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REVIEW ARTICLE

Complex Perineal Injuries in Blunt Trauma Patients: The Value of a Damage Control Approach

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ABSTRACT

Purpose: In a previous work, we presented a protocol for the management of patients with complex pelviperineal injuries (CPI) resulting from blunt trauma. This treatment protocol included: early hemorrhage control, surgical debridement of devitalized tissue, selective loop transverse colostomy according to the location of the perineal wound, distal colonic irrigation with saline solution, pulsatile saline solution irrigation of the perineal wound, maintenance of the perineal wound open, management of bone fractures and visceral injuries, surgical revisions at intervals of 24 to 48 hours, presumptive antibiotic therapy, early nutritional support, and definitive repair of wound defect and visceral injuries after infection control and metabolic recovery. In order to determine whether the evolution of the authors's protocol for the assessment and management of patients with CPI is associated with improved patient outcome we conduct this review.

Materials and methods: The medical records of 42 patients with CPI resulting from blunt trauma admitted in the level I trauma center at the HC-USPSM, were reviewed. Demographic data, mechanism of trauma, revised trauma score (RTS) and injury severity score (ISS), classification of perineal injuries, associated systemic trauma, infection complications and mortality rates (overall, early and late) were collected.

Results: The early mortality was 19% and the late mortality was 17%. The overall mortality was 36%. Patients who died had higher average ISS (average ISS = 45) comparing to patients who survived (average ISS = 25) with significant statistical difference ($p < 0.05$). Damage control principles applied to CPI was the standard of care and a selective approach to perform fecal stream diversion were used.

Conclusion: The results of this study showed that the use of this protocol was effective and reinforced the importance of the priority in early control of hemorrhage, early fecal diversion in selected cases, multiple surgical perineal revisions, and avoidance of complex visceral injury repair at the first surgical intervention.

Keywords: Blunt trauma, Complex pelviperineal injuries, Open pelvic fracture, Pelvic injury, Perineum.

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RESUMEN

Propósito: En un trabajo previo, hemos presentado un protocolo para el manejo de pacientes con lesiones pelviperineales complejas (CPI) resultantes de traumatismo cerrado. Este protocolo de tratamiento incluye: control de la hemorragia precoz, el desbridamiento quirúrgico de tejido desvitalizado, colostomía en asa selectiva a nivel de colon transverso de acuerdo con la localización de la herida perineal, la irrigación del colon distal con solución salina, riego pulsátil con solución salina de la herida perineal, el mantenimiento de la herida perineal abierta, tratamiento de las fracturas óseas y lesiones viscerales, las revisiones quirúrgicas con intervalos de 24 a 48 horas, terapia presuntiva con antibióticos, soporte nutricional precoz y la reparación definitiva del defecto de heridas y lesiones viscerales después de control de la infección y la recuperación metabólica. Con el fin de evaluar si la aplicación del protocolo para la evaluación y manejo de los pacientes con CPI se asocia con una mejor evolución de los pacientes, es que realizamos esta revisión.

Materiales y métodos: Se revisaron las historias clínicas de 42 pacientes con CPI resultante de un traumatismo cerrado, admitidos en el centro de trauma del HC-USPSM. Se recogieron los siguientes datos: datos demográficos, mecanismo del trauma, revised trauma score (RTS) y el injury severity score (ISS), clasificación de las lesiones perineales, asociación o no de trauma sistémico, complicaciones infecciosas y mortalidad (global, temprana y tardía).

Resultados: La mortalidad precoz fue del 19% y la tardía fue de 17%. La mortalidad global fue de 36%. Los pacientes fallecidos tuvieron mayor promedio de ISS (ISS = 45) en comparación con los pacientes que sobrevivieron (ISS = 25), con diferencia estadística significativa ($p < 0,05$). El principio de control de daños fue el "standard of care" en las CPI, realizándose un enfoque selectivo para la colostomía derivativa.

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Conclusión: Los resultados de este estudio mostraron que el uso de este protocolo fue efectivo y reforzó la importancia de que la prioridad es el control temprano de la hemorragia, colostomía derivativa temprana en casos seleccionados, múltiples revisiones perineales quirúrgicas y evitar la reparación de las lesiones viscerales complejas en el primera intervención quirúrgica.

Palabras claves: Fractura pélvica abierta, Lesiones pelviperineales complejas, Lesión pélvica, Perineo, Traumatismo cerrado.

