Secondary definitive surgery for multiple injuries from Wenchuan earthquake in China

ZHAO Jian-ning 赵建宁 *, WANG Rui 王瑞, WANG Bei-yue 王北岳, SHI Xin 施鑫, MAO Guang-ping 毛广平, BAO Ni-rong 包倪荣, QIAN Hong-bo 钱红波 and CONG Yu 丛宇

Objective: To investigate the opportune time of secondary definitive surgery for patients with multiple injuries from earthquakes based on the acute physiology and chronic health evaluation II (APACHE II) score and the principles of damage control.

Methods: Twenty-one patients with critical earthquake injuries were treated with damage control strategies, followed by medical support and surgical intervention to restore their physical potential in the intensive care unit (ICU). Successive APACHE II scoring was adopted to evaluate the patients’ physiological status, and then, internal fixation of fractures and other definitive operations were performed.

Results: All the patients were effectively treated with few complications, low deformity rate and no death.

Conclusions: Appropriate evaluation of patients’ physiological potential, right decision on surgical time and proper operative method can reduce the rates of complications, disability and death for patients with critical earthquake injuries.

Key words: Multiple trauma; Fractures; Surgery, operative

Critically-injured patients from earthquakes, especially the elderly ones complicated with severe internal complications, should receive prompt damage control treatment so as to reduce the possibility of secondary surgery and increase the chance of earlier recovery of physiological potential. Right after the patients getting through the critical stage, definitive treatment should be considered for the purpose of earlier initiation of rehabilitative and functional exercises. During this period, acute physiology and chronic health evaluation II (APACHE II) score and index-injury severity score (ISS) can help assess the traumatic conditions and provide proper schemes for operation. Damage control treatment can limit the primary injury, prevent further harm and reduce the mortality. Restoration of physiological potential is also an important strategy of damage control. All supportive measures should be employed to improve the patients’ status in such main aspects as internal environment, immune function and functions of important organs. Physiological potential recovery can be confirmed by repeated APACHE II scorings, followed by right surgeries on the right individuals at the right time to reduce the rates of complications, disability and mortality. We applied these strategies to 21 critically-injured patients with severe multiple fractures from Wenchuan earthquake and satisfactory results were obtained.

METHODS

Patients
A total of 47 patients were admitted to our hospital from May 23 to May 28, 2008 after Wenchuan earthquake and 21 patients (11 males and 10 females, aged 12-83 years, mean: 48.3 years) with multiple injuries were treated in our department. Among the 21 patients, 5 were injured by falls and 16 by crushing collapse of heavy objects. Among them, 4 patients had brain concussion (1 with brain hernia), 7 had rib fracture (3 with flail chest), 4 had midrange thoracic and abdominal cavity fluidification, and 4 had vertebral column fracture involving 9 vertebral bodies. One patient was complicated with pancreas injury, 3 with cranium fracture, 2 with paraplegia, 4 with pelvic fracture, 3 with crush syndrome, 13 with wound infection, and 3 with multiple organ failure. And 48 places of limb fracture and 32...
places of critical soft tissue bruise were found. Besides, severe circulatory system diseases were found in 6 patients, respiratory failure in 2, pulmonary infection in 3, hepatic failure in 4, renal failure in 4, diabetes mellitus in 3, stress ulcer in 2, moderate and severe anemia in 12, pancytopenia in 1, coagulation disorders in 14, and hypoproteinemia in 16. All the patients underwent damage control protocol, including early treatments such as traction, external fixation bracket, and closed thoracic and abdominal cavity drainage, and secondary definitive treatments such as cranial decompression, vertebral canal decompression, amputation, and internal fixation. The ISS and APACHE II scores on admission were 18-43 (mean: 31) and 5-29 (mean: 17), respectively.

Treatment methods

After consultation with surgeons and physicians, specific protocols were established and each patient received an individual treatment. The patients with lower APACHE II scores (<10) underwent definitive surgery, which mainly included postponed suture of the open wound surface, re-debridement, dermoplasty, blood vessel transplantation, reconstruction of soft tissues, and changing temporary external fixation to internal fixation.

For the patients with higher APACHE II scores (>20), the focus of treatment was to improve their physical states and deal with complications. The detailed measures were taken as follows: keeping blood sugar and blood pressure under control, improving the functions of important organs, partly substituting the kidney function of those with renal failure from crush syndrome by hemodialysis until creatinine reached 300 µmol/L in the blood, employing respirators for those with respiratory failure, improving the patients’ physical status by blood transfusion and nutritional support, treating those with wound infection by isolation and highly effective antibiotics according to the results of bacterial culture, and conducting continuous APACHE II scoring every other day to monitor the patients’ status and provide indications for the next treatment. Psychological counseling was performed for the patients with mental disorders.

