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Traumatic hemipelvectomy: Improvements in the last decennia illustrated by 2 case reports

T.K. Timmers[a,*], D. Tiren[a], P.F. Hulstaert[a], P.P.A. Schellekens[b], L.P.H. Leenen[a]

[a] University Medical Centre Utrecht, Department of Surgery, P.O.-box 85500, 3508 GA Utrecht, The Netherlands
[b] University Medical Centre Utrecht, Department of Plastic Surgery, P.O.-box 85500, 3508 GA Utrecht, The Netherlands

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ABSTRACT

INTRODUCTION: In this article we present two cases of young men who sustained a traumatic hemipelvectomy.
PRESENTATION OF CASE: The first case occurred more than 10 years ago and the second case happened less than 1 year ago. Changes in the management for resuscitation, surgical intervention, and in postoperative treatment are detailed. Goal of this article is to evaluate the changes over time in the treatment of trauma in general and this specific injury in particular.
DISCUSSION: Maximum survival chance could be achieved by an aggressive resuscitation (following a massive transfusion protocol-ratio of 1:1:1 unit of blood-products), starting pre-hospitally and continued in the emergency department, immediate control of the haemorrhage and direct surgical intervention. Early and frequent re-explorations are necessary to prevent complications as sepsis and to minimize the chance for complications such as disturbed wound healing and fistula formation. The use of the Vacuum-Assisted Closure therapy nowadays gives the patient an earlier recover and lesser chance at developing complications. Early consultation with plastic surgeons needs to be done in order to achieve an adequate definitive wound-closure (reconstructive surgery).
CONCLUSION: A traumatic hemipelvectomy is a catastrophic and mutilating injury, seldom survivable. Maximum survival chance could be achieved by an aggressive resuscitation, frequent re-explorations, the use of VAC therapy and early consultation with a plastic surgeon for reconstructive surgery.

1. Introduction

The traumatic hemipelvectomy (hindquarter amputation) is a catastrophic injury associated with a high percentage of death and morbidity. Because of improvements in pre-hospital assessment, resuscitation and shorter transport time,[1–8] more-and-more patients survive this injury. The traumatic hemipelvectomy is a rare entity with 0.6% of all pelvic fractures,[8] therefore experience in resuscitation and subsequent treatment is scarce. After the first case report in the literature,[9] there has been a slight increase in the number of reports for this severe injury over the last 50 years.[7,8] With a total of 52 cases reported in the literature up to 2010.[10] Morbidity is due to the combined loss of the lower extremity with urological, gastro-intestinal and peritoneal injuries.[11] Improvement in surgical treatment and medical management decreases the risk of complications during the postoperative course.

In this article we present two cases of young men who sustained a traumatic hemipelvectomy. The first case occurred more than 10 years ago, the second case happened less than 1 year ago. Changes in the management for resuscitation, surgical intervention, and in postoperative treatment are detailed. Goal of this article is to evaluate the changes over time in the treatment of trauma in general and this specific injury in particular. Each patient was informed that data concerning the case would be submitted for publication, and each agreed to this.

2. Case report A[12]

A 33-year-old motorcyclist collided with a traffic light at approximately 180 km/h. His left leg lay upside down along side the patient's head and seemed to be near (complete) amputated. At the scene the ambulance personnel repositioned his left leg in line with his body.

Upon arrival at the Emergency Department, the airway was patent and there were no evident ventilatory problems. The patient had an ongoing blood loss and the first blood pressure at the emergency department was 80/50 mmHg with a heart rate of 90 beats/min. Resuscitation was continued using crystalloid infusions and transfusion of red blood cells (RBC) and fresh-frozen plasma (FFP) in a 3 to 1 ratio. The patient was quickly transferred to the operating room and he underwent an emergency laparotomy.

2.1. Operative procedure

A clamp was put on the abdominal aorta to obtain proximal vascular control. Further exploration showed an internal

* Corresponding author.
E-mail address: tk.timmers@gmail.com (T.K. Timmers).

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Fig. 1. Near complete avulsion of the left leg after repositioning.

