

Early Transcatheter Arterial Embolization for the American Association for the Surgery of Trauma Grade 4 Blunt Renal Trauma in Two Institutions

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Objectives: To evaluate the efficacy of early transcatheter arterial embolization for hemodynamically stable patients with The American Association for the Surgery of Trauma (AAST) grade 4 blunt renal trauma.

Materials and Methods: The medical records of consecutive patients with grade 4 blunt renal trauma who were transported to our two critical care centers in Japan and treated with early transcatheter arterial embolization (TAE) between 2001 and 2013 were retrospectively reviewed. Treatment failure was defined as the need for further surgical intervention or re-embolization after initial embolization. We divided these cases into two groups, a group who survived and a group who died, investigating the factors that led to death.

Results: Seventeen patients underwent early TAE, with an average time between presentation and embolization for renal trauma of 125 minutes (66–214 minutes). There was no case of treatment failure. Three of the patients died, but none solely because of renal injury. Significant factors associated with patient death were the number of concomitant injured organs ($p=0.04$), the presence of pelvic fractures ($p<0.01$), and the presence of visceral injuries ($p<0.01$). The presence of lumbar fractures ($p=0.09$) also tended to be associated with patient death.

Conclusions: Early TAE is an effective treatment and should be actively performed for hemodynamically stable patients with grade 4 blunt renal injuries without multiple concomitant organ injuries.

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Key words: blunt renal trauma, multiple trauma, interventional radiology, angioembolization, treatment failure

Introduction

In a previous study, we reviewed renal trauma treated with transcatheter arterial embolization (TAE) in two institutions¹. This study focuses on grade 4 blunt renal trauma with TAE. Over the last 2 decades, TAE for The American Association for the Surgery of Trauma (AAST) grade 4 and 5 blunt renal trauma has become increas-

ingly common because of advances in interventional radiology (IR) technology²⁻⁷. However, some reports have noted that TAE failure for grade 4 and grade 5 blunt renal trauma is not rare (**Table 1**)^{2,3}. The efficacy and safety of TAE for grade 5 blunt renal trauma remain controversial³⁻⁵. The cause of these results might be the high rate of TAE failure in grade 5 blunt renal trauma^{3,4}. On the other

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Table 1 Transcatheter arterial embolization (TAE) failure rate in past reports and the present report

Author	Period	Country	Population	TAE failure/Renal trauma treated with TAE	TAE failure/Grade 4 treated with TAE
Shigehara ¹	2006–2008	Japan	National data base	20 (12.2%) /160	NA *
Hotaling ²	2002–2007	USA	National data base	22 (45.8%) /48	14 (38.9%) /36
Menaker ³	2002–2008	USA	1 institution	4 (22.2) /18	3 (17.6%) /17
Brewer ⁴	2004–2007	USA	1 institution	0 (0%) /9	-
Shoobridge ⁵	2002–2008	Netherlands	1 institution	1 (12.5%) /8	NA
Charbit ⁶	2005–2009	France	1 institution	1 (11.1%) /9	NA
Present study	2001–2013	Japan	2 institutions	0 (0%) /19	0 (0%) /17

* NA: not available

Table 2 Characteristics of patients treated with early TAE

Patients, n	17
Mean age, years (mean±SD)	39.7±20.0
Male/female, n	13/4
Laterality left/right, n	7/10
GSPs/MCs/GSPs+MCs/NBCA-Lipiodol (NBCA: Lipiodol=1: 2)	8/2/6/1
The number of concomitant injured organs 0/1/2/3/4/5/6	2/5/4/4/1/0/1
Brain injury, n	4
Lumber fracture, n	2
Pelvic fracture, n	6
Outcome, Survival/Dead, n	14/3

hand, past reports revealed that even in grade 4 blunt renal trauma TAE failure is not rare²⁻⁴. Hence, the present study focuses on grade 4 blunt renal trauma treated with TAE. Moreover, we examine the risk factors for death in these cases, because the purpose of treatment for renal trauma is to save the patient's life.

Materials and Methods

The medical records of consecutive patients with blunt renal trauma treated with early TAE in Nippon Medical School Hospital and Nasu Red Cross Hospital between April 2001 and March 2013 were retrospectively reviewed. The cases were graded based on enhanced computed tomography (CT) and intraoperative findings according to the AAST Organ Injury Scale⁸. The attending physicians of the critical care team make the decisions about treatment, taking into account the opinions of the radiologists and urologists. Hemodynamically stable patients with grade 4 trauma were indicated for and treated with early TAE. In our institutions, an interventional radiology (IR) team is on call in the hospital, and the attending physicians of the critical care team can immediately mobilize the team if necessary. We defined TAE with such a well-timed system as early TAE. The radiologists can perform selective embolization. Access to the renal artery was through the common femoral or brachial

artery. After selection of the injured renal artery, diagnostic angiography was performed. Selective embolization was performed based on angiographic findings. The embolization agents were selected according to the radiologists' preference. The radiologists used micro coils (MCs), gelatin sponge particles (GSPs) and n-butyl-2-cyanoacrylate (NBCA)-Lipiodol as embolic agents.

TAE failure was defined as the need for further surgical intervention or re-TAE after initial TAE.

We divided these cases into 2 groups, a survival group and death group, investigating the factors of death. Statistical analysis was carried out with Student's t-test. A p value <0.05 was considered significant.