INTRODUCTION

The management of complex perineal injuries (CPI) continues to pose a challenge for surgeons despite advances in the field of trauma care. Although rare CPI may present with a myriad of soft-tissue, visceral and skeletal lesions demanding complex diagnostic and treatment workup. Stratification of mortality in two peaks is necessary to understand the critical points in the management of this surgical problem.[1-7] Exsanguination may results in recalcitrant retroperitoneal hemorrhage from tears of the sacral plexus, associated intra-abdominal solid organ trauma and extensive perineal soft-tissue injuries which are the most frequent cause of early death (first 24 hours) in these patients.[8] Following hemorrhage control, the surgeon usually faces other problems, such as massive contamination of soft tissues of the perineum, complex visceral pelvic injuries and open fractures.

Soft-tissue infection following severe trauma patients with physiological deterioration often leads to sustained sepsis in compromised hosts, resulting in multiple organ dysfunction syndrome, a frequent cause of death.[9,10] If the patient survives, chronic disability in physical functions may be present for several years after trauma.[11]

Forty two patients with CPI were admitted in the level one trauma center at the HC-USPSM. This paper reviews our current experience in the initial treatment of this unique patient population, their clinical presentation and outcomes after introduction of a protocol of assessment and management initiated in the eighties. Results of the two previous published series from our hospital were reviewed to compare overall, early and late mortality rates.[4]

MATERIALS AND METHODS

These patients were admitted with CPI secondary to blunt trauma at the surgical emergency department of the HC-USPSM. Clinical data were collected by reviewing the medical records and operative charts under an institutional review board approved protocol. Data collected included: injury mechanism, associated injuries of the pelvis (rectum, anus and genitourinary tract) and associated systemic trauma. Stratification of severity was calculated using the injury severity score (ISS).[12,13] The degree of immediate clinical deterioration was scored using the revised trauma score (RTS).

Patients with closed pelvic fractures, penetrating gun shot or stab wounds of the perineum, isolated injuries to the genitalia, puncture wounds of the perineum or superficial (skin and subcutaneous fat) perineal lacerations barely extending to the pelvis were excluded. Trauma patients who had blunt pelvic trauma with continuity to a deep wound into the perineum, pubis and area over the sacrum extending to the thighs inferiorly, to the patella or posteriorly to the mid thigh were all included following the definition of expanded perineum proposed by Kusminsky et al.[3] Pelvic and perineal anatomic location of the injuries was categorized in tree anatomic zones according to Faringer et al.[14] The clinical relevance of this classification is complicated by the presence of wounds which fall into more than one area.

Associated open pelvic fractures were classified by the presence of pelvic ring disruption.[15] Mortality was stratified in early (first 24 hours after admission) and late (later than 24 hours).

Diagnosis of wound sepsis was obtained clinically by purulent discharge and progressive necrosis or by positive cultures of tissues removed during sequential surgical revisions. Sepsis syndromes categorized criteria for recognition of systemic inflammatory response syndrome (SIRS) of the American College of Chest Physicians.[16]

After patient admission, the trauma staff and surgical residents performed the initial assessment according the advanced trauma life support (ATLS) outlined by the American College of Surgeons (ACS).[17] During the primary survey, contemporary maneuvers for bleeding control from perineal and pelvic injuries, such as packing bleeding wounds and pelvic stabilization with sheets were selectively performed according to the presence of active hemorrhage from soft tissue lacerations or clinical evidence of open book fractures respectively. After initial assessment and management in the trauma room, hemodynamic unstable patients were immediately taken to the operate room. Laparotomy was performed first in hypotensive patients who had a grossly positive diagnostic peritoneal lavage (mostly performed during the first 2 years of the study) or a positive focused assessment for the sonographic examination of the trauma (FAST), with the intent to avoid intra-abdominal exsanguination and missed injuries. Stable patients underwent computed axial tomography. However, emphasis to early transportation to the operating room was a rule, with specific attention to the critical ill patient. Multiple sources of bleeding and the resultant physiological deterioration in patients who present with these devastating injuries offer

opportunity to practice the involve concept of damage control surgery.

The abbreviated laparotomy varied, because there was no specific protocol and was left to the discretion of the attending surgeon.

