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경운기 사고에 의해 발생한 복부 및 회음부 장기 손상

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- Abstract -

Abdomino-perineal Organ Injuries Caused by Cultivators

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Purpose: Cultivator accidents are frequent and often lead to abdomino-perineal organ injury and, if severe, to death. This study presents the clinical characteristics, outcomes, and factors associated with mortality in patients who sustained an abdomino-perineal organ injury in cultivator accidents.

Methods: We retrospectively analyzed the records of 53 patients who visited the emergency department of a tertiary hospital with abdomino-perineal organ injuries caused in cultivator accidents from April 2005 to March 2010.

Results: All 53 patients had visited other medical institutions before visiting our hospital. Their mean age was 64.0±11.1 (range, 20-80) years and 32 (60.4%) patients were 65 or older. The male-to-female ratio was 46:7. The chief complaint was abdominal pain (38 cases, 71.7%). The 53 patients included 41 cultivator operators (77.4%), 11 passengers (20.8%), and 1 passerby (1.9%). The causes of the injuries included a direct impact of the handlebar in 20 cases (37.7%), a rollover in 21 cases (39.6%), a fall in 10 cases (18.9%), and a wheel in two cases (3.8%). Several of the 53 patients had injuries to multiple abdomino-perineal organs, and the injured organs included the liver (23 cases, 26.4%), spleen (16 cases, 18.4%), pancreas (7 cases, 8.0%), small bowel (7 cases, 8.0%), mesentery (6 cases, 6.9%), adrenal gland (5 cases, 5.8%), and other organs. According to the abbreviated injury scale (AIS) dictionary, a thoracic injury was the most frequent co-injury (33 of 53 cases, 62.3%). Abdomino-perineal surgery was performed in 31 cases (58.8%) and angio-embolization was performed for six liver and two kidney injuries. Thirteen patients died (24.5%); all were males. The Injury Severity Scale (ISS) was lower in the survivors (17.8±8.5 vs. 27.0±16.0; p=0.010).

Conclusion: With the aging of agricultural workers, safety education programs should be implemented. Furthermore, the patient transfer system in agricultural areas must be improved. [J Trauma Inj 2015; 28: 60-66]

Key Words: Cultivator, Abdomino-perineal organ injury, Agricultural

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I. Introduction

In the Republic of Korea, with the rapid industrialization and development of technology since the 1960s, much of the agricultural population migrated to urban areas to find employment in secondary and tertiary industry. Accordingly, the agricultural labor pool has decreased steadily. Simultaneously, the mechanization of agriculture became a crucial alternative to human labor, and greatly increased the efficiency of agricultural work. The first simple agricultural machines, such as threshers, water pumps, and sprayers, do not have much potential for injuring humans. The introduction of large agricultural machines such as cultivators, tractors, and combines, increased the productivity of farmers. However, the farmers who use these machines tend to be elderly, and include women. Due to inexperience with the use of agricultural machinery, accidents are frequent and increasingly result in human injuries. Of the accidents involving agricultural machinery, those due to cultivators are the most frequent.(1-4)

Cultivators can result in abdominal injuries when they overturn on slopes or farm roads or collide with automobiles on national highways. Steering-wheel injuries frequently affect the abdomen. These injuries may involve the abdomino-perineal region and, if severe, this may lead to death.

Given this background, we examined the clinical characteristics, outcomes, and factors associated with mortality in patients sustaining abdomino-perineal organ injuries caused by cultivators.

II. Patients and Methods

We retrospectively analyzed the records of 60 patients with abdomino-perineal organ injuries among 324 patients who visited the emergency department of a tertiary hospital after cultivator accidents between April 2005 and March 2010. 7 patients not admitted and transferred to other hospital were excluded.

The abbreviated injury scale (AIS) dictionary was used to classify the sites and severity of injuries. Organ injuries were graded according to the definition of the American Association for the Surgery of Trauma (AAST). The patients were classified into two groups: the survivor and non-survivor groups. We analyzed differences in the clinical characteristics of these two groups.