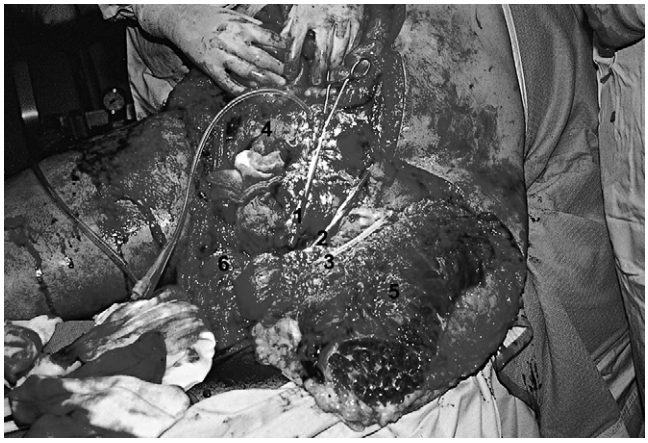

Fig. 2. Details of the wound on the left pelvic side during the initial operation (clamp on the left external iliac artery)—1: left iliac vein; 2: left iliac artery; 3: left internal iliac artery; 4: bladder; 5: greater gluteal muscle; 6: rectum/anus.

hemipelvectomy (left side, Figs. 1 and 2) with a complete avulsion of the external genitals, the rectum and the left iliac vessels and nerves. The ventral part of the bladder was torn off from its anatomical position. A suprapubic catheter was inserted. The internal hemipelvectomy was completed. The peri-vesicular and presacral venous plexus locations were packed with gauzes and the left iliac artery and vein were surgically ligated. The wound defect on the left side was temporarily closed with clamps (see Fig. 3).

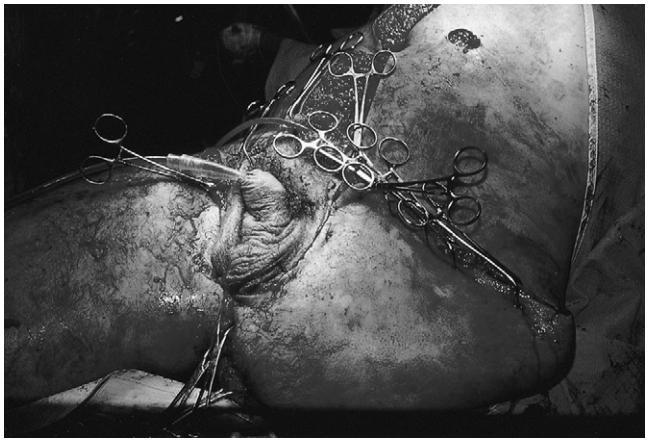

Fig. 3. Primary closure of the wound after initial operation with clamps.

During his complete intensive care period he received antibiotic treatment with Cefuroxim® and Metronidazol® intravenously.

During the emergency assessment and the following emergency operation, the patient continued to have serious disruption of vital signs despite aggressive resuscitation (fluids, RBCs and FFPs). Further stabilization of his vital signs took place during his admission to the intensive care unit (ICU) postoperatively (see Fig. 4).