After laparotomy, the patients were positioned with abduction of the legs (lithotomy position) to allow definitive control of hemorrhage from soft tissue injuries by ligature of identifiable vessels and packing of diffuse bleeding areas. At this moment, the trauma surgeon performs meticulous inspection of perianal tissues, examination of the vaginal vault and rectal digital examination, with assessment of anal sphincter tone, content of the ampulla recti and localization of the prostate. Early orthopedic consultation for fixation of unstable pelvic fractures was performed only after intra-abdominal and perineal source of hemorrhage were excluded or resolved. Patients with persistent hypotension despite external fixation of pelvic fractures with ring disruption underwent selective angiography and transcatheter angioembolization.

After hemorrhage control, the trauma staff initiates surgical debridement of dirty and devitalized areas of the perineum and subsequent pulsatile irrigation with warm saline until complete removal of gross particles deposited into the deep wound. The wound was intentionally left open and covered with dressings commonly used in burned areas. A selective loop transverse colostomy was performed according to the anatomic location of the perineal soft tissue injury with subsequent saline irrigation of the distal colon. Faringer zone I injuries involving the anus and rectum or deep gluteal and perineal injuries in proximity of the anal margin required loop transverse colostomy to reduce continuous fecal contamination in the open soft tissue defects. Diversion of the fecal stream was also required occasionally in Faringer zone II and III injuries when the trauma staff judged necessary.

No attempt at definitive repair of anal, rectal, urethral or soft tissue injuries was performed during the initial operation.

Priority on ongoing resuscitation to obtain physiological and metabolic recovery and reduce the secondary systemic inflammatory response in ICU dictated the policy of abbreviated operative interventions.

Early supportive nutritional therapy and presumptive broad-spectrum antibiotics were utilized in all patients who survived more than 24 hours. Antibiotics were administered before operation and continued when progressive soft-tissue infection, necrosis or open fractures were present. Definitive antibiotic therapy was guided by positive cultures.

Surgical revisions were made at intervals of 24 to 48 hours. Multiples surgical revisions were required when persistent contaminated soft tissue injuries were present.

After infection control and guided by the plastic surgery team consultation, definitive repair of perineal defects was conducted utilizing secondary closure, split-thickness skin grafts or rotation myocutaneous flaps. Definitive treatment of others visceral and osseous injuries were also performed by urology, general surgery or orthopedics teams.

STATISTICAL ANALYSIS

Numerical data are presented as mean ± SD (standard deviation). Differences in means were assessed using Student's test or Wilcoxon rank sum test. Differences in proportions were tested using X-test or Fisher's exact test. All statistical analysis was performed using significance set at $p < 0.05$.

RESULTS

Mechanism of Injury Demographics and Trauma Scoring

The predominant mechanism of injury was pedestrian struck by an automobile (n = 25) followed by motor vehicle crashes (n = 07), motorcycle collisions (n = 04), falls (n = 04) and industrial traumatic incidents (n = 02). The 42 patients included in the present comprised 26 males and 16 females, with a mean age of 26 (4–77) years old.

The injury severity expressed in terms of ISS for the 42 patients, varied from 13 to 70 (mean = 36), and in terms of RTS varied from 3.97 to 7.84 (mean = 7.23). The mean ISS value for the 15 patients who did not survive was 45 (27–70) that was significantly higher ($p < 0.0001$ compared to the mean ISS of 25 (13–43) for the survivors. The mean RTS value for the 15 nonsurvivors was of 6.67 (3.97–7.84) that was significantly lower when compare to the average RTS of 7.56 (4.94–7.84) which was identified in the 27 survivors ($p = 0.02$). Thus, the ISS and RTS values confirm the higher severity of the nonsurvivors, presented in Table 1.

Table 1: Mortality, revised trauma score ($p = 0.002$) and injury severity score ($p = 0.0001$)

Deaths	*N*	*Median RTS*	*OR*	*Median ISS*	*OR*
No	27	7.84 (4.94–7.84)	0.64	22 (13–43)	9.52
Yes	15	4.23 (3.97–7.84)	1.40	48 (27–70)	12.95

Table 2: Farringer's perineal wound classification

Zone	*N*	*Percentage*
I	20	48
II	4	9.5
III	7	17
I + II	4	9.5
I + III	3	7
I + II + III	4	9.5

Classification of Pelvic Fractures and Anatomic Location of Perineal Soft-tissue Injuries

Associated open fractures of the pelvis were identified in 28 (66%) patients. Pelvic ring disruption was present in 20 patients. One traumatic hemipelvectomy was identified in the open fracture group of patients.