Statistical analyses were performed using the SPSS software (ver. 12.0 for Windows; SPSS, Chicago, IL, USA). The chi-squared test and Student's t-test were performed for the analysis. p-values less than 0.05 were deemed to indicate statistical significance.

III. Results

1. Clinical characteristics of the patients (Table 1)

The mean age of the 53 patients was 64.0±11.1 (range 20-80) years. Thirty-two (60.4%) were elderly (i.e., 65 years or older). By age group, there were 30 patients (56.6%) in their 60s and 11 patients (20.8%) in their 70s, and only three patients (5.7%) who were 50 years or younger.

The male-to-female ratio was 46:7 and underly-

Table 1. Clinical characteristics of the patients with abdomino-perineal organ injuries caused in cultivator accidents.

	Number of patients (%)
Age (mean±SD*, range)	64.0±11.1 (20-80)
Gender	
Male	46 (86.8)
Female	7 (13.2)
Comorbidity	24 (45.3)
Chief complaint	
Abdominal pain	38 (71.7)
Abdominal distension	3 (5.7)
Flank pain	3 (5.7)
Chest pain	3 (5.7)
Dyspnea	2 (3.8)
Perineal pain	2 (3.8)
Pelvic pain	1 (1.9)
Back pain	1 (1.9)
Injured person	
Operator	41 (77.4)
Passenger	12 (22.6)
Part of cultivator causing injury	
Handle	
Rollover	20 (37.7)
Fall	21 (39.6)
Wheel	10 (18.9)

* SD: standard deviation

ing disease was present in 24 patients (45.3%). All 53 patients had visited other medical institutions before visiting our institution.

In this series, the major symptom was abdominal pain in 38 cases (71.7%), with three cases each of abdominal distension, flank pain, and chest pain, two cases each of dyspnea and perineal pain, and one case each of pelvic pain and back pain.

The patients included 41 cultivator operators (77.4%) and 12 passengers (22.6%). The cause of the injury included a handlebar in 20 cases (37.7%), rollover in 21 cases (39.6%), a fall in ten cases (18.9%), and a wheel in two cases (3.8%).

2. Abdomino-perineal organs that were injured (Table 2)

The mean number of abdomino-perineal organs sustaining injury was 1.6±0.7. One to four organs were involved in 27 (50.9%), 19 (35.8%), 6 (11.3%), and 1 (1.9%) case, respectively. The affected organs included the liver (23 cases, 26.4%), spleen (16 cases, 18.4%), pancreas (7 cases, 8.0%), small intestine (7 cases, 8.0%), mesentery (6 cases, 6.9%), adrenal gland (5 cases, 5.8%), large intestine (5 cases, 5.8%), duodenum (4 cases, 4.6%), and kidney (4 cases, 4.6%). Additionally, the urinary bladder, stomach, and rectum were injured in some patients. According to the Organ Injury Scales (OIS) grades of the AAST, there were severe injuries, of grade IV or higher, involving the liver (12 cases, 54.5% of the respective organ injuries), spleen (3 cases, 17.6%), pancreas (4 cases, 57.1%), duodenum (1, 25.0%), and kidney (1 case, 25.0%). The right adrenal was injured in four patients and the left in one.

3. Co-injured body regions (Table 3)

According to the AIS dictionary, there were 33 cases (62.3%) of thoracic injury, eight cases (15.1%) of facial injury, seven cases (13.2%) of spinal cord injury, seven cases (13.2%) of lower extremity, pelvis and buttocks injury, four cases (7.5%) of head injury, and four cases (7.5%) of upper extremity injury.

Table 2. Abdomino-perineal organ injuries occurring in cultivator accidents and multiple abodmino-perinieal organs injured patients.