Twenty-four hours after the initial operation a re-exploration was performed. We started with the construction of a diverting colostomy. Inspection of the hemipelvectomy wound showed an adequate vital gluteal muscle tissue. The defect was again closed with clamps. Postoperatively the patient continued to be treated at the intensive care unit. After another 24 h the patient underwent a second elective operation in which re-exploration of the hemipelvectomy wound and stabilization of right tibial fracture took place. The flap at the defect on the left half of the pelvis was completely ischemic and was resected together with the necrotic external genitals. The defect was closed using a sterile operation-towel for mechanical stabilization. During the extend of his further ICU-admission the patient developed severe electrolytes shifts (several times) from fluid and blood loss localized at the pelvic defect and had a persistence of urine leakage. On day 4, 9, 16, 23 and 35 he underwent multiple explorations of his hemipelvectomy wound to address the infection and to evacuate the haematoma and other fluid collections. Antibiotic treatment was continued because the infection and fluid collections returned after addressing it by surgery and stopping the intravenous antibiotics would lead to sepsis. After a total intensive care length of stay of 40 days the patient could be admitted to the general surgical ward. Several operations were performed to manage the recurrent infection localized at the pelvic wound (debridement and necrotectomy), and to close the defect using split skin grafts. Nevertheless, it was not possible to manage the persistent urine leakage from the defect, to stabilize the infection, or to improve coverage of the defect. At the time of the event the senior author has treated this patient at a different Level 1 trauma centre. Eventually, the patient was transferred to our hospital for further interventions 3 months after the accident. A Brickerbladder was constructed and various plastic surgery procedures were needed to improve coverage of the defects. In our hospital (UMC Utrecht) the communication with the rehabilitation team is very close. This team of different experts was consulted after each operation concerning the coverage of the defects and they started treatment in the hospital (mobilizing in the swimming pool). When the patient was discharged from the hospital the rehabilitation physicians wanted to admit him to their own facility. However, he refused further rehabilitation support. He is not able to walk, is currently staying at home, and does not work or hardly have any contact socially. Nevertheless, he mentioned to have a visual analogue scale (VAS) of 8 on a scale of 10. The patient has discharged himself of any further physical follow-up.

3. Case report B

In February 2010 a 17-year-old male scooter-driver was involved in a head on collision with a car. He sustained a catastrophic injury resulting in a complete disruption of the left hemipelvis. His left leg was completely separated from his pelvis. The patient was in haemodynamic shock because of the ongoing haemorrhage from the wound in the left groin. The pre-hospital assessment included securing the airway (intubation). There were no obvious pulmonary or breathing problems. The circulation was severely compromised with an initial blood pressure of 77/48 mmHg (at the scene) with a tachycardia of 125 beats/min. The patient was resuscitated with 2500 cm^3 of fluids during the

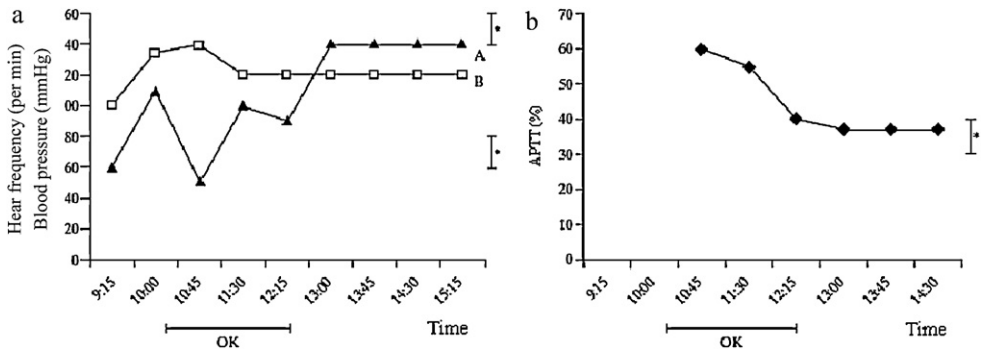

Fig. 4. Disturbances of vital signs during the assessment at the emergency department and during the initial operation, continued at ICU admission. Heart frequency (part A, curve B), blood pressure (part A, curve B), and activated partial tromboplastin time (APTT), part B.

transportation due to haemorrhage that could not be controlled by pressure on the wound only, the assisting pre-hospital doctor cross-clamped the iliac artery and vein in the open wound preventing more blood loss and to maintain haemostasis.

The accident occurred at 23:07 hour, the ambulance was at the scene at 23:29 hour and the patient was admitted to the hospital at a distance of 35 km at 00:12 hour. On arrival at the emergency department his blood pressure had risen to 95/32 mmHg. Blood loss was estimated to 3–4 L of blood.

