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Role of plastic surgeons in the trauma center: national level I trauma center startup experience in South Korea

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Abstract

Although it is well recognized that other surgical specialties perform various procedures related to trauma care, there is a lack of analyses focusing on the role of plastic surgical management in trauma centers. This retrospective study was designed to investigate the scope of plastic surgery services in acute trauma care, using clinical data obtained from a single, regional, level I trauma center.

This study included patients who presented to a single, regional, level I trauma center between March 1, 2016 and February 28, 2018. Patients with acute trauma to the facial soft tissue and skeleton, soft tissue of the upper and lower limbs, trunk and perineum, and other areas requiring plastic surgical procedures were included in the analysis. Cases requiring consultation for the correction of posttraumatic deformity or secondary deformity and trauma sequelae, such as scars, were excluded. Data on patients' demographics and detailed surgical procedures were acquired from electronic medical records. The reviewed cases were categorized by the primary anatomical region requiring surgery and the primary procedure performed.

A total of 1544 patients underwent surgery, and 2217 procedures were recorded during the 2-year study period. In 2016, 1062 procedures on 690 patients, and, in 2017, 1155 procedures on 787 patients were registered. The average age of the patients who underwent plastic surgical procedure due to a trauma-related cause was 38.4 years (range, 2 days to 91 years), and 1148 patients (77.7%) were male. The head and neck region was the most commonly observed anatomical area that was operated on. The facial bone requiring the largest degree of surgical intervention was the mandible, followed by the zygomatic bone, nasal bones, orbital floor, and maxilla. Microsurgical procedures, such as flap surgery and microsurgery, were performed in 121 cases. The most commonly elevated free flap was the ALT flap (n=69).

Plastic surgeons play various roles in level I trauma centers, such as in the management of facial injury, performing limb-saving free tissue transfers, and complex wound reconstruction with flaps or skin grafts. Thus, plastic surgeons are an essential part of trauma centers.

Abbreviation: ALT = anterolateral thigh.

Keywords: craniofacial trauma, lower extremity reconstruction, plastic surgery, trauma center, trauma reconstruction

1. Introduction

Injuries and their related sequelae are significant public health issues. Acute trauma care represents a significant challenge to surgeons and requires a multidisciplinary team effort. Trauma surgery, chest surgery, neurosurgery, and orthopedic surgery are regarded as vital in these settings. The provision of comprehensive care among patients with acute injury in level I trauma centers, however, warrants the recognition of the integral role of plastic surgeons.[1]

The central tenet of this article is that plastic surgeons have unique training that makes them suitable for inclusion as integral members of level I trauma teams. Plastic and reconstructive surgery is a surgical specialty involving the restoration, reconstruction, or alteration of the human body. It can be further divided into craniofacial surgery, microsurgery, and cosmetic surgery. The mataim of this specialty is the reconstruction of a part of the body, to improve its function and appearance. Plastic surgery is used not only in the beginning, but also beyond the acute phase of trauma management.

Although plastic surgery is an integral part of most major trauma centers worldwide, in some countries such as South Korea, trauma institutes still do not offer plastic surgery services focusing on trauma reconstruction. In addition, there is a lack of analyses focusing on the role of plastic surgical management for trauma care. This retrospective study aimed to investigate the scope of the plastic surgery service in acute trauma care using clinical data from a single, regional, level I trauma center. Herein, we present the 2-year experience in a single, newly opened, trauma center, demonstrating the utility and added value of including plastic surgeons as part of trauma teams, as opposed to the primary reliance on consultants or other medical practitioners.

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2. Materials and methods

This study was performed at the Department of Plastic and Reconstructive Surgery, Ajou University Medical Center located in Suwon-si (South Seoul, Korea) and was approved by our institutional review board (AJIRB-MED-BDR-20–163) before data acquisition. The requirement to obtain informed consent from patients was waived due to the retrospective study design. The Ajou University Trauma Center is an independent nationally certified center that is categorized as a level I trauma facility by the Korean Surgical Society with the capacity to accept and treat pediatric patients. The center is equipped with three independent operating rooms that are used only for patients with a trauma-related diagnosis, and it serves as a key resource facility in a nationwide trauma system established in March 2016. It has four national board-certified plastic surgeons with at least 5 years of experience performing general plastic surgery procedures, including microsurgical reconstruction and craniomaxillofacial trauma surgeries. In addition, the surgeons also encounter a large number of patients with non-trauma-related problems, such as external posttraumatic deformity or functional deformity. The plastic surgery service is provided all day, every day, and comprises of 4 attending plastic surgeons and two residents.

