



Significance of orthopedic trauma specialists in trauma centers in Korea

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Abstract

Introduction In 2012, the Korean central government selected trauma centers to provide effective treatment and reduce preventable mortality in severe trauma patients. General surgeons, thoracic surgeons, orthopedists, and neurosurgeons play pivotal roles in trauma centers, as most trauma patients require orthopedic procedures. This study aimed to underscore the importance of trauma orthopedic specialists (TOSs) by comparing treatment outcomes between a TOS and general orthopedists.

Patients and methods Orthopedic trauma patients with injury severity scores > 15 points, admitted to level 1 trauma centers between March 2015 and December 2016, were divided into the TOS group (treated by 1 orthopedic trauma specialist who treats trauma patients with no limitation in the joint of specialization) and the general orthopedist group (GOG; treated by several general orthopedists who manage both trauma and disease but are each specialized in a certain joint). Emergency room response time, triage time, surgical preparation time, number of surgeries per patient, intensive care unit (ICU) duration, complications, and mortality were retrospectively analyzed.

Results Among 272 patients, 52 were treated by a TOS and 220 were treated by several general orthopedists. For the TOS group and the GOG, the average emergency room response time was 8 and 32 min; average triage time, 27 and 162 min; average surgical preparation time, 141 and 350 min; average number of surgeries per patient, 1.9 and 2.7; and average ICU duration, 8.5 and 12.2 days, respectively. The TOS group saved \$2700 per patient. No statistical differences were found in complications and mortality between the 2 groups.

Conclusions TOSs can provide rapid treatment to trauma patients and systemically participate in collaborative treatment with other specialists in a trauma center. As treatment provided by a TOS can also reduce the ICU duration, TOSs can play an important role in rapid rehabilitation and cost reduction for trauma patients.

Keywords Orthopedic trauma · Orthopedic trauma specialist · General orthopedist · Korea

Introduction

Severe trauma patients include those with an injury severity score (ISS) of > 15 points with accompanying life-threatening multiple traumas requiring initial aggressive treatments, according to advanced trauma life support (ATLS) protocols [1, 2]. Orthopedic trauma patients commonly present with fractures of the arm, leg, and pelvis as well as skeletal fractures in the regions of the head, thorax, and abdomen [3]. The severity of these injuries requires that trauma orthopedic specialists (TOSs) treat these patients, as is the practice in major developed countries including the United States and European countries [2, 4, 5].

In Korea, the central government recognized the urgent need to provide specialized intensive care units (ICUs)

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and trauma specialists for treating severe trauma patients [6]. Therefore, 16 regional trauma centers were designated across the country as established emergency medical service systems for severe trauma, with the aim of reducing the preventable mortality of trauma patients to $\leq 20\%$ by 2020. Owing to financial and political issues, the trauma centers are operated utilizing existing facilities with university hospital employees and with government financial aid rather than establishing independent trauma centers [7]. This new policy resulted in the emergence of a small number of TOSs who are specialized in treating multiple musculoskeletal traumas and work in trauma centers, as opposed to their conventional counterparts who practice within specialized areas of expertise.

Not every hospital with a trauma center has TOSs. Furthermore, there are only a few TOSs who have chosen severe orthopedic trauma as their specialty during their fellowship. Most trauma patients are treated in orthopedic departments of hospitals; however, even in hospitals with trauma centers, only a few musculoskeletal trauma patients are treated by TOSs. Some physicians who are accustomed to the existing orthopedic system question the need for orthopedists specializing in trauma and are anxious about intrusions into their specialty. However, there is a need for trauma physicians who specialize in treating patients with multiple fractures involving various joints and bones with soft tissue damage.

Except for developed countries including the United States and some in Europe, specialized trauma centers for trauma patients are lacking or are currently still being established [8–10]. Despite differences in the medical environment of each country, comparing and analyzing the treatment outcomes provided by a TOS and by general orthopedic surgeons in Korea will allow for a discussion of

common issues, including whether or not TOSs are required, the role of TOSs, and the most ideal structure of a trauma center. Issues that occurred during the establishment and operation of initial Korean trauma centers can be useful in the establishment of additional trauma centers in the future [11].

To address some of these issues, the entire treatment procedure (from the first visit of a severe trauma patient presenting with musculoskeletal trauma to the final discharge) was compared and analyzed between the treatment provided by a TOS and that provided by general orthopedists. This helps in establishing the desired role of a TOS and aids in the developmental planning for future trauma centers.

