arterial pressure <65 mmHg (after receiving 2 L of intravenous crystalloid), significant transfusion requirement at least 6 units of red blood cells (RBCs) during resuscitation.(14,15) Patients who did not fulfill inclusion criteria or who arrived after 12 hours from injury were excluded from the analysis.(16)

The following demographic variables were collected and evaluated in both groups: Age, Sex, Fracture classification (Tile classification), (17) Injury Severity Score (ISS), Revised Trauma Scale (RTS), Systolic blood pressure, Mean arterial blood pressure, Heart rate, injury mechanism, Type of admission, Lactate level (mmol/L), Base excess level (mmol/L).

We analyzed outcomes in each group with respect to Time interval for admission order (min), Time interval for CT evaluation (min), Total length of stay in ED (min), Total length of stay in ICU (days), 24-hour transfusion of packed RBCs (unit), 24-hour mortality, Time interval for definitive fixation (days), and Definitive fixation in the time-window of opportunity.

2. Trauma team approach and activation

The specialized trauma team, which had been actively operated since March 2014, is composed of experienced clinicians from the emergency, trauma surgery, orthopedic, chest surgery, neurosurgery, plastic surgery, and urological surgery departments. In contrast to the previous treatment pathway, which

is based on primary survey by a resident and a step-by-step notification system, the primary survey is performed by an emergency care specialist and a specialized trauma team is operated depending on trauma UTPS activation.(7)

The criteria for trauma UTPS include the following: (1) systolic blood pressure <90 mmHg in adults; (2) requirement of intubation or transferred with intubation; (3) body trunk or extremity injuries with Glasgow coma scale <13; (4) unstable pelvic bone fracture; (5) degloving injuries; (6) multiple fractures; (7) penetrating neck or trunk injuries; and (8) fall from a height above 5 m in adults.

When a patient meets the criteria, the trauma UTPS is activated. The patient is classified as severely traumatized patient by highlighting with red on the order communication system (OCS), and a pop-up text box shows "Trauma UTPS". The basic information of the patient is sent to all the trauma team members' cellular phones via SMS, and further clinical information is transmitted a few minutes later from the trauma coordinator (Fig. 1).

In general, clinical departments that need to be called were selected by an emergency care specialist

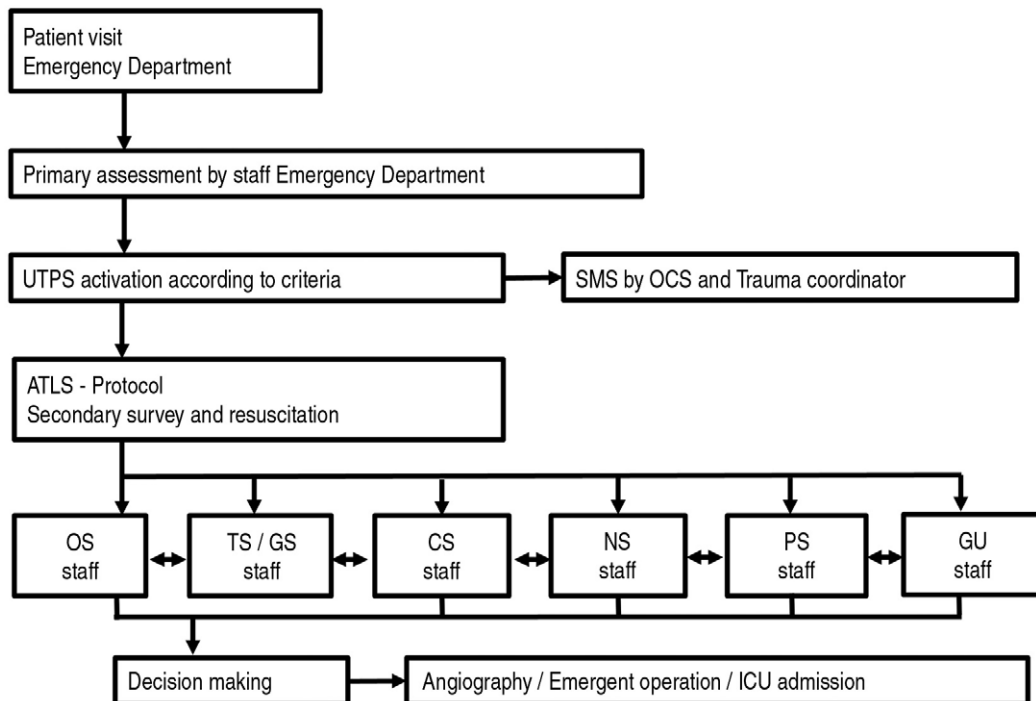


Fig. 1. Flow chart of trauma team approach. UTPS: urgent treatment processing system, SMS: short message service, OCS: order communication system, ATLS: advanced trauma life support, OS: orthopaedic surgery, TS: trauma surgery, GS: general surgery, CS: chest surgery, NS: neurosurgery, PS: plastic surgery, GU: genitourinary surgery, ICU: intensive care unit

depending on injury regions and diagnosis. However, the trauma surgery department is always on standby as a residual duty and participates in initial resuscitation. The orthopedic or other departments should come to the ED and proceed secondary survey within 30 min after UTPS activation. The treatment pathway for hemodynamically unstable pelvic bone fracture patients is based on advanced trauma life support (ATLS) guidelines.