Stratifying the perineal wound location by zones in accordance with the classification proposed by Faringer et al, we found a predominance of Faringer zone I injuries (n = 20). Following are the anatomic limits of the Faringer zone I: between the pubic tubercles (anterior limit), extending parallel to the inguinal creases and continuing posteriorly over the sacrum.

Injuries of Faringer zone II were less common (n = 4) and is defined by the following anatomic limits: medial thigh bounding laterally on the anterior thigh by a line drawn between the anterior superior iliac spine extending to the medial patella inferiorly by the mid thigh including the groin creases.

Faringer zone III injuries (n = 7) are defined by injuries localized in the posterolateral buttock inferior to the iliac crest.

Injuries extending to more than one zone were observed in 11 patients (Table 2).

Open Fractures Management, Hemorrhage Control of Pelvic Injuries and Indication of Diverting Colostomy

External stabilization to control persistent pelvic hemorrhage was necessary in 21.4% of patients with open pelvic fractures. One patient was submitted to late external stabilization of an open-book pelvic fracture. Immediate external hemipelvectomy was performed in one young female because of a devitalized leg. The young female patient suffered a traumatic ejection from the car compartment resultant from a high speed motor vehicle crash. After multiples surgical revisions a definitive repair with polypropilene onlay mesh over the pelvic wound prevented evisceration. Cutaneous defect was covered with split-thickness skin grafts.

Retroperitoneal hemorrhage from pelvic trauma was identified in 17 patients during laparotomy (12 Zone III and 05 Zone II retroperitoneal hematomas). In one patient, unilateral internal iliac artery injury was identified into the expansible zone III hematoma requiring ligature of the vessel. Pelvic packing was required in three patients.

Selective transcatheter angioembolization was required in two patients. One patient developed bilateral buttock necrosis after bilateral hypogastric artery embolization and died secondary to septic complications.

Fecal stream diversion was selective performed in 25 patients (59.5%). Selectively loop transverse colostomy was the most performed modality of fecal stream diversion (n = 21). Loop transverse colostomy was required in 12 patients with Faringer zone I injuries (60% of the patients with zone I injuries), one patient with Faringer zone II (25% of the patients with zone II injuries), two patients with Faringer zone III (28.6% of the patients with zone III injuries), six patients with wounds extending for more than one zone (54.5% of the patients with more than one zone). Of note, all patients with wounds extending to the three zones required fecal stream diversion. In four patients, end colostomies and stump rectal closure were performed as part to the damage control strategy because these hypotensive patients were submitted to segmental rectal and sigmoid resection.

Colostomy related complications (prolapsed colostomy) occurred in two (7.4%) patients.

Associated Visceral Pelvic, Perineal, Intra-abdominal and Extra-abdominal Injuries (Tables 3 and 4)

Visceral injuries diagnosed during perineal examination were most common in the genitourinary tract (n = 18) presented in 43% of patients. Urethral injuries were present in 10 (24%) patients. All of the urethral injuries were in male and associated with open fractures with pelvic disruption (open book fractures). Suprapubic catheters were placed at the initial procedure in all patients with urethral injuries. Injuries of the anus and low rectum occurred in 15 (36%) patients. In nine (22%) patients combined injuries of the genitorurinary tract, anus and rectum were diagnosed during perineal examination.

Intra-abdominal visceral injuries were found in 23 (55%) patients.

Seven (17%) intra-abdominal solid organ injuries were identified during laparotomy. One patient required

Table 3: Sites of injuries and mortality

		Deaths		
Injuries	*N*	*<24 H*	*>24 H*	*Overall*
Ano rectal	15	33%	20%	53%
Urogenital	18	16%	16%	32%
Both	9	22%	22%	44%
Pelvic ring disruption	20	30%	15%	45%
Without pelvic ring disruption	8	13%	25%	38%

Table 4: Pelvic sites of injuries

Sites of injuries	*N*	*Percentage*
Urethra	10	37
Vagina	7	26
Bladder	5	19
Testicles	3	11
Penis	2	8