Patients and methods

A total of 272 patients who visited a level 1 trauma center (as determined by the Korean central government) with an ISS of > 15 points and an orthopedic trauma in at least 1 body region, were treated between March 2015 and December 2016, and completed follow-up for ≥ 1 year were included in this study. The patients underwent treatment and surgery provided by either a TOS (orthopedic trauma specialist who treats trauma patients with no limitation in the joint of specialization) or several general orthopedists (who treat both trauma and disease but are each specialized in a certain joint) (Table 1). The patients were divided into two groups: the TOS group (52 patients treated by 1 TOS) and the general orthopedist group (GOG; 220 patients treated by 7 different orthopedists, each of whom is specialized in a certain joint). The 272 patients (205 men, 67 women) had an average age of 44.8 years (range 18–81 years).

Table 1 General characteristics of patients

Parameter	TOS group ($n = 52$)	GOG ($n = 220$)	<i>P</i> value
Average age	48.5 years (range 20–77 years)	43.2 years (range 18–81 years)	0.198
Sex			
Male	34 patients	171 patients	0.398
Female	18 patients	49 patients	0.274
Mechanism of injury			
Traffic accident	25 patients	121 patients	0.165
Fall	16 patients	57 patients	0.154
Direct blunt trauma	5 patients	31 patients	0.276
Miscellaneous	6 patients	11 patients	0.547
Average injury severity score	21.57 points (range 16–50 points)	23.32 points (range 16–53 points)	0.287
Vital sign			
Stable	35 patients	131 patients	0.258
Unstable	17 patients	89 patients	0.554

TOS trauma orthopedic specialist, GOG general orthopedist group

After securing the patients' airway, breathing, and circulation upon admittance to the emergency room and treating them according to ATLS guidelines, the emergency room response time, triage time, time interval from the emergency room to the operating room (i.e., surgical preparation time, when an emergency operation was required), number of surgeries per patient, number of collaborative treatments during the hospitalization, duration of ICU hospitalization, complications, and mortality were retrospectively analyzed based on the medical records.

To analyze the treatment outcomes between the 2 groups, Fisher's exact test was used and P values < 0.05 were considered statistically significant. The Statistical Package for the Social Sciences (SPSS) version 12.0 (SPSS, Inc., Chicago, IL, USA) was used for the statistical analyses.

Results

The average response time for TOSs and general orthopedists was 8 min (range 0–21 min) and 32 min (range 15–71), respectively. TOSs were able to respond to the patients immediately, whereas the group of general orthopedists was called after the primary treatment has been provided by a resident. The average time spent from admission to the emergency room to determining the treatment plan including surgery and hospitalization was 27 min (range 3–42 min) in the TOS group and 162 min (range 57–272 min) in the GOG. In the TOS group, a treatment plan was established immediately after taking a radiograph, and a prompt response

was given even if radiography was not possible because of extremely unstable vital signs. On the other hand, in the GOG, the patient's condition was reported by a resident to a fellow, then to a professor. The treatment plan was conveyed from the professor to a fellow, then to the resident who initiated the treatment. The average elapsed time from determining the need for surgery to the transfer of the patient to the operation room was 141 min (range 75–255 min) in the TOS group and 350 min (range 201–507) in the GOG (Table 2). The average number of orthopedic surgeries conducted for one patient was 1.9 (range 1–4) in the TOS group and 2.7 (range 1–6) in the GOG. This difference occurred because TOSs could reduce multiple fractures and pelvic fractures during one surgery depending on the patient's condition, whereas each orthopedic surgeon in the GOG arranged their own surgery. Occasionally, several separate orthopedic surgeries for each body region were required. In addition, complications that occurred during the hospitalization included two cases of infection in the TOS group and five cases of infection in the GOG. Eight patients in the TOS group and 27 patients in the GOG died; however, none of these deaths were due to orthopedic trauma. The deaths were due to hypovolemic shock in the early stages of admission, acute respiratory distress syndrome, multiple organ failure, and/or disseminated intravascular coagulation in the later stages of hospitalization. The average ICU duration was 8.5 days in the TOS group and 12.2 days in the GOG, which resulted in an average increased patient cost burden of \$2700 more per patient in the GOG. The short ICU duration in the TOS group was considered to be the result of the ability of the