3.1. Condition on admission

The patient had a marble white skin colour. He was intubated and mechanically ventilated. Still, there was ongoing blood loss from the groin-wound. The separated left leg was brought as well, Figs. 5 and 6. A quick primary assessment did not identify any problems in the airway and the breathing, however, there was an evident continuous problem in the circulation: even though there was a palpable carotid pulse, a blood pressure could not be measured at the beginning of the resuscitation. From the beginning, resuscitation was performed using a 1:1:1 ratio of RBCs, FFPs, and platelets. A total number of 8 (2400 cm^3) units of RBCs and two units of (650 cm^3) FFPs were given in the preoperative period. This aggressive resuscitation resulted in a blood pressure of 85/45 mmHg with a decreasing tachycardia of 110. The first haemoglobin count was 3.4 mmol/L. During the resuscitation at the emergency department antibiotic treatment (amoxicillin and clavulanic acid®) was started. The routine X-rays showed:

- *Chest X-ray* (Fig. 8): Tube in the inserted too deep almost in the right main bronchus, no evident trauma to the lungs, a fracture dislocation of the right humeral head at the shoulder joint and a gastric dilatation.
- *Pelvic X-ray* (Fig. 9): Four clamps in the left pelvic region, absence of bony structures (superior and inferior rami, the acetabulum, os Ileum and the sacro-iliac joint) of the complete left hemipelvis.

After repositioning of the endotracheal tube, the patient was transferred to the operating theatre after 40 min time on the emergency department/shock room for further haemodynamic stabilization.

3.2. Operative findings (Fig. 7)

1. Separation of the extremity had taken place at the symphysis pubis and the left sacro-iliac joint.
2. The rectum had been torn across just below the peritoneal reflection.
3. The peritoneum was visible but intact.
4. The prostate was floating free and there was gross haemorrhage from the peri-vesicular venous plexus.
5. Clamps were still attached at the iliac vessels and femoral and sciatic nerves.
6. The left ureter could not be identified.
7. The left greater gluteal muscle was still viable.

Fig. 5. The complete left lower limb with the hemipelvis attached.

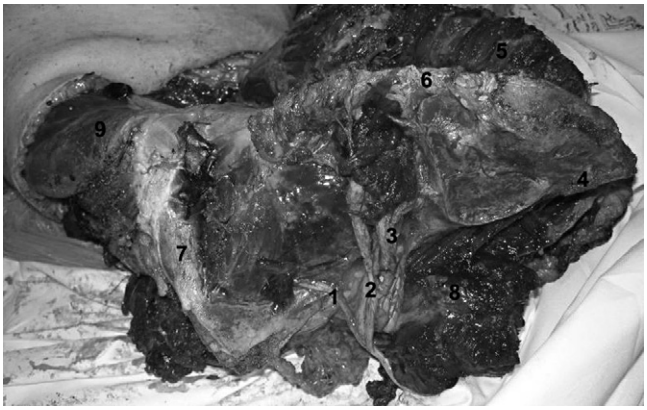

Fig. 6. Detail of the avulsed femoral and sciatic nerves—1: left iliac vein; 2: sciatic nerve; 3: left iliac artery; 4: os ileum; 5: greater gluteal muscle; 6: left sacro-iliac joint; 7: ramus superior of os pubis; 8: internal and external obliques muscle; 9: long adductor muscle.

Fig. 7. Detail of the wound in the left groin pre-operatively—1: left iliac vein; 2: left iliac artery; 3: greater gluteal muscle; 4: anus; 5: scrotum; 6: gauze tamponade of the peri-vesicular venous plexus.

3.3. Operative procedure

Before determining the extent of damage, the main bleeding vessels were identified. The iliac artery and vein were ligated, and the clamps could be removed. All other bleeding structures were identified and ligated. This immediately controlled the violent bleeding. However, diffuse haemorrhage was from the peri-vesicular and presacral venous plexus, which was treated by gauze packing and with clotting factor enhanced dressings. This pack effectively controlled the oozing. The peritoneum was inspected, it was intact and there were no indirect signs of injury to the visceral organs. The groin-wound was closed with support of the gluteal muscle (a full-thickness gluteus myocutaneous flap), after aggressive necrosectomy, Fig. 10, facilitating in the necessary packing in an adequate way.

It was not possible to identify the left ureter, and because of the ruptured and high riding prostate, a suprapubic catheter was inserted at the end of the procedure.