This study included all patients who presented with acute trauma of the facial soft tissue and skeleton, soft tissue of the upper and lower limbs, trunk and perineum, and other areas requiring plastic surgical reconstruction from March 1, 2016 to February 28, 2018, irrespective of age and sex. Patients requiring chronic wound reconstruction, correction of a posttraumatic deformity or secondary deformity, and those with trauma sequelae such as scars after complete wound healing were excluded from the study.

At the trauma bay in our center, acute injury is initially managed by the attending trauma surgeon, who decides on the intervention and specialist care required. In cases with lower-limb trauma and facial trauma, the plastic surgery service participates in the initial management, as there may be a need for soft tissue reconstruction and facial management.

Data on patients' demographics and detailed surgical procedures were acquired from electronic medical records. The reviewed cases were categorized by the primary anatomical region requiring surgery, as well as the primary procedure performed. In patients who underwent multiple major procedures, such as soft tissue reconstruction and facial bone fracture repair, each procedure was annotated separately. When various reconstructive procedures were performed on a single anatomical region, the most complex or important procedure was included. For example, when an adjunctive skin graft procedure was accompanied by flap reconstruction, or when fixation of a zygomatic maxillary complex fracture was accompanied by the repair of an impure orbital blowout fracture, only the flap and zygomatic maxillary complex fracture repair were recorded. When concomitant skin graft procedures and primary wound repair were performed, only the skin graft was recorded. Temporary maxillomandibular fixation for Le Fort fractures or mandibular fractures was not recorded. In cases with soft tissue injury, those with serial debridement and definite coverage procedures were all annotated. Reconstruction in flap donors with primary repair or skin grafting was not included in the analysis. Superficial lacerations of the face requiring primary repair were not recorded. The discrepancy between the proportion of specific procedures and surgery cases reflects this methodology. Only cases requiring treatment in an operating room were tabulated, including those that received treatment from other specialty teams in the operating room

3. Results

During the study period, a total of 3931 patients were admitted to the trauma center, at least for one day. A total of 5142 operations were performed for these patients. Among these patients and procedures, plastic surgical service was involved in 1544 patients (39.3%) and plastic surgical procedures were performed in 2217 cases (43.1%). In 2016 and 2017, 1062 procedures on 690 patients and 1155 procedures on 787 patients, respectively, were registered. The average age of the patients requiring plastic surgical procedures due to a traumatic cause was 38.4 years (range, 2 days to 91 years), and 1148 patients (77.7%) were male. A total of 4 infants aged younger than 1 year underwent surgery, and 121 patients were aged over 65 years (Table 1).

3.1. Interaction with other surgical services

A total of 869 patients required surgical intervention involving the participation of other specialties (Table 2). As anticipated, the major interacting surgical services were orthopedics and trauma surgery. These services usually represent the surgery teams that provide the initial evaluation at trauma bays, along with plastic surgery, and each service determines the need for additional specialty involvement. Other surgery service consultations usually reflected the need for additional intervention outside the area of experience of the aforementioned specializations.

Table 1

Patients' distribution by sex in different age intervals.

Age intervals, year(s)	Male	Female	Total	Percentage
<1	2	2	4	0.3
1–9	38	12	50	3.2
10–19	178	39	217	14.1
20–29	230	46	276	17.9
30–39	201	71	272	17.6
40–49	177	50	227	14.7
50–59	210	50	260	16.8
60–69	102	32	134	8.7
70–79	47	33	80	5.2
80–89	15	8	23	1.5
90–99	1	0	1	0.1

Table 2

Mostly interacting services of surgical specialty.

Surgical services	Patients (n = 1544)
Orthopedic surgery	497 (32.2%)
General surgery	20 (1.3%)
Trauma surgery	196 (12.7)
Neurosurgery	50 (3.2%)
Otorhinolaryngology	37 (2.4%)
Ophthalmology	27 (1.7%)
Dental surgery	9 (0.6%)
Obstetrics and gynecology	6 (0.4%)
Thoracic surgery	4 (0.3%)
Urology	18 (1.2%)
Vascular surgery	5 (0.3%)
Plastic surgery alone	675 (43.7%)

Table 3

Case distribution by anatomical area.

	Patients (n = 1544)	Procedures (n = 2217)
Head and neck	997 (64.6%)	1254 (56.6%)
Lower extremity	392 (25.4%)	700 (31.6%)
Upper extremity	104 (6.7%)	182 (8.2%)
Trunk/urogenital	51 (3.3%)	81 (3.7%)

Only plastic surgery services were involved in patient management in 47.3% of cases. Isolated facial injury or degloving injury of the extremities without fractures were categorized as plastic surgery cases alone. Of 869 patients, intervention including one other area of surgical specialization was required in 570; 177 patients received intervention involving two other departments, and 122 involving three or more departments.