Table 2 Comparison of treatment outcomes between the TOS group and GOG

Parameter	TOS group ($n=52$)	GOG ($n=220$)	P value
Average time spent waiting for the doctor's arrival	8 min (range 0–21 min)	32 min (range 15–71 min)	0.007
Average time spent for treatment plan decision making	27 min (range 3–42 min)	162 min (range 57–272 min)	0.011
Average time spent from the emergency room to the operation room	141 min (range 75–255 min)	350 min (range 201–507 min)	0.005
Average time spent from the emergency room to the ward	201 min (range 62–175 min)	420 min (range 314–711 min)	0.013
Total number of emergency surgeries	17 surgeries	45 surgeries	
Average number of surgeries per patient	1.9 surgeries (range 1–4 surgeries)	2.7 surgeries (range 1–6 surgeries)	0.089
Average number of consultations per patient during their hospitalization	5.7 consultations (range 2–8 consultations)	8.3 consultations (range 3–12 consultations)	0.091
Average number of days in the ICU per patient	8.5 days (range 3–28 days)	12.2 days (range 3–31 days)	0.041
Average duration of hospitalization per patient	17.2 days (range 13–45 days)	21.7 days (range 12–51 days)	0.064
Complications	2 cases of infection	5 cases of infection	
Total number of deceased patients	8 patients	27 patients	0.075

TOS trauma orthopedic specialist, GOG general orthopedist group, ICU intensive care unit

TOS to systematically evaluate the entire condition of the patient before, during, and after the surgery.

Discussion

This study showed that the prompt and systematic multidisciplinary treatment offered by a TOS results in a more efficient treatment of severe trauma patients. Many severe trauma patients die of hypovolemic shock at the initial stage [3, 4]. It is well known that there is a “golden time” for treatment during multiple organ injury, and this study shows that TOSs can make decisions about the treatment plan and promptly conduct treatment [12].

Although the term “trauma” covers a considerably large portion of the field of orthopedics, both accidents and the demand for trauma-specialized labor and equipment, which requires a large budget, are not predictable [13]. Furthermore, patients who require major surgeries are often financially constrained and experience difficulties in paying for medical expenses. Moreover, as private hospitals need to secure a certain amount of profit, treating trauma patients can be a burden for these institutions. Therefore, the central government of Korea considers trauma as a public issue and has assigned 16 trauma centers across the country, in an effort to increase the opportunity for patients to be treated by TOSs with the aid of government subsidies [6].

The treatment of trauma patients, as part of public health care, should receive support and cooperation from all hospital members of the existing system; however, some conflicts occur. Existing general orthopedists in private university hospitals are reluctant to adopt such a system, as they believe that the reduced number of trauma patients in their department will result in a reduction in the number of surgeries and hospitalized patients, thereby reducing the total income of the department, and that the traditional system is sufficient for treating severe trauma patients. In addition, trauma centers are operated with the cooperation of numerous other departments including neurosurgery, thoracic and cardiovascular surgery, general surgery, and orthopedics, yet no resident belongs to the department of orthopedic trauma. Hence, all procedures and surgeries are performed by specialists and physician assistants, resulting in a heavy workload for the specialists. Nevertheless, the department of orthopedics does not consider dispatching residents or providing a backup, because providing help by dispatching residents would further increase the burden of the decreasing income.

With the establishment of trauma centers comprising a number of departments with the aim of reducing preventable mortality, general surgeons and thoracic and cardiovascular surgeons are the first to respond to severe trauma patients with unstable vital signs admitted to a trauma center [14].

Orthopedists can only initiate treatment when vital signs are stabilized, except for patients with pelvic fractures and blood vessel injuries. Hence, the significance of orthopedists in a trauma center is often overlooked. However, the survival of a patient does not always mean success in the treatment. In other words, TOSs are required to ensure that the patients survive without disability [1, 15].

Trauma specialists who specialize in treating trauma and general orthopedists have completely different views of how severe trauma patients should be treated. General orthopedic departments comprise different orthopedists, each an expert at treating a certain joint. Injuries in trauma patients are not limited to only one region, such as the knee, shoulder, and pelvis. Multiple fractures of the four limbs as well as injuries to the head and thorax are a predictable result of a collision of a person and a car moving at 60 km/h. Such a patient is not suitable for treatment by a general orthopedist. If the patient is to be treated by an existing general orthopedist, the surgery will likely be performed depending on the schedule of the orthopedist rather than at the optimal time for the treatment of severe trauma, which is usually within 5–10 days from the injury [16]. The reason why the average number of surgeries conducted in a patient was larger in the GOG than in the TOS group was that it was not possible to conduct the surgery with all of the relevant joint specialists attending at the same time.