3. Statistical Analysis

The primary endpoint of this analysis was to evaluate the effectiveness of the trauma team approach on the management of hemodynamically unstable pelvic bone fracture patient. SPSS 20.0 software package (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Descriptive statistical methods were applied to analyze the demographic information of patients. Independent t-test, Chi-square, and fisher exact test were performed for comparisons between the two groups. A *p* value <0.05 was considered statistically significant. Unless otherwise

noted, data are presented as mean ±SD.

III. Results

1. Demographic data

Fifty-three patients met the inclusion criteria between March 2008 and December 2015. Among these, 28 patients were enrolled in group A and 25 patients in group B. Comparison of demographic data showed that no significant difference was found in mean age, sex, and fracture type (Tile classification). Traffic accident was the most common injury type. No statistically significant differences were also found between each groups regarding Systolic blood pressure, Mean arterial blood pressure, ISS, RTS, Lactate level and Base excess level (Table 1).

2. Outcome data

The time interval for doctors' arrival (min, 63.09±50.48 vs 21.48±17.75; *p*=0.038) and admission order (min, 153.55±94.85 vs 60.73±32.66; *p*=0.019) were

Table 1. Demographic data of patients

	Before (N=28)	After (N=25)	<i>p</i> -value
Age (years)	56.35 ± 17.31	54.08 ± 21.93	0.362 †
Sex (M/F)	20/8	21/4	0.337 §
Fracture type (Tile)			0.229*
A	3	3	
B	17	13	
C	8	9	
Trauma type			0.513*
Traffic	20	17	
Fall from > 3 m	6	7	
Fall from < 3 m	1	1	
Others	1	0	
Type of ED admission			0.404*
Primary visit	26	21	
Transfer	2	4	
Initial SBP (mmHg)	84.52 ± 31.7	85.33 ± 28.3	0.625 †
Initial MAP (mmHg)	72.12 ± 28.3	62.33 ± 24.7	0.505 †
RTS	6.49 ± 0.82	6.31 ± 0.73	0.892 †
ISS	25.8 ± 14.36	22.86 ± 13.45	0.867 †
Lactate level (mmol/L)	5.17 ± 2.51	4.21 ± 3.35	0.369 †
Base excess level (mmol/L)	-5.43 ± 3.81	-7.63 ± 6.62	0.254 †

† Independent t-test

§ Chi-square test

* Fisherman's exact test

significantly improved. The total length of stay in ED (min, 269.33 ± 105.96 vs 115.49 ± 56.24 ; $p=0.023$) was significantly shortened. However, no difference was observed in the time interval for CT evaluation, total length of stay in ICU, and 24-hour transfusion of packed RBCs. The 24-hour mortality was also not significantly different between the two groups (% 14.3 vs 12.0; $p=1.000$). By contrast, significantly better results were found in the time interval for definitive fixation (days, 7.63 ± 4.17 vs 5.15 ± 2.63 ; $p=0.031$) and definitive fixation in the time-window of opportunity (% 54.2 vs 86.4; $p=0.026$) (Table 2).

IV. Discussion

This study shows that the time interval for doctors' arrival, time interval for admission order, and total length of stay in ED were improved significantly more than 2 or 3 times after the trauma team approach.

Prior to the establishment of the trauma team approach, the treatment pathway was initiated by on-duty residents who were responsible for the visiting patients in the ED. However, the effectiveness of the previous system in managing new traumatized patients is remarkably limited because the on-duty or on-call doctors are usually assigned to another main job in the wards or out-patient clinic at the same time. A traumatized patient who visits the ED always becomes an additional burden to the on-duty doctor in any department. It is difficult to flexibly convert rde from a routine job. Furthermore, it was a time-consuming process that on-duty doctor had

visited ED following a call from an intern of the ED consequently. After the trauma team approach, trauma specialists in each department are taking on a duty. They obtain direct and rapid contact from a trauma coordinator or digital call system without a cumbersome reporting process when there is a patient. This change of process remarkably shortened the interval time for doctors' arrival. Furthermore, through trauma team specialists, precise assessment and rapid management at resuscitation stage were available.

In the previous system, deciding which department is responsible and admitting a severely multiple traumatized patient are difficult. There were delays in decision making because of arguments among residents in each associated department. They shifted the admission of a patient to another department, which was considered more priority for management, or waited for a confirmation from a senior resident or faculty. Nevertheless, the patient was admitted to the priority department; managing associated injuries was ineffective and discontinuous due to the lack of close connection for consulting another relevant department after admission. These factors contribute to the increase in the total length of stay in the ED inevitably. After the trauma team approach, specialists from each department, who have main roles, perform initial management and create an overall treatment plan simultaneously through direct communication during the stay in the ED. Therefore, the admission was confirmed rapidly, and the management could be continuous and effective by simultaneous multidisciplinary approach.

