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가천대학교 길병원 권역외상센터 3개년 내원 환자 및 치료 경험 분석(2011~2013)

가천대학교 길병원 권역외상센터

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- Abstract -

Three-year Analysis of Patients and Treatment Experiences in the Regional Trauma Center of Gachon University Gil Hospital between 2011 and 2013

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Gachon University Gil Hospital Regional Trauma Center

Purpose: The first regional trauma center selected in Korea was the Gachon University Gil hospital regional trauma center; expectation on its role has been high because of its location in the Seoul metropolitan region. To determine if those expectations are being met, we analyzed the patients visiting the center and their treatment experiences for the past 3 years in order to propose a standard for the operation of a trauma center.

Methods: The visiting route, visiting methods, performance of emergency surgery, the ward and the length of stay, the injury mechanism, the injury severity score (ISS), the department that managed the surgery, and the cause of death were analyzed for 367 patients visiting the center from its establishment in June 2011 through December 2013.

Results: The mean age of the patients was 47 years (285 male and 82 female patients). A total of 187 patients directly visited the center whereas 180 were transferred to the center. Traffic accidents comprised the majority of injury mechanisms, and 178 patients underwent emergency surgery. The mean length of stay per patient was 11 days for those in the ICU and 27 days for those in a general ward. These patients occupied 4 beds in the ICU and 10 beds in the general ward per day. A total of 1.21 surgeries were performed per patient, and the mean number of surgeries performed per day was 0.49. The mean ISS was 15.91, and 183 patients (50%) had an ISS of $\geq$16. Thirty-one patients died; they had a mean ISS of 28.42. The most frequent cause of death was multi-organ failure. The mean number of treatment consultations during a patient's stay was 6.32. Forty-five patients (13%) were discharged from the center, and 291 (79%) were transferred to another hospital.

Conclusion: A systematic approach to establishing a treatment model for trauma patients, including injury mechanism, multidisciplinary treatment, and trauma surgeon intervention, is required for treating trauma patients. [J Trauma Inj 2014; 27: 170-7]

Key Words: Regional trauma center, Injury severity score, Trauma model

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I. Introduction

The Korean Ministry of Health and Welfare (KMHW) has established an emergency medical services system for trauma to reduce preventable death rates to less than 20% in trauma patients by 2020. Supporting ICUs and medical specialists that specialize in trauma are the most urgent issues to address in terms of insufficient treatment facilities and medical specialists specializing in severe trauma compared with other developed countries.(1,2) KMHW announced its plan to train and support trauma surgeons and to build 17 regional trauma centers by 2016 by dedicating emergency medical funds of approximately 200 billion Korean won to the severe trauma field.(3)

KMHW invited medical institutions to apply to become regional trauma centers in 2012 and selected Gachon University Gil Hospital, Kyungpook National University Hospital, Dankook University Hospital, Mokpo Hankook Hospital, and Yonsei University Wonju Severance Christian Hospital. As a result, establishing an advanced emergency medical service system for trauma is in progress in Incheon, Daegu, Choongnam, Jeonnam, and Kangwon. The system will provide a maximum of 800 million Korean won to install equipment for trauma facilities-including ICUs, ORs, and wards specialized for trauma patients-and to fund 70~270 million Korean won annually for personnel expenses.

Among these institutions, the Gachon University Gil Hospital became the first regional trauma center in Korea; expectation of its role is high because of its location in the Seoul metropolitan region. In addition, the Gachon University Gil Hospital established a trauma center in 2011 and has been operating a division of trauma surgery there, taking full charge of patients with severe trauma and handling not only surgical treatment but also inpatient care.

To the best of our knowledge, treatment on patients and treatment experiences in government-designated regional trauma center has never been reported and our hospital is the first one reporting this in the journal of The Korean Society of Traumatology. Through accumulation and communication of such data by reporting them to the academic society, success rate of treatment for trauma patients can be improved, foundations for development in management of regional trauma centers initiated by the government can be established, and furthermore, preventable death rate can be lowered by the level of that in developed countries. Our study analysed patients visiting the regional trauma center of Gachon University Gil Hospital and their treatment experiences in the past 3 years as a means of proposing a standard for operating trauma centers.