		Number of patients (%)
Number of injured organs, (mean ± SD*=1.6 ± 0.7)	1	27 (50.9)
	2	19 (35.8)
	3	6 (11.3)
	4	1 (1.9)
Injured organ, n (%)		
Liver		23 (26.4)
Spleen		16 (18.4)
Pancreas		7 (8.0)
Kidney		4 (4.6)
Adrenal gland		5 (5.8)
Mesentery		6 (6.9)
Bladder		1 (1.1)
Stomach		1 (1.1)
Duodenum		4 (4.6)
Small bowel		7 (8.0)
Colon		5 (5.8)
Rectum		1 (1.1)
Abdominal wall		3 (3.5)
Others		4 (4.6)

* SD: standard deviation

Table 3. Co-injured body regions according to the AIS dictionary in the patients with abdomino-perineal organ injuries caused in cultivator accidents.

Co-injured body region	Number of patients (%)
Head	4 (7.5)
Face	8 (15.1)
Neck	0
Thorax	33 (62.3)
Spine	7 (13.2)
Upper extremity	4 (7.5)
Lower extremity, pelvis, and buttocks	7 (13.2)
External (skin) and thermal injury and other trauma	0

4. Treatment modalities and outcomes

Abdomino-perineal surgery was performed in 31 patients (58.5%), including six small bowel segmental resection and anastomosis procedures, five splenectomies, three cases each of hepatorrhaphy, distal pancreatectomy, damage control surgery with pad packing, and mesentery repair, and two cases each of primary closure of small bowel and right hemicolectomy. Angioembolization was performed in eight patients (15.1%): six hepatic and two renal injuries.

In our series, the mean hospital stay was 19.2±19.1 days. Thirteen patients (24.5%) died during the treatment, of which nine patients died within 48 h of arriving at our emergency department.

5. Univariate comparison of the survivor and non-survivor groups (Table 4)

Of the 53 patients, 40 (75.5%) survived and 13 (24.5%) died. All of the deaths were males, although the gender difference was not significant. On admission, the mean hemoglobin was 10.9±2.7 g/dL in the survivors and 7.9±2.4 g/dL in the non-survivors (p=0.001). The number of involved abdomino-perineal organs was 1.5±0.6 in the survivors and 1.9±1.0 in the non-survivors; this difference was not significant. According to the AIS classification, the number of other co-injured body regions was 1.4±1.2 in the survivors and 0.5±0.7 in the non-survivors (p=0.016). The Injury Severity Scale (ISS) was 17.8±8.5 in the survivors and 27.0±16.0 in the non-survivors (p=0.010). The ISS exceeded 15 points in 23 (57.5%) survivors and 12 (92.3%) non-survivors (p=0.040). The New Injury Severity Scale (NISS) was 21.6±11.3 in the survivors and 35.3±16.0 in the non-survivors (p=0.001). The Glasgow Coma Scale (GCS) score was 14.9±0.8 in the survivors and 12.9±4.3 in the non-survivors (p=0.007).

IV. Discussion

With the industrialization and modernization of Korean society, much of the formerly agricultural population has migrated to urban areas. Consequently, there is a shortage of agricultural labor, which now includes the elderly and women. With the widespread distribution of agricultural machinery, together with the aging of the agricultural population, the risk of accidents has increased. Cultivator is one of the three major agricultural machines, together with combines and tractors, in South Korea. Of the three, it is the most prevalent,

Table 4. Univariate comparison of survivors and non-survivors in the patients with abdomino-perineal organ injuries caused in cultivator accidents.