Table 5: HC-USPSM comparative series among pelvic trauma patients

		Deaths			
Authors	*N*	*<24 H*	*>24 H*	*Overall*	*Infection*
Birolini D et al[35]	10	20%	50%	70%	50%
Birolini D et al[4]	38	13%	19%	32 %	19%
Present paper	72	19%	17%	36%	17%

splenectomy, another patient required nephrectomy, four patients had hepatic lacerations and two required perihepatic packing. One patient had a pancreatic injury. Hollow visceral injuries were identified in 14 (33%) patients. Five patients had small bowel injuries treated with resections, four had rectal (n = 2) and sigmoid (n = 2) lacerations requiring segmental resections, and five patients had intraperitoneal bladder ruptures requiring repair. Abdominal wall injuries were present in six (14%) patients. In three patients, traumatic evisceration with partial loss of abdominal wall components were initially treated by temporary abdominal closure using Bogota bags silos.

Associated extremity fractures were present in 41 (98%) patients.

Septic and Others Complications

Septic complications occurred in 26 patients (62%). Perineal wound infection occurred in 15 (36%) patients. Four (9.5%) patients developed ventilator associated pneumonia. Three (11%) patients developed urinary tract infections. Central venous catheter related infections developed in seven (17%) patients. Two (5%) patients developed an intracavitary abscess and one patient, developed meningitis. Seven (17%) patients developed septic shock. Bacteriological investigation resulted in 42 positive cultures. *Pseudomonas aeruginosa* was the most common agent isolated in cultures (37%) followed by *Staphylococcus* sp. (30%), *Acinetobacter baumannii* (30%) and *Escherichia coli* (19%).

Six patients developed acute respiratory failure secondary to acute lung injury. Deep venous thrombosis occurred in three patients requiring Greenfield filter placement. Three patients developed acute renal failure requiring hemodialysis and one developed a perforated duodenal ulcer requiring laparotomy.

Overall, Early and Late Mortality

An overall mortality of 35.7% (n = 15) was observed in the patient series. Eight (19%) patients died within 24 hours (early mortality) of arrival at the hospital due to exsanguination. Seven patients (16.7%) died after 24 hours (late mortality) from the arrival at the hospital and were related to septic complications. In three septic patients deaths occurred after development of pulmonary embolism. The mortality in patients with open pelvic fractures was 42%.

Mortality in patients with Faringer zone I injuries was 25% (n = 5), 25% (n = 1) in Faringer zone II, 57% (n = 4) in Faringer zone III, 42% (n = 3) in injuries extending to more than one zone, and 50% (n = 2) when all three zones were involved (Table 2).

Comparing results related to mortality of our current series with the first two previous published series (first series = 1978 – 1980 and second series = 1981 – 1988) we observed an improvement in overall mortality since the introduction of the protocol (initiated in 1981) with no significant difference in the late mortality in the last two series (Table 5).

DISCUSSION

The main clinical endpoint in the management of major trauma is survival. However, mortality resulting from CPI is related to multiple clinical factors and influence of many variables.[18-21]

Older studies stratified mortality in two peaks, early and late, aiming to assemble the predominant causes of death in each of these periods.[22] However, few studies stratified risk factors of overall mortality.[21,22] In the last four decades, a limited number of publications have shown the treatment results of CPI secondary to blunt trauma. Mortality rates were reported to be as high as 50% in the 1970s and 1980s, due to uncontrolled early hemorrhage, or late sepsis secondary to contamination of the soft tissue wounds, open fracture or multiple organ dysfunction due to systemic infection.[1-3,23,24]

The lack of a protocol of assessment and management was evident in the earlier series.[1-3] Development of a protocol of assessment and management of CPI in our hospital was initiated in 1981 resulting in lower mortality rates. Surgical principles, such as early control of intra-cavitary bleeding, avoidance of continuing wound fecal contamination using mandatory diverting colostomy and colonic saline irrigation, maintenance of pelvic wound open and periodic routine debridement were outlined.[4]

In the studies where a protocol of management is followed, overall mortality rates range from 18 to 37%.[19,22,25]

The current study examined the association of specific demographic, clinical factors and interventional therapies in CPI and mortality rates. This retrospective analysis may not have statistical power to identify significant differences for specific outcomes or recommend a level one scientific evidence therapeutic intervention.

It is difficult to create good evidence-based protocols when there are so few large series dealing with this rare

injury. However, a historical comparison between the older and the current series allows some conclusions about the evolutionary