II. Materials and Methods

A retrospective analysis of medical records and radiographs obtained from 367 patients who were admitted and treated in our trauma center was performed between June 2011 and December 2013. Patients who died of unknown causes at the time of arrival, who were transferred to another hospital with unknown treatment outcome, who were discharged against medical advice, and who had injuries not related to trauma were excluded.

Visiting route, mode of transportation, mechanism of injury, ISS, mortality rate in hospital, the ratio of ICU admission, number of surgeries performed, departments who collaborated, and treatment outcome were investigated for those 367 patients. Severe trauma was defined as an ISS $>$15.

The ISS used in this study was calculated by summing the squares of the Abbreviated Injury Scale (AIS) score, with a range between 1 and 6, that was obtained from 3 regions with the most severe injuries among 6 anatomical regions including the head and neck, facial, thoracic, abdominal, limbs and pelvic, and external regions according to the patients' final diagnosis. ISS was calculated as 75 regardless of injuries in other regions when the AIS score in 1 region was 6.(4)

III. Results

The sex ratio of patients who visited our trauma center was 3.48:1, with 285 male and 82 female patients comprising the total 367 patients. The mean age of the patients was 46.7 years. A rapid growth

in the number of visiting patients was observed: 31, 123, and 213 patients visited in 2011, 2012, and 2013, respectively. For visiting route, 170 (49%) were transferred from another hospital, indicating that almost half of the total number of visiting patients were not brought to the facility directly after injury but were instead transferred after being evaluated at another hospital for treatment at a tertiary medical institution (Table 1).

A total of 138 patients were directly admitted to the trauma ICU (TICU) and 137 patients were admitted to the TICU after undergoing emergency surgeries. The patients stayed in the TICU for a total of 3981 days, the number of per-patient days in the TICU was 14.48 (3981/275) days, and 4.38 (3981/908) beds were occupied per day. approximately 5 patients per day in average were treated in TCIU and the patients were treated in TICU for 15 days once these trauma patients were admitted Monthly analysis of visiting patients did not show specific differences in the number of trauma patients during different seasons (Table 5).

When helicopter service (Doctor Helicopter) for medical emergencies was introduced in our center in September 2011, the geographical range of patient transport was expanded to regions within 60 km of our hospital and included all of Gangwha County and the neighbouring islands such as Youngheungdo in Ongjin County, Muuido, Deokjeokdo, and Soyado (Fig. 1). 9 patients in 2012 and 22 patients in 2013

Table 1. Analysis on visiting route and transportation in patients admitted to the Gachon University Gil Medical Center between 2011 and 2013.

Characteristics		2011	2012	2013	Total
Total admission		31	123	213	367
Sex	Male	28	98	159	285
	Female	3	25	54	82
Mean age, years		42.61	43.79	51.48	46.74
Visiting route	Direct visit	17	52	118	187
	Transfer from other hospital	14	71	95	180
Visiting transportation	119	17	38	92	147
	Aero-transfer	0	9	22	31
	Private Ambulance (129)	13	56	74	143
	Other vehicle	1	20	25	46

Table 2. Analysis on surgery and admission treatment conducted for patients visited.

Characteristics		2011	2012	2013	Total
Surgery	Emergency surgery	5	68	105	178
	Regular surgery	26	41	73	140
	Observation		14	35	49
ICU/ward	Direct ICU	26	37	75	138
	Postoperative ICU	5	45	87	137
	Direct ward	0	18	33	51
	Postoperative ward	0	23	18	41
Number of days admitted	ICU	253	1388	2340	3981
	Ward	857	2972	6132	9961
	Days in ICU/person	253/31=8.16	1388/82=16.93	2340/162=14.44	3981/275=14.48
	Days in ward/person	857/31=27.64	2972/82=36.24	6132/162=37.85	9961/275=36.22
	Number of beds in ICU occupied/day	253/178=1.42	1388/365=3.80	2340/365=6.41	3981/908=4.38
	Number of beds in ward occupied/day	857/178=4.81	2972/365=8.14	6132/365=16.80	9961/908=10.97
Method of discharge	Discharge	3	27	15	45 (45/367=13%)
	Transfer	0	82	181	291 (291/367=79%)
	Death	0	14	17	31 (31/367=8%)