Most important, professors do not work in an emergency room. According to the on-duty system in university hospitals where a call is first made to a resident, then to a fellow, and finally to a professor, prompt treatment is not guaranteed and the quality of the treatment is poor for multiple trauma patients with rapidly worsening conditions due to simultaneous injuries to numerous organs. The possibility of missing the optimal timing for a surgery owing to poor cooperation between other medical staffs frequently arises and may unnecessarily increase the number of consultations.

TOSs are the ideal physicians for providing treatment for trauma patients and are always on call to respond to any emergency. To them, trauma patients are not different from general patients, and they are willing to stay overnight for treating trauma patients. They make every effort to conduct surgeries under the most optimal conditions for severe trauma patients and patients with multiple fractures. The strength of TOSs is their ability to conduct simultaneous surgeries for many injuries, as their expertise is not limited to one specific joint. In addition, TOSs work in the trauma center and are able to participate in a systematic cooperation with other departments related to the treatment; hence, multidisciplinary treatment can be provided directly in the trauma center. Owing to structural limitations that cannot be predicted, large manpower with equipment is required when treating trauma patients, which decreases the profits of a private university hospital; however, an average of more

than \$2700 per patient was saved as the TOS system reduced the patients' stay in the ICU.

In this study, significant differences in the outcome of the entire treatment (from the admission to the emergency room to the patients' discharge) were observed between the TOS group and the GOG. Beyond the simple difference in the point of view with respect to trauma patients, these outcome differences clearly indicate different treatment domains and prove that disability in severe trauma patients can be minimized when a TOS provides the treatment. A severe trauma patient with fractures of the pelvis and multiple limbs should be evaluated systemically rather than individually for each joint by several orthopedists. In addition, the patient needs a physician who can cooperate with other departments and conduct surgeries at the optimal time for the patient rather than according to their own schedule.

To foster such a TOS system and ensure a high quality of treatment, the Central Government should offer adequate rewards to TOSs. These should include financial benefits and a guaranteed stable position as a faculty member of a private university. Such a government-awarded reward system is essential because TOSs are not the ones leading the private university hospital to a financial surplus; hence, private university hospitals have no reason to keep TOSs in their trauma centers. Therefore, sufficient financial and human resources are required for maintaining TOSs and nurses in private university hospitals that operate trauma centers. In addition, a transfer system allowing for the smooth and prompt transfer of severe trauma patients to a trauma center must be established.

According to the reports by Ostrum and Helfet, many hospitals in the United States have closed, as they were not able to hire fellows specializing in trauma owing to the heavy workload of a TOS, poor reimbursement, and malpractice fears [17, 18]. The authors were anxious about the shortage of orthopedic trauma surgeons. These trauma centers, established 30 years before the establishment of the Korean centers, can offer suggestions for TOSs working in trauma centers in Korea. We do not insist that all orthopedic trauma patients should be treated by orthopedic trauma specialists. Rather, we argue that patients who present with polytrauma, open fracture, and degloving injury (which require special and careful treatment by orthopedists) and patients who may have severe complications (such as infection, non-union, and hypofunction) due to delayed or inappropriate treatment at least must be treated by orthopedic trauma specialists. Institutional support to secure this idea will greatly help the treatment of trauma patients.

There are several limitations to this study. This study was only based on severe trauma patients presenting with pelvic fractures or fractures of the 4 limbs with an ISS of > 15 points; hence, the number of patients included is relatively small. Furthermore, it was difficult to determine the clinical

outcomes of late complications, including non-union, mal-union, and osteomyelitis, that may occur after the discharge from the hospital, as the patients were studied only from their admission to the emergency room to their discharge from the hospital. However, the quality of treatment offered by a TOS and by a group of general orthopedists are different, and sufficiently significant outcomes were observed even during this limited study duration. In addition, as most life-threatening complications occur during hospitalization, the validity of TOSs was considered to be sufficiently supported. This study was a retrospective study based on medical records collected in a single private university hospital with a trauma center; hence, consequent bias may exist although two authors cross-reviewed and checked the data to minimize such bias.

Conclusion

TOSs can perform prompt procedures and treatment for trauma patients and systemically participate in collaborative treatment with other specialists in a trauma center. When trauma in multiple limbs and the pelvis are effectively treated by a TOS, the ICU duration can also be reduced; hence, TOSs can have a beneficial role in rapid rehabilitation and medical cost reduction for trauma patients.

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