The initial operation took 80 min. During the operation fluid and component resuscitation continued with massive transfusion

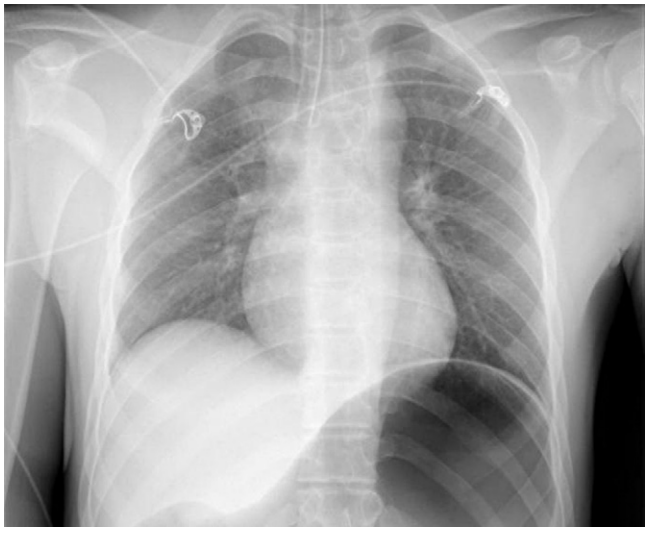

Fig. 8. Chest X-ray study in the emergency department on patient's arrival.

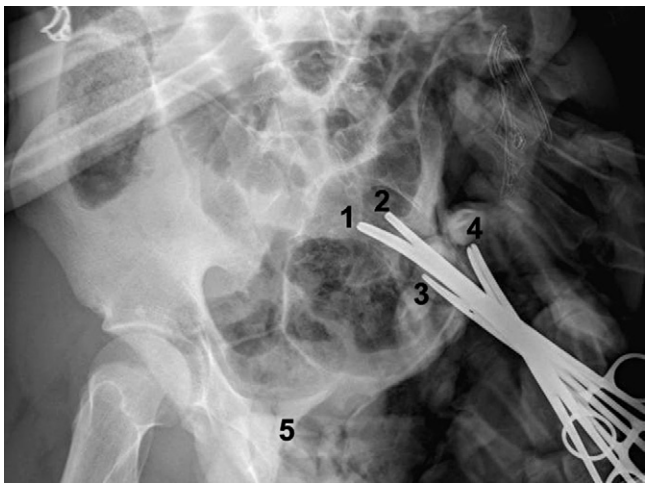

Fig. 9. Pelvic X-ray study in the emergency department on patient's arrival showing no bony structure on the left side of the pelvic—1: left iliac vein; 2: left iliac artery; 3: left internal iliac artery; 4: left internal iliac vein; 5: original symphysis location.

at the ratio of 1:1:1, resulting in a total of 11 (3300 cm^3) *units of RBCs*, 20 (6500 cm^3) FFPs and 25 (1250 cm^3) supplements of platelets. At the end of the operation the patient had a blood pressure of 100/60 mmHg and a tachycardia of 100 beats/min and the haemoglobin count was 4.5 mmol/L. Postoperatively the patient was transported to the ICU and resuscitation was continued. During the operation the body temperature was 34.4 °C.

3.4. Postoperative course

Antibiotic treatment was changed to ceftriaxon® and metronidazol® intravenously. This was continued during the extend of the intensive care period. Postoperatively, the patient stabilized rapidly over the initial 36 h. After 36 h the patient underwent re-exploration of the pelvic wound. Plastic surgeons were consulted for an early reconstruction plan (due to signs of ischemia of the gluteal myocutaneous flap). There was still diffuse oozing from the peri-vesicular venous plexus after removing the gauze. There was no sign of urinary leakage. Inspection of the perineum showed no damage to the rectum and the stripped rectum was reinserted in its original position, however, with limited remnants of sphincter draped around its distal extension. Further debridement of the remaining gluteus myocutaneous flap was performed after which the flap was used to provisionally close the pelvic wound, Fig. 11. In the same setting a laparotomy was performed in order to construct a diverting colostomy. A postoperatively performed retrograde urethral cystogram made the diagnosis of

Fig. 10. Primary closure of the wound after initial operation with SPC in situ.