Fig. 1. As arranged by Gil Hospital, Doctor Helicopter is on standby at a heliport. A doctor boards the helicopter and arrives on site within 30 min of an emergency. The helicopter program operates on the principle of transferring patients to the hospital within 1 h. The range of operation is an approximate 60-km radius in consideration of the survival rate of patients with trauma with heart and brain.

from other area were evacuated to hour hospital by using doctor helicopter." Most of the patients were transported from island region and it would take at least 5 hours to our hospital if they used existing transportation including ships or vehicles.

In terms of injury mechanisms, traffic accidents (TAs) were the most common, with 48%, followed by direct blunt trauma (12%) and injuries caused by falling down and stab injuries (10% each). The mean ISS was 15.91. Patients with an ISS ≥16 were considered to have severe trauma (183 patients), and accounted for 50% of the total cases. A total of 178 patients underwent emergency surgeries, whereas 49 received treatment while undergoing follow-up observation because of a lack of surgical indications (Table 3, 4).

Patients underwent a total of 443 surgeries after

Table 3. Mechanism of injury analysis.

Characteristics		2011	2012	2013	Total
Mechanism of injury	Pedestrian TA*	4	9	28	41
	In-car TA	7	38	55	100
	Motorcycle TA	5	8	15	28
	Bicycle TA	2	1	4	7
	Falling down	7	6	25	38
	Violence			9	9
	Slip		5	11	16
	Stab	1	14	22	37
	Machine	3	2	7	12
	Burn				
	Direct blunt trauma	1	26	18	45
	Miscellaneous	1	14	19	34

* TA: traffic accident

Table 4. ISS analysis.

Characteristics		2011	2012	2013	Total
ISS	1~8	3	22	50	75
	9~15	8	35	66	109
	16~24	9	34	61	104
	25~40	10	28	32	70
	41~49	1	3	1	5
	50~74		1	3	4
	75				
	Mean ISS score	19.65	15.58	15.72	15.91
No. of patients with ISS >16		20 (20/31=65%)	66 (66/123=54%)	97 (97/213=46%)	183 (183/367=50%)
Mortality rate in hospital			14/123=11%	17/213=8%	31/367=8%
Mortality rate in patients with ISS >16			14/66=21%	17/97=17.5%	31/183=17%

Table 5. Monthly analysis of patients admitted to Gachon University Gil Medical Center between 2011 and 2013.

		2011	2012	2013	Total
Month	January		19	7	26
	February		10	8	18
	March		10	9	19
	April		8	12	20
	May		15	11	26
	June	3	19	28	50
	July	2	11	14	27
	August	4	2	20	26
	September	5	13	27	45
	October	8	5	26	39
	November	7	6	31	44
	December	2	5	20	27

Table 6. Analysis of mortality cases.