	Survivors (n=40)	Non-survivors (n=13)	p-value
Age	63.1±12.0	66.7±7.8	0.313
Gender			0.121
Male	33 (82.5)	13 (100)	
Female	7 (17.5)	0	
Comorbidity	16 (40.0)	8 (61.5)	0.151
Interval from trauma to hospital arrival (hour)	7.1±6.4	5.5±5.9	0.438
Hemoglobin (g/dL)	10.9±2.7	7.9±2.4	0.001
Packed red cells transfused (IU)	18.2±14.3	4.7±5.5	0.005
WBC* ($\times 10^3/mm^3$)	14.1±6.3	11.4±5.1	0.172
Number of injured intra-abdominal and pelvic organs	1.5±0.6	1.9±1.0	0.074
ISS†	17.8±8.5	27.0±16.0	0.010
ISS≥15	23 (57.5)	12 (92.3)	0.040
NISS	21.6±11.3	35.3±16.0	0.001

* WBC: white blood cell

† ISS: injury severity scale

† NISS: new injury severity scale

at a rate of 78.6%, while 85.5% of the accidents involving these three machines involve cultivators. While accidents associated with cultivators constitute at most 0.1% of all accidents, they represent 0.3% of the mortality. Additionally, with the aging of operators, complications due to accidents and the resulting mortality have also increased.(5)

Accidents involving agricultural machinery cause health impairment, a loss of labor, and economic loss in agricultural workers. Thus, it is important to prevent cultivator accidents. Part of this effort is a campaign to use reverberators.(5) Park et al.(6) reported that more professional, inclusive education programs should be implemented to reduce the occurrence of accidents due to agricultural machinery. They also noted that a license certification system should be established to regulate the imprudent use of agricultural machinery.

Of all the accidents involving agricultural machinery occurring in rural areas during the 1990s, those due to cultivators were the most prevalent. These involved primarily males aged 65 or younger.(2-4,7)

Our clinical series included 46 (86.8%) males of which 30 (56.6%) were in their sixties and 11 (20.8%) in their seventies. Including one woman, there were 32 elderly patients (60.4%), aged 65 years or older. Thus, our clinical series included a greater preponderance of elderly patients than previous reports. By season, there were 25 (45.3%) cases during the summer and 5 (9.4%) during the winter.

Lee et al.(5) reported that the incidence of accidents was 36.8% in the group using a reverberator versus 7.7% otherwise, indicating that the use of a reverberator helped to prevent traffic accidents. The safety of cultivators travelling on unlit national highways at night cannot be assured solely by the use of a noctilucent reflection plate and warning signs for low-speed vehicles. It is also necessary to equip cultivators with rear lights and turn indicators, because the cultivator operator may be relatively senile and accidents happen frequently when the cultivator turns suddenly without the operator noticing an automobile close behind, because of the noise.

Ten percent of trauma patients with a negative abdominal examination have occult abdominal/pelvic injuries. An objective evaluation of the abdomen should be performed liberally for adult blunt trauma patients regardless of physical findings, to avoid missing clinically significant injuries.(8)

On report from Hong et al.,(9) chest and abdominal trauma were common in handlebar injuries. The incidence of receiving some kind of surgery and the mortality rate after cultivator-related accidents were higher in handlebar injuries (13/5 patients, 43.3%/16.7%) than in the overturning (13/2 patients, 27.1%/4.2%) or fall-down (4/2 patients, 17.4%/8.7%) injuries.

D'Errico et al.(10) reported that 7% of nonoperative management (NOM) patients needed surgical exploration during the 24 h following trauma. NOM may be used safely in cases of blunt abdominal trauma. Hemodynamic instability, suspicion of hollow viscera perforation, and multiple transfusions are contraindications to NOM.

The liver is the organ injured most frequently with abdominal trauma. NOM is preferred in stable patients, while laparotomy is indicated in unstable patients. Interventional radiological techniques are being used more widely, particularly in patients who are being managed nonoperatively or have been stabilized by perihepatic packing.(11) In our series, 9 (40.9%) of 22 patients with liver injury underwent emergency surgery for a liver injury or co-injury. Hepatorrhaphies were performed in three patients, a right posterior sectionectomy with perihepatic packing in one, and a right hepatectomy in one patient. Angioembolization was performed in 6 of the 22 patients with a liver injury. Five (22.7%) patients died. Angiographic embolization is used to control hemorrhage in adult blunt liver, spleen, and kidney injuries. Angiographic embolization is a safe, effective technique for controlling hemorrhage from blunt injuries in select patients.