Fig. 11. Further debridement of the remaining gluteus myocutaneous flap was performed. 1: remaining of the gluteus mucocutaneus flap.

urethral rupture definitive, Fig. 12. During a following elective re-exploration, 96 h after the accident, the gluteal myocutaneous flap was excised because of ongoing ischemia and necrosis. The gauze packs were removed and full haemostasis was achieved. During this session the urologist reinstated the continuity of the urethra by performing a 'rendezvous procedure'. The pelvic wound was closed using a Vacuum-Assisted Closure (VAC) device. Six days after ICU admission the patient was extubated, and the next day (7th day) he was transported to the surgical step-down unit. Eleven days after the accident, he was discharged to the general surgical ward. Eventually, 20 days after the accident, the groin wound was closed by the plastic surgeons. A large, free antero-lateral thigh perforator flap (ALT flap) was dissected from his right upper leg (Figs. 13 and 14). The free flap was revascularized using the right greater saphenous vein and the common femoral artery as an arterio-venous loop tunnelled through the perineum to the defect. The vascular pedicle of the free ALT flap was anastomozed end-to-side on the A-V loop using microsurgical techniques. The fascia of the free flap was used to reinforce the abdominal wall whereas the skin and subcutis was used to reconstruct the external defect, Fig. 15. The donor defect on the right leg was closed by split skin grafts, Fig. 14.

During the ward-admission period and the admission in a rehabilitation centre, the patient developed multiple abscesses in the retroperitoneal woundbed that was covered with the ALT flap.

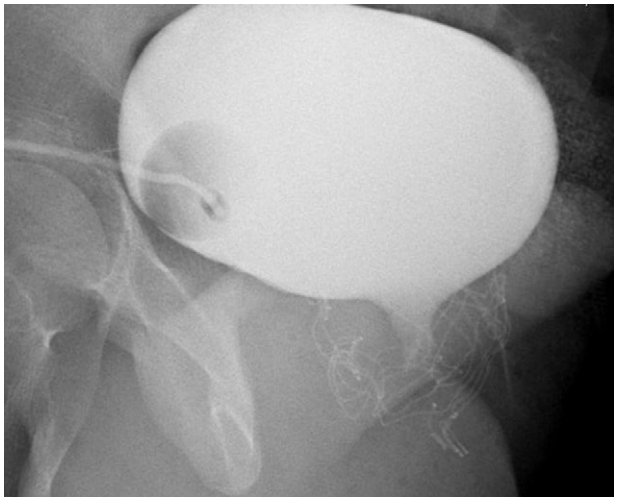

Fig. 12. Retrograde urethral-cystogram showing the discontinuity of the urethra.

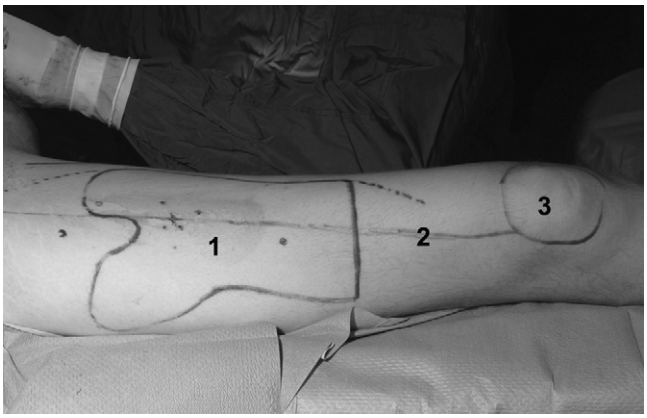

Fig. 13. Free antero-lateral thigh perforator flap (ALT flap) was dissected from his right upper leg—1: antero-lateral thigh perforator flap incision location; 2: femur location; 3: patella and knee joint location.

Fig. 14. The donor defect on the right leg was closed by split skin grafts.

These were all treated with CT guided drainage and antibiotics. He was discharged from the hospital nearly 3 months after admission. The patient is currently (9 months after the accident) in good mental, physiological, and physical health.