For the patients with $10 \leq \text{APACHE II scores} \leq 20$, most operations were not adequate. However, sometimes limited surgery was essential for those who could not afford to lie in bed for a long period. Operations such as drainage, debridement and artificial femoral head replacement, should aim at resolving the main problems and leaving the secondary ones for the next procedure.

RESULTS

After treatment for one month, all the patients survived. Anemia, coagulation disorders and acidosis were corrected in the first 3-5 days. Definitive operations were performed 3 days on average (ranging 0-8 days) after admission, except for one patient with pancytopenia, who was diagnosed to have aplastic anemia later. Out of the 13 patients with infected wounds, 12 got good healing and 1 recovered after a re-amputation operation. Those with brain hernia were discharged with dysnoesia. And those with paraplegia were improved by 2 Frankel levels.

DISCUSSION

Wenchuan earthquake happening on May 12, 2008 inflicted injuries to more than 370,000 people. Most of them were limb trauma patients and only received such simple treatments as debridement, amputation, and temporary fixation for referral transportation. With so large a cohort of patients, what counted most was how to control complications, minimize disability, promote rehabilitation, and prevent plague.

As an unexpected natural catastrophe, the earthquake caused massive victims, destroyed many medical facilities and damaged most of the roads in a very short time, which resulted in a relative deficiency of medical support. Consequently, many of the seriously-wounded could not be transferred for due treatment until 1-2 weeks later, which gave rise to some uncontrollable infections and complications, such as decubital ulcer, hypostatic pneumonia, and renal failure. And infections and renal failure were reported to be the top two lethal factors. In our group, there were 14 cases of infections, accounting for 38% of the open injuries. The most common pathogens of most multiinfections were bacillus claussenin, baumanii, staphylococcus aureus, staphylococcus aureus and enterococcus. As for the patients with crush syndrome-induced renal failure, step-by-step debridement and hemodialysis were employed once a day to keep serum creatinine under 300 µmol/L until the urine volume returned to normal.
Damage control is a series of principles to control the harm from "the 1st hit" such as trauma and restrain the harm from "the 2nd hit" such as open reduction and tissue reconstruction.2 This theory puts its emphasis on saving lives first instead of surgery. Some researchers thought that enhancing patients' tolerance to "the 2nd hit" might be the first thing to be done for reducing fatality.3 Once macrotrauma patients got first-aid, how to control blood coagulation disorder and multiorgan dysfunction syndrome (MODS) became the highlight part of treatment. Friedl and Trentz4 suggested that MODS could be improved by three physiopathologic factors, namely microcirculation resuscitation, source control and metabolism support. When we should perform the secondary definitive operation was not quite certain.5 In our group, we employed APACHE II and ISS at the same time to assess the status of the patients. There is no doubt that ISS is very helpful in damage control, but some factors such as original internal medicine and age are omitted. In 1996, Cunnion et al.6 asserted that APACHE II score could predict the hospital onset of infection. After that, Ho et al.7 certified that APACHE II score could also predict hospital mortality. When the score is lower than 10, the patients have little possibility to die; when the score is 10-20, the morality is about 50%; and when the score is higher than 20, the morality is 80%-100%. Some documents showed that the optimum conditions for definitive surgery were as follows: normal temperature, normal respiratory function, stable hemodynamics, normal blood coagulation, adequate urine volume (1 ml·kg⁻¹·h⁻¹), low enough serum lactic acid (2 mmol/24h) and no life-threatening factors.8

The victims from Wenchuan earthquake, a catastrophe in the mountain area, had their own characteristics: (1) More than 85% of them suffered multiple injuries, mostly from crush and falls, with complicated traumatic conditions; (2) Most of them received first-aid treatment, and many underwent such emergency operations as early debridement, amputation, thoracic close drainage, decompression procedure of the brain, and simple fixation of fracture, but none received definitive treatment; (3) More infections developed than usual, most of them were multiple ones, and some were aggravated by surgical expedients under tough conditions; (4) Anemia and hypoproteinemia were found in more than 66% of the patients, which suggested weak resistance and slow healing; (5) More than 1/3 of the patients were over 60 years, generally with various complications, even with impaired functions of organs; (6) The rate of missed diagnosis was high, with 13 injuries including vertebral fractures missed in our group (Dai et al.9 found that in multiple injuries, the rate of missed diagnosis of spinal fracture ranged 9%-33%); And (7) mental disorder was easily found after great calamity.10 In our group, 7 patients with traumatic mental disorder were all found to have lower education levels and suffer from both severe physiological and psychological traumas. For the correct choice of strategies for definitive surgery, it is essential to have an overall view of the patient's condition. During this course, APACHE II score could be very helpful.

REFERENCES


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