3.2. Distribution by anatomical regions

The head and neck region was the most commonly noted anatomical area that was operated on (Table 3). The lower extremity was the second most frequently observed area that was treated by a plastic surgeon. Small upper-extremity-related procedures were used primarily due to the performance of tendon repair by orthopedic services during the period. As the trunk of the body has multiple layers of muscle and can be repaired with approximation in many cases, plastic surgeons have a lower level of involvement in soft tissue reconstruction in this region.

3.3. Head and neck

Of the facial fractures that were operated on, 53 cases consisted of multiple fractures. The facial bone requiring the largest degree of surgical intervention was the mandible, followed by the zygomatic bone, nasal bones, orbital floor, and maxilla. Closed reduction of the nasal bone was the most commonly practiced procedure in terms of facial bone fractures. The specifications applied to the correction of the facial fracture are presented in Table 4. Of the

Table 4

Head and neck procedures.

	Procedures (n = 1254)
Facial bone fractures (n = 1139, 90.8%)	
Zygomaticomaxillary	207 (16.5%)
Orbital floors	99 (7.9%)
Nasal bones	612 (48.8%)
Mandibles	78 (6.2%)
Medial orbital walls	44 (3.5%)
Zygomatic arches	27 (2.2%)
Le Fort I/II	37 (3.0%)
Nasoethmoidoorbital	5 (0.4%)
Panfacial	6 (0.5%)
Frontal sinuses	15 (1.2%)
Other facial bone	9 (0.7%)
Soft tissue (n = 115, 9.2%)	
Debridements	12 (1.0%)
Primary/delayed repairs	73 (5.8%)
Regional flaps	6 (0.5%)
Skin grafts	22 (1.8%)
Neurorrhaphies (facial nerve)	2 (0.2%)

Panfacial: facial fractures involving upper, mid, and lower third face.

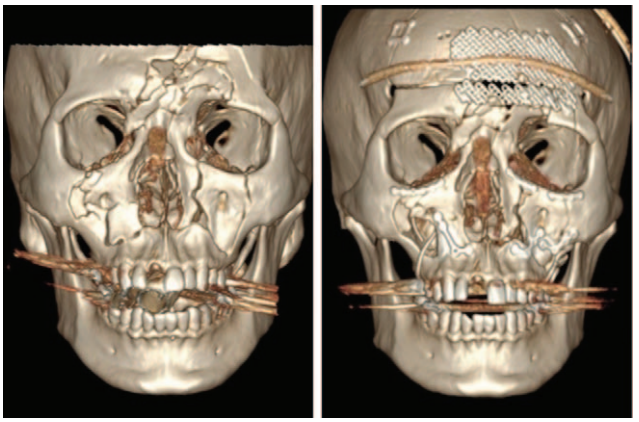

Figure 1. A 36-year-old male patient was referred to the trauma center for facial fracture and intracranial hemorrhage. For Le Fort II fracture with frontal sinus fracture combined with intracranial hemorrhage, open reduction with internal fixation and cranialization were performed by plastic surgeon and neurosurgeon.

244 cases with open reductions of midfacial fractures (zygomaticomaxillary, Le Fort I/II), 81 underwent repair with a titanium plate/screw and 163 with an absorbable plate/screw system. Of the 78 cases with the open reduction of a mandibular fracture, 15 were treated only with maxillomandibular fixation and 16 with an absorbable plate/screw system. Of the 27 cases with zygomatic arch fractures, only two were surgically treated using Keen's approach (oral incision). Regional flap surgery was used in 6 cases for head and neck soft tissue reconstruction, of which one case entailed partial ear reconstruction of an upper third auricular defect. Figure 1 is the case of Le Fort II fracture with frontal sinus fracture combined with intracranial hemorrhage, which was managed with open reduction with internal fixation and cranialization by plastic surgeon and neurosurgeon.

3.4. Lower extremity

Of the 392 patients requiring plastic surgical involvement in lower extremities, 107 (72.2%) also required cooperation with orthopedic services. Early evaluation of soft tissue deficits was frequently performed at the time of the initial orthopedic fixation, and subsequent debridement was often performed by either service, based on staff availability. Skin grafting for the reconstruction of post-traumatic soft tissue defects was the most commonly observed procedure, accounting for 214 cases (Table 5).