Fig. 15. Groin situation directly after reconstructive surgery.

4. Discussion

The trauma mechanism of a traumatic hemipelvectomy has been well described by Beal and Blaisdell: the patients' knee is caught by a car bumper and causes extreme abduction and external rotation.[1,13] The definition of traumatic hemipelvectomy is a complete dislocation of the hemipelvis with disruption through the symphysis pubis and sacro-iliac joint combined with a traumatic rupture of the iliac vessels.[7,8,11,14] In addition, a severe stretch injury or a disruption of the femoral and sciatic nerves takes place. The traumatic hemipelvectomy results either in a complete avulsion or an incomplete open/closed disruption. The soft tissue is often severely damaged and the wound is contaminated with soil/urine and/or feces. 88% have associated injuries of the genitourinary and anorectal tract.[2,7,8]

The aim of the initial treatment is to stabilize the circulation (reduce the haemorrhage and start transfusing blood-products) and to exclude extrapelvic injuries (48% has extrapelvic injuries[5,8]). To control the haemorrhage several authors have described application of direct pressure and clamping of large bleeding vessels at the scene.[7,10,14–17] Early operative intervention is required, and exploration of the wound before the operation should be avoided.[2,4,17–20]

The aim of the operation is first to achieve haemostasis, secondly to treat lacerations of the genitourinary and anorectal system and thirdly to excise damaged tissue before closing the wound.[21] There has been some discussion in the literature whether to close the wound or to leave it open (better drainage and the possibility of cleaning the wound more often, frequently/daily).[5] Initial coverage of the wound is desirable to create wall stability for mechanical compression/local packing, to control fluid loss, and to protect the exposed structures.[22] Haemostasis can be achieved by suture ligation of individual injured vessel and mechanical compression of the sacral and peri-vesicular venous plexus.[11,23,24] In patients with an incomplete separation where the limb remained partially attached, bleeding may continue and is difficult to control. The hemipelvectomy should be completed, as a life-saving intervention (see our first patient). The second aim of an operative intervention could be done in the initial operation but could also take place in a second operation 24–48 h later.

We describe two different patients who underwent a traumatic hemipelvectomy. There was proximally 10 years between the presentations of both patients. In the last decennia improvements have been made in the treatment (preoperatively and postoperatively) of patients with sever trauma injuries. Improvements are seen in the resuscitation (pre-hospital: helicopter trauma support team; and hospitally), postoperative wound-management, and wound-closure techniques. All different case reports in the literature describe an aggressive resuscitation following a massive transfusion (MT)-protocol at the scene and on arrival at the hospital.[10] However, we have experienced the importance of using whole blood or a 1:1:1 ratio of blood-products (*erythrocyte concentrates*, FFPs and platelets) in order to stabilize and to reduce the amount of blood loss. By addressing the early coagulopathy of trauma and acidosis promptly by limiting crystalloid infusion and augmenting the traditional resuscitation practice of packed RBC transfusion with early and increased use of warm plasma and platelets, the focus is as much on providing a suitable intravascular milieu as it is on prompt surgical intervention. Gonzalez et al. revealed that resuscitation using a standard international MT-protocol resulted in perpetuation of coagulopathy, but resuscitation with an RBC-to-FFP ratio of 1:1 resulted in correction of coagulopathy. Earlier initiation of this MT-guideline (1 unit of RBCs: 1 unit of plasma: 1 unit of platelets) may prevent or correct the coagulopathy of trauma, leading to more effective surgical intervention and decreased mortality.[25–30] During the resuscitation period in case A we did not have the knowledge in applying such an aggressive transfusion at the ratio of 1:1:1 of blood-products as we have implemented during the resuscitation period in case B. Our old protocol recommended that FFP should only be transfused if prothrombin time or partial thromboplastin time was elevated, or after 10 RBC units were transfused. For case B, this resulted in a quicker haemodynamic stabilization and less loss of electrolytes and blood after the first emergency damage (haemorrhage) control surgery. Aggressive resuscitation with crystalloids will eventually result in more edema and give problems in the equilibrium (case A).