Year	Case No.	Sex	Age	Injury Mechanism	ISS	Cause of Death	Death Time (Days)
2012	1	F	85	Direct blunt trauma	20	Aspiration pneumonia	8
	2	M	48	Pedestrian TA*	4	HS†	3
	3	M	41	In car TA	22	HS	2
	4	M	45	Pedestrian TA	13	MOF†	24
	5	M	56	Falling down	25	HS	2
	6	M	57	Pedestrian TA	25	ARDS§	10
	7	M	69	In car TA	25	DIC‖	4
	8	M	35	Direct blunt trauma	32	HS	1
	9	M	56	Direct blunt trauma	45	HS	1
	10	M	49	In car TA	25	HS	2
	11	F	70	In car TA	18	MOF	9
	12	M	51	In car TA	25	HS	1
	13	M	49	Direct Blunt trauma	16	MOF	19
	14	M	53	Direct Blunt trauma	25	HS	2
2013	1	M	38	Pedestrian TA	66	HS	2
	2	M	58	In car TA	26	HS	2
	3	M	76	Pedestrian TA	25	HS	2
	4	M	60	Pedestrian TA	9	MOF	5
	5	F	61	In car TA	18	MOF	8
	6	M	68	In car TA	27	MOF	10
	7	M	79	Motorcycle TA	17	HS	2
	8	M	69	Falling down	29	MOF	20
	9	M	54	Pedestrian TA	38	MOF	20
	10	M	80	Pedestrian TA	38	MOF	4
	11	M	42	In car TA	50	Tension pneumothorax	1
	12	M	73	Direct blunt trauma	75	MOF	10
	13	M	57	Falling down	18	MOF	27
	14	M	42	Bicycle TA	20	MOF	11
	15	M	49	In car TA	41	MOF	5
	16	M	72	Pedestrian TA	35	HS	2
	17	M	69	Pedestrian TA	29	DIC	3
Grand Mean			58.42		28.42		7.16

* TA: traffic accident, † HS: hypovolemic shock, † MOF: multi organ failure, § ARDS: acute respiratory distress syndrome, ‖ DIC: disseminated intravascular coagulation

admission. In other words, 1.21 (443/367) surgeries were performed per trauma patient and 0.49 (443/908) surgeries was performed per day. The Department of Trauma Surgery performed 186 (186/443=42%) surgeries, and 257 surgeries required consultation with and were conducted by other departments (Department of Orthopedics, 142 cases; Spine Center, 20 cases; and the Department of Neurosurgery, 32 cases). For the collaborated surgeries, only those conducted by other departments and other procedures including presurgical treatment and postsurgical treatment were performed in the Department of Trauma Surgery. In addition, a mean of 6.32 consultations was performed per patient during hospitalization; the consultations were done with the Department of Orthopedics, the Department of Infectious Diseases, and the Department of Neurosurgery, in that order.

The hospital mortality rate was 8.4%. Thirty-one patients died while receiving treatment and the mortality rate among severe trauma patients with an ISS ≥16 was 21% (14/66) in 2012 and 17.5% (17/97) in 2013. Hypovolemic shock was the most common cause of death in 2012; however, multiorgan failure rather than hypovolemic shock was the main cause of death in 2013, as we had established an adequate system of initial response to emergency treatment (Table 6). Most patients (79%) were transferred to secondary medical institutions after receiving treatment in our trauma center, and underwent rehabilitation treatment and follow-up observation at outpatient clinics and other departments of our trauma center after transfer (Table 2).

IV. Discussion

According to statistics calculated in the United States, the annual loss of productivity resulting from trauma is 500 in 100,000 individuals.(5) Severe trauma also results in high mortality and prevalence rates and may result in disabilities that negatively influence returning to a regular, everyday life.(6) The World Health Organization recognizes trauma as a major public health issue that leads to approximately 5 million deaths annually. In 2002, TA, intentional injury, violence, burns, and drowning were named as some of the 15 major causes of death in patients aged between 5 and 44 years. Millions of patients die of trauma and more than 1 million develop transient or permanent disabilities after trauma.(7)

Despite the differences in the incidence of trauma from different sources, injury was the cause of death in 32,444 individuals, which is approximately 15% of 240,000 total deaths according to Statistics Korea in 2011.(8,9) Injury is the main cause of death in young and middle-aged populations, and so is a serious public health issue. However, recognizing the seriousness of severe trauma is important because trauma causes more damage than any other emergent diseases because it results in the death of young people who are socially productive. It causes not only damage to public health but also to socioeconomics because it can lead to lingering disabilities that restrict resumption of everyday life and productive labor.(10,11) As the statistics we previously reported in our hospital show, the number of patients visiting the trauma center shows an upward and rapidly increasing trend. This does not mean there has been an increase in trauma patients, but rather an absence of specialized trauma centers that can provide appropriate treatment and a diffused recognition that severe trauma patients are supposed to be treated at a trauma center.