At our trauma center, thorough debridement was performed on all open injuries on the day of admission. All patients received preoperative antibiotic coverage. When indicated, skeletal fixation and fasciotomy were performed simultaneously. Multiple trauma and open fracture cases were treated in conjunction with trauma and orthopedic services. In cases with unsalvageable fractures and injuries, orthopedic surgeons performed major amputations. The performance of soft tissue reconstruction of open tibial/foot fractures is among the greatest challenges that plastic surgeons face in level I trauma centers. With the introduction of free tissue transfer using microsurgical techniques, a new dimension has been added to the reconstruction of post-trauma defects. Early microsurgical reconstruction of complex lower-extremity trauma has resulted in superior functional and aesthetic results.

Table 5

Lower extremity procedures.

	Procedures (n = 700)
Debridement	272 (38.9%)
Primary/delayed repair	108 (15.4%)
Skin grafts	214 (30.6%)
Regional flaps	25 (3.6%)
Free flaps	71 (10.1%)
Amputation	10 (1.4%)

The number of amputations performed indicated the provision of adjunctive treatment by soft tissue reconstruction in cases with lower-extremity trauma by the plastic surgery service, as well as participation in care among cases with necrosis of the toe tip due to vasoconstrictor complications. Of the 10 amputations performed by plastic surgeons, nine were toe amputations and one was a transmetatarsal amputation. The preference of free flap over regional flap surgery in traumatic lower-extremity reconstruction was attributed to the fact that the zone of injury was wider than indicated by the wound appearance.

3.5. Upper extremity

The upper extremity was the anatomical region showing the third highest submission rate to plastic surgery. The surgical procedure most frequently performed, accounting for 73 cases, was the treatment of soft tissue defects with skin grafts (either full-thickness or partial thickness) (Table 6). Nine free flap surgeries were performed successfully for the reconstruction of complex wounds, and most of them were anterolateral thigh (ALT) flap surgeries (7 cases). Two cases of partial finger amputation were performed as a result of vasoconstrictor complications.

3.6. Trunk/perineum

The trunk/perineal region accounted for the lowest rate of reconstructive surgery, representing 3.7% of all the plastic surgery procedures (Table 7). The most commonly used procedure for soft tissue reconstruction was skin grafting. Although no free flap reconstruction was performed in the trunk and perineal region, 2 perineal reconstructions with a regional flap and one chest wall reconstruction with a regional flap were performed during the study period.

3.7. Microsurgical operations

Specialized procedures commonly associated with plastic surgery, such as flap surgery and microsurgery, were performed in 121 cases (Table 8). The most commonly elevated free flap was the ALT (n = 69). Figure 2 is the case of open fractures of distal femur and proximal tibia with soft tissue defect, which was managed with open reduction with internal fixation and ALT free flap transfer by plastic surgeon and orthopedic surgeon.

Other flaps included the medial sural artery perforator flap and latissimus dorsi muscle/perforator flaps. One toe pulp free flap for fingertip reconstruction and one fibular osteocutaneous free flap for tibial bone reconstruction were used during the study period.

Table 6

Upper extremity procedures.

	Procedures (n = 182)
Debridement	66 (36.3%)
Primary/delayed repair	27 (14.8%)
Skin grafts	73 (40.1%)
Regional flaps	5 (2.7%)
Free flaps	9 (4.9%)
Amputation (finger)	2 (1.1%)

Table 7

Trunk/perineum procedures.

	Procedures (n = 81)
Debridement	31 (38.3%)
Primary/delayed repair	22 (27.2%)
Skin grafts	25 (30.9%)
Regional flaps	3 (3.7%)

4. Discussion

In this study, we found that plastic surgeons play various roles in level I trauma centers in Korea, from the management of facial injury to the performance of limb-saving free tissue transfer and complex wound reconstruction with flaps or skin grafts. Plastic surgeons work alongside experts from other specialties to restore the appearance and function of various body parts. Thus, plastic surgeons are essential members of trauma centers.

Level I trauma centers are equipped to provide the highest level of care to patients with severe injury. Ideally, trauma care centers should include all surgical components identified as being required for optimal trauma care, such as vital organ surgery, musculoskeletal surgery, and anesthesia. To achieve this goal, optimal resources at these trauma centers should include inhouse board-certified general surgeons, orthopedic surgeons, radiologists, neurosurgeons, and anesthesiologists.

Recently, there has been an increase in the level of social interest in organized trauma systems among the South Korean government and academia, and the establishment of trauma centers is being considered across the country. However, the establishment of such a system has not been easy in Korea due to the requirement for a large proportion of resources and experience.

The objectives of this study were as follows:

1. to estimate the scope of plastic surgery services in a level I trauma center during the course of management,
2. to provide data on the appropriate role of plastic surgeons in trauma centers, and
3. to analyze the level of cooperation between plastic surgery services and other surgical services from other specialties.