The results showed a statistically significant improve-

Table 2. Comparison of outcomes

	Before (N=28)	After (N=25)	p-value
Time interval for doctors' arrival (min)	63.09 ± 50.48	21.48 ± 17.75	0.038 [†]
Time interval for admission order (min)	153.55 ± 94.85	60.73 ± 32.66	0.019 [†]
Time interval for CT evaluation (min)	64.31 ± 47.54	40.53 ± 23.75	0.235 [†]
Total length of stay in ED (min)	269.33 ± 105.96	115.49 ± 56.24	0.023 [†]
Total length of stay in ICU stay (days)	18.30 ± 10.53	12.15 ± 4.47	0.214 [†]
24-hour transfusion of packed RBCs (unit)	8.72 ± 6.51	7.38 ± 5.35	0.932 [†]
24-hour mortality	14.3% (4/28)	12.0% (3/25)	1.000 [§]
Time interval for definitive fixation (days)	7.63 ± 4.17	5.15 ± 2.63	0.031 [†]
Definitive fixation in the time-window of opportunity	54.2% (13/24)	86.4% (19/22)	0.026 [§]

[†] Independent t-test

[§] Fisherman's exact test

ment of the time interval for definitive fixation. The percentage for the definitive fixation in the time-window of opportunity was 86.4% after the trauma team approach ($p=0.026$).

Due to the lack of a systematic process to multi-disciplinary approach, there was always limitation in the management and difficulty in being assisted by other departments for complicated medical problems including hemodynamic instability after ICU admission. After the trauma team approach, multiple clinical departments, which were initially involved at resuscitation stage, voluntarily performed further management and observation without any request of consultation. Also, there was regular inter-department conference for polytraumatized patient to decide treatment plan and to review previous management. Consequently, the prognosis of a patient can be improved. This was a great achievement by composition of trauma team approach.

In general, management of hemodynamically unstable pelvic ring injury proceeds in two stages. The first stage is composed of rapid resuscitation according to ATLS and assessment of resuscitation response. When the initial resuscitation is unsuccessful due to continuous uncontrolled bleeding, we performed the compression of the pelvic ring by pelvic packing and interventional angiography with embolization. In the second stage, following a successful resuscitation, we perform definitive fixation at the day of injury, or after a suitable "window of opportunity", which is from 5 to 10 days after injury, in view of immunology. (18,19) A surgery past the window of opportunity can worsen a medical condition by acting like a secondary hit to the immunosuppressive physiology of a patient. Therefore, definitive fixation of unstable pelvic ring injury in the window of opportunity is closely related to prognosis. (18-21)

The results showed no significant difference of the 24-hour mortality between the two groups. (% 14,3 vs 12,0; $p=1,000$) Initially, we expected more favorable outcome of the 24-hour mortality from trauma team approach than before. However, there was no obvious difference from the data which was collected in a short period. But, what we have experienced from trauma team is that the improvement in the treatment process and quality can make better outcome

of the mortality than before. Further study that involves more patients and longer study period should be considered to achieve statistically significant differences.

This study has several limitations. First, we enrolled a small number of patients in a short period. Second, the result indices were not standardized. Several analyzed factors were weighed; the management process was insufficient to show the management outcome. Third, there may be a possible omission of additional factors due to incomplete data, which had not been recorded systematically before this study. We are currently building a recording system for trauma patients, which will help improve subsequent studies. Forth, there was no data analysis on the data of number and type of emergent operations between the treatment group. Fifth, the functional score and complication rate after operation were not evaluated although those index can show the improvement of outcome.

The most significant result of this study is the confirmation of better management of severely traumatized patients through the trauma team approach, which is based on manpower. Our hospital had relatively sufficient orthopedic trauma specialists compared with other hospitals. We built an effective duty system for emergent operation that focused on hemodynamically unstable pelvic bone fracture patients by modifying a previous system several times. These factors may positively affect the outcome of this study.

One of the strong advantages of the trauma team approach was the satisfactory outcome without additional support of medical facilities with comprehensive medical care. Although manpower, such as trauma specialists from each department, and financial fund for the operating trauma team are definite prerequisites, it is difficult to equip using bootstrap from a university hospital or medical center. An institutional framework with active support from government and a standardized trauma management protocol are essential for favorable improvement.

V. Conclusion

The trauma team approach has positive effects, which include initial resuscitation through multidis-

ciplinary approach and shortening the time interval to definitive fixation, on the management of hemodynamically unstable pelvic bone fracture.

The outcome of the trauma team approach is greater than the total result of each clinical department's effort on the management of hemodynamically unstable pelvic bone fracture, including initial resuscitation, multi-disciplinary decision making, reduction of time to definitive fixation, and definitive fixation in the time-window of opportunity. This achievement was accomplished by the modification of the treatment pathway and the effort of faculties from each department without additional support of medical resources and expansion of facilities.

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