In blunt splenic injury, NOM has become the preferred treatment for hemodynamically stable patients.(12) The management of blunt splenic injury with observation and organ preservation avoids the lifelong risk of overwhelming post-splenectomy infection.(13) Carvalho et al.(14) reported that there was no NOM failure in grade I or II splenic injuries, while the failure rate was 17.5% in grade III and IV

injuries combined, and 80% in grade V injuries (p= 0.0008). The increased use of initial splenic artery embolization in high-risk patients has increased the successful use of NOM, but has not been associated with other incremental improvements.(12) In our series, splenectomies were performed in 5 (29.4%) of the 17 patients with splenic injury. There were two grade III, two grade IV, and one grade V injuries.

Pancreatic injuries are associated with high morbidity and mortality, due to accompanying vascular and duodenal injuries. Pancreatic injuries are not always easy to diagnose, resulting in life-threatening complications. Their management depends on the severity of the pancreatic injury, as well as associated injuries. Damage control surgery in hemodynamically unstable patients reduces morbidity and mortality.(15) In our series, three (42.9%) of the seven patients with pancreatic injuries died.

Approximately 10% of all significant blunt abdominal injuries manifest with renal injury. CT can help detect active hemorrhage and urinary extravasation and is very useful in guiding transcatheter embolization and delineating pre-existing disease entities that may predispose the kidneys to post-traumatic hemorrhage.(16) In our series, the right and left kidneys were injured in two cases each. Angioembolization was performed in two patients. NOM was successful in all patients with renal injuries.

Campillo-Soto et al.(17) reported that CT for the detection of bowel and mesenteric injuries following blunt abdominal trauma had a sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 84.2, 75.6, 76.2, 83.8, and 79.7%, respectively. Rey Valcarcel et al.(18) reported that in patients with gastrointestinal and mesenteric injuries, surgery was delayed for more than 8 h in 20% of patients, the most common reason being a false-negative CT result. Several factors delayed the diagnosis and treatment in five patients, such as an initial lack of symptoms, the low diagnostic sensitivity of CT (34% false negatives), and the NOM of solid organ injuries. The beading and termination of mesenteric vessels indicating surgically important mesenteric injury is an example of one of these new features.(19)

In duodenal injuries, differentiation between a contusion of the duodenal wall or mural hematoma and duodenal perforation is vital. Contrast-enhanced CT is the gold standard for diagnosing patients with duodenal perforation after blunt abdominal trauma.(20) In our series, hollow viscera injuries affected the stomach, duodenum, small bowel, colon, and rectum in 1, 4, 7, 5, and 1 cases, respectively. Mortality was high in patients with duodenal injury; 3 of 4 (75%) patients with duodenal injuries died.

In poly-traumatized patients with blunt abdominal trauma, chest trauma is the most common extra-abdominal trauma (67%). In a published series, 36 patients (38.3%) died during their hospital stay; the most frequent causes were hemorrhagic shock (27.8%), acute respiratory distress syndrome (27.8%), and head trauma (22.2%).(12) In our series, chest trauma was also the most common extra-abdominal trauma (62.3%).

V. Conclusion

With the adoption of mechanical technology in agriculture and the aging of agricultural workers, safety education programs should be implemented. Additionally, efforts should be made to reduce the occurrence of accidents by adding safety features to agricultural machinery and roads used by agricultural machinery at night. For example, a noctilucent plate and turn indicators should be installed at the rear of agricultural machinery. Given the mortality of patients sustaining injuries to the liver, pancreas, and duodenum in cultivator accidents, special attention should be paid to patients with these injuries.

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