Table 8

Microsurgical procedures.

	Procedures (n = 121)
Regional flap (n = 39, 32.2%)	
Pedicled flap	21 (17.4%)
Random flap	18 (14.9%)
Free flap (n = 80, 66.1%)	
Anterolateral thigh	69 (57.0%)
Medial sural artery flap	4 (3.3%)
Other free flap	7 (5.8%)
Neurorrhaphy of facial nerve (n = 2, 1.7%).	

Figure 2. A 65-year-old male patient was referred to the trauma center for his lower extremity trauma. For open fractures of distal femur and proximal tibia with soft tissue defect, open reduction with internal fixation and ALT free flap transfer were performed by plastic surgeon and orthopedic surgeon.

While the role of plastic surgeons in the improvement of a person's appearance is well understood by the public and medical professionals, their role in acute trauma settings, with the probable exception of facial lacerations and facial bone fractures, is not as clear. This study clearly demonstrated that the scope of plastic surgery extends well beyond these boundaries. To a large extent, this is afforded by the training provided for both soft-tissue surgery and facial fracture surgery in programs with a strong reconstructive base. The tremendous flexibility of the plastic surgery specialty afforded by this training allows for overlap and interactions with other surgical specialties. This overlap can be capitalized on both by working in conjunction with other surgical services and through the use of plastic surgeons to cross cover other surgical specialties with a surgeon shortage.

The large number of cases involving orthopedic surgery reflects both the large number of high-energy lower-extremity trauma cases and the close working relationship that exists between orthopedics and plastic surgery in lower-extremity trauma cases. As level I trauma centers cover patients with serious injuries in the regional medical system, plastic surgery services should include microvascular surgery for the reconstruction of complex soft tissue defects. We utilized a multidisciplinary approach including plastic surgeons, vascular surgeons, rehabilitation specialists, orthopedic surgeons, and infectious disease specialists to determine if patient function can be improved with free flap surgery or major amputation. Although major amputation is considered to produce positive functional outcomes, lower-extremity salvage and reconstruction procedures improve patients' quality-of-life-related outcomes.[2] As an alternative to major amputation such as below-the-knee amputation, reconstruction of the amputation stump using free flaps as a method of preserving the maximal foot length following transmetatarsal amputation also offers stable functional outcomes.[3] For patients with a lower-extremity injury, we work closely with prosthetists and physical therapists to ensure patients have well-designed prostheses and undergo appropriate rehabilitation to regain independent ambulation after amputation or limb salvage.

In the trunk and perineal region, exposed skeleton or orthopedic hardware is not commonly observed due to the abundance of muscles, and the direct approximation of malleable soft tissue after component release is sufficient for the achievement of wound healing. In addition, wound contraction in these regions is greatest in humans,[4] and only adequate debridement sometimes leads to complete wound closure without surgical reconstruction. However, larger defects with an exposed visceral cavity require abdominal wall reconstruction with flaps by a plastic surgeon.

In cases with deep lacerations of the cheek, traumatologists should specifically look for injury to the branches of the facial nerve and parotid duct. Facial nerve and duct injuries should be primarily repaired within 48 hours under an operative microscope. After at least 6 months of observation following facial nerve repair, plastic surgeons consider "reanimation surgery" to restore the function of the muscles related to smiling and other facial expressions.

Although not addressed in this study, the management of wound complications by plastic surgeons is an intensive process. Surgeons are required to address complications related to surgical wounds across a wide range of anatomical areas, often requiring a range of specialist care. As plastic surgeons are able to manage various soft tissue defects, they often play a vital role in the treatment of complex soft tissue problems. Plastic surgeons are usually involved in the secondary management of complicated wounds with spine surgery.[5,6]

Level 1 trauma centers usually provide services for the treatment of complex multisystem injuries including that with referral cases. Within the geographic area under its jurisdiction, trauma centers are obliged to manage all minor cases too. This may aid in resident training for the dissemination of skills for the management of all injury types.

While this study demonstrates a significant finding, one limitation of our study is its retrospective, observational approach. As such, no specific interventions could be performed. Further, this study of only 2-year data in a single center limit generalizing to other countries and circumstances. Future studies will focus on cost-effectiveness and additional cost of plastic surgeon's involvement in a trauma center.

5. Conclusion

Plastic surgeons play various roles in level I trauma centers in Korea and are an essential part of trauma center teams. Therefore, health policymakers should consider our results in the allocation of plastic surgeons to level 1 trauma centers along with experts across other specialties, as the intervention provided by a competent plastic surgeon can prove vital to saving patients' lives and limbs.

Author contributions

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