Wound-healing complications are one of many complications to be expected in the postoperative course. Rieger et al. reported wound-healing problems in 75% of all the survivors.[5] If the wound is closed primarily, it should be re-explored and debrided early in the postoperative course, because the amount of non-viable tissue is frequently underestimated.[4,31] It is crucial to excise all non-viable tissue in the initial operation before closing the groin-wound. However, the problem exists (as we have seen in case A) that there is not enough soft-tissue (gluteal muscle) to close the defect during the several explorative operations because of ongoing tissue ischemia and infection. In the last decennia this problem was covered in using the Vacuum-Assisted Closure (VAC) therapy[32] for temporary wound-closure (all kind of wounds) or using dermal® for additional wall reconstruction. We choose to use the VAC therapy in case B, providing stabilization of electrolytes disturbances, providing a temporary coverage which positively supports wound-conditioning, reduces infectious complications and therefore reduces length of ICU-stay, and facilitating definitive wound-closure. This conclusion is in accordance to Labler et al., who concluded that the Vacuum-Assisted Closure therapy should be used in such conditions.[33–36]

Eventually and several reoperations later, definitive closure requires reconstructive surgery techniques. The reconstructive goals are to provide: (1) a thin and pliable flap that could sustain shear forces; (2) muscle bulk to obliterate dead spaces; (3) a strong fascia preventing abdominal wall herniation. Unfortunately, patients who survive a traumatic hemipelvectomy usually have massive defects, while very few reconstructive options exist. The use of several techniques of musculocutaneous flaps have been described in the literature (full-thickness gluteus myocutaneous, thoracoabdominal, rectus abdominal, latissimus dorsi, contralateral gluteal flaps, or a composite island flap).[1,14,21,37–42] There have also been reports in the literature where they have used flaps and skin of the already amputated leg.[43] Nevertheless, this kind of definitive closure techniques requires experienced physicians in reconstructive surgery. Due to the complicated wound-healing period in case A and the extensive experience of the plastic surgeons of the University Medical Center of Utrecht, this patient was transferred from the Level 1 trauma centre. This coincided with the objective of this institution (UMC Utrecht), where we continued the treatment of this patient.

In conclusion, we describe two separate case reports of young men who sustained a traumatic left hemipelvectomy and survived. A traumatic hemipelvectomy is a catastrophic and mutilating injury, seldom survivable. Maximum survival chance could be achieved by an aggressive resuscitation, starting pre-hospitally and continued in the emergency department, immediate control of the haemorrhage and direct surgical intervention. Aggressive resuscitation should be done following a massive transfusion protocol (ratio of 1:1:1 unit of blood-products). Early and frequent re-explorations are necessary to prevent complications as sepsis and to minimize the chance for complications such as disturbed wound healing and fistula formation. However, the use of the Vacuum-Assisted Closure therapy nowadays gives the patient an earlier recover and lesser chance at developing complications. Early

consultation with plastic surgeons needs to be done in order to achieve an adequate definitive wound-closure (reconstructive surgery).

Conflict of interest statement

None.

Funding

We received no source of funding for our study.

Ethical approval

Each patient was informed that data concerning the case would be submitted for publication, and each agreed to this. We have obtained written consent from the patients.

Author contributions

Each author certifies that he or she has participated sufficiently in the intellectual content, the analysis of data, and the writing of the Work, to take public responsibility for it. Each has reviewed the final version of the Work, believes it represents valid work, and approves it for publication. We herewith state that all authors provided an equal contribution to this study and act in concordance to the 'Uniform Requirements'.

Timmers carried out the complete acquisition of data, carried out the interpretation of data, and made the draft of the manuscript. Tiren had admitted the second patient (Case B) at the emergency department; together with Timmers they did a review research on PubMed. Hulstaert carried out a substantial draft of the manuscript, had supervision of the study design, and had done critical revisions to the manuscript for important intellectual content. Leenen participated in the concept and design of the study, helped in the acquisition of data, and interpretation of data. Schellekens had supervision of the Section of reconstructive surgery and revised the manuscript.

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