Results

Seventeen consecutive patients with AAST grade 4 blunt renal trauma, including 4 females and 13 males who were 13 to 72 years old, were treated with early TAE in our institutions between April 2001 and March 2013. The mechanism of injury included traffic accidents (n=12), falls (n=3), and sports accidents (n=2). Ten patients had injuries on the right side, and 7 were injured on the left (Table 2).

All of the patients were followed up strictly with monitoring of serial hematocrit levels and vital signs in an intensive care unit setting. The average time between

Table 3 Risk factors for death of patients treated with early TAE

Outcome	Survival n=14	Dead n=3	P value
Mean age (years)	39.7 (13–72)	40.0 (18–65)	0.5
Sex/Male	11	2	0.38
Laterality/Left	5	2	0.23
Time between arrival and embolization	120 (75–214)	96 (66–171)	0.32
The number of concomitant injured organs	1.6 (0–3)	4.3 (3–6)	0.04
Presence of brain injuries	2 (14%)	2 (66%)	0.13
Presence of lumber fractures	0 (0%)	2 (66%)	0.09
Presence of pelvic fractures	3 (21%)	3 (100%)	<0.01
Presence of visceral injuries	8 (57%)	3 (100%)	<0.01

arrival and embolization for renal trauma was 125 minutes (range, 66–214 minutes). The treatment time for embolization therapy was approximately 20 minutes. The radiologist used GSPs, MCs, GSPs with MCs, and NBCA-Lipiodol (NBCA:Lipiodol=1:2) as embolic agents (Table 2). No technical complications occurred in relation to the embolization procedure. None of the patients had TAE failure.

Of the 17 patients who were treated with early TAE, 15 patients had concomitant injury to other organs. Three of these 17 patients died, but none solely because of renal injury. Two died of brain injury, and one died of acute circulatory failure after TAE.

Significant factors that were associated with patient death were the number of concomitant injured organs ($p=0.04$), presence of pelvic fractures ($p<0.01$), and presence of visceral injuries ($p<0.01$). Presence of lumber fractures ($p=0.09$) also tended to be associated with patient death (Table 3).

Discussion

None of the patients in the present study had TAE failure. The well-trained IR and critical care teams worked early and rapidly to achieve selective embolization for injured organs. The time between presentation and early embolization for renal trauma was relatively short (mean, 125 minutes; range, 66–214 minutes). The patients were successfully treated with embolic agents.

In the treatment of trauma, hemorrhage control minimizes coagulopathy caused by shock and resuscitation⁹. Therefore, early initiation of TAE most likely increases its success rate because TAE involves biological coagulability. Brewer et al reported that in their institution, hemodynamically unstable patients with AAST grade 5 blunt renal trauma were treated with TAE within approximately 1 hour after onset of trauma, without embolization failure⁵. They indicated that with timely access to an-

giography with IR, embolization can be considered as a first-line option⁵.

These results suggested that early initiation of TAE contributes to successful TAE.

In the present study, early TAE was an effective local treatment for grade 4 patients, because there is no case of TAE failure. Though embolization for renal injury was successful, 3 patients died. The patients who died had multiple concomitant injuries of other organs. One patient who died of acute circulatory failure with pelvic and lumber fracture and without brain injury was treated for renal trauma with TAE 66 minutes after arrival at hospital and had 3 concomitant injuries other than to the kidneys. Embolization was performed for renal trauma and bleeding due to pelvic fracture to keep circulation stable. Bleeding cessation was confirmed by using angiography, but cardiopulmonary arrest occurred immediately after the angiography. He received resuscitation but died approximately 9 hours after. One patient, who had pelvic and lumber fractures, died of cerebral herniation the next day after being treated for renal trauma with TAE 96 minutes after arrival at hospital and had 6 concomitant injuries other than the kidneys. The other patient also successfully treated with TAE died of brain injury.

In this study, we examined the risk factors for death, because the purpose of treatment for renal trauma is to save the patient's life. The number of concomitant injured organs ($p=0.04$), presence of pelvic fractures ($p<0.01$), and presence of visceral injuries ($p<0.01$) were risk factors for death. Presence of lumber fractures ($p=0.09$) tended to be a factor associated with patient death (Table 3).

These results suggest that early TAE is an effective treatment and should be actively performed for hemodynamically stable patients with grade 4 blunt renal injuries without more than 2 concomitant organ injuries and pel-

vic fractures or visceral injuries. It is controversial in patients with more than 2 concomitant organ injuries, pelvic fractures, or visceral injuries. The choice of whether or not to perform early TAE depends on the state of the patients.

This study has limitations. It was a retrospective study with a small number of patients.

Only a few studies have reported the time between arrival and embolization. To the best of our knowledge, this is the first series to describe in detail the time between arrival at a hospital and embolization for AAST grade 4 blunt renal trauma. Therefore, the present cases cannot be accurately compared with other cases. In addition, the present study did not include long-term follow-up of renal function. Therefore, future prospective studies are needed that involve a greater number of patients with long-term follow-up, that examine additional factors such as arrival and embolization time, and that evaluate the causes of TAE failure.

Conclusions

Early TAE is an effective treatment and should be actively done for hemodynamically stable patients with grade 4 blunt renal injuries with no more than 2 concomitant organ injuries, pelvic fractures, or visceral injuries. The choice of whether or not to perform early TAE depends on the state of the patients with more than 2 concomitant organ injuries or with pelvic fractures or visceral injuries.

Conflict of Interest: None declared.

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