The major problem in the treatment of severe trauma is that patients are transferred to a trauma center after spending most of the "Golden Time"-the most critical period within 1 h of injury-in hospitals not equipped or with insufficient medical personnel for treating trauma patients. Our statistics on trauma patients indicated that almost half of the patients were transferred to our center after undergoing CT or MRI at another hospital (Table 1). Sampalis et al. reported increased mortality and longer ICU and ward stays in transferred patients; the mortality rate in the directly visiting patient group was 4.8%, and 8.9% in the transferred patient group. ICU stay was 13.2 days in the directly visiting patient group compared with the 16.0 days in the transferred patient group in the same study.(12)

In Korea, establishing an emergency medical service system is under way by dividing the country,

except Seoul, into 8 regions to effectively manage emergency patients and by building regional centers for emergency medical services following the government's lead; however, specific functions have not yet been set.(13) It is essential to establish criteria for selecting medical institutions as trauma centers based on the severity of patient injuries and developing a patient classification system as a medical delivery system for proper transfer of patients between medical institutions. The Korean emergency medical service system currently has problems such as patients visiting large general hospitals; an absence of effective medical information systems, facilities, equipment, and transportation system personnel; and the dual systems of incidence reporting and transportation.(9)

Trauma centers require trauma surgeons specialized in general, thoracic, and cardiovascular surgery. Trauma surgeons specializing in orthopaedic surgery and neurosurgery in a trauma center are not enough for the overall treatment of trauma patients. A higher quality of treatment is achievable through internal medical therapy in addition to surgical treatment. Additionally, intimate cooperation with various departments, including nutrition and social welfare services, is essential for smooth patient treatment.(14)

A sudden visit by a trauma patient can be predicted based on the mean age, sex, and mechanism of injury, which would allow facilities to increase and place appropriate equipment and medical personnel by using a standard model for trauma patients. In other words, TA patients are multiple-trauma patients with the main mechanism of injury being blunt trauma in which an extensive region of the body is damaged because of massive compressive pressure. Unlike a knife or gunshot injury, multiple trauma causes not only shock but also sepsis and multiple organ dysfunction. As a result, doctors from numerous specialities are required for treatment. The statistics in our hospital also presented overwhelming proportion of TA patients indicating the need of investment on equipment, workforce, and facilities by building standard model of injury appropriate for blunt trauma of TA patients.

In Korea, funds are provided for personnel expenses to pay trauma specialists; this is in addition to 800 million Korean won of government expenditure covering installation of facilities and equipment specialized for trauma patients including ICUs, ORs, and wards in trauma centers. However, essential assisting personnel including nurses and radiologic technologists are compensated by each institution. In our hospital, although 9 trauma specialists (4 general surgeons, 3 thoracic and cardiovascular surgeons, 1 orthopaedic surgeon, and 1 neurosurgeon) and 40 specially trained medical personnel participated in the operation at the trauma center, experienced nurse specialists are required because trauma specialists treat and perform surgeries without assistance from residents. Providing treatment for severe trauma patients who visit without notice causes stress and physical exhaustion in both trauma specialists and nurses. National support for essential assisting personnel should be required to ensure stable and continuous operation of a trauma center after it has been established.

V. Conclusion

National support for personnel and steady installation of facilities and equipment are required because of the rapid increase in the number of patients visiting our severe trauma center over the past 3 years. Constructing a standard model of trauma patients is essential; proper preparation and a handling procedure for such a model are also required. As the number of consultations performed for trauma patients in our facility shows that a department for trauma surgery alone is not sufficient for the overall treatment of trauma patients. Close cooperation with other departments, including that of Internal Medicine and Rehabilitation Medicine, is essential. Finally, establishing a patient transportation classification system based on the severity of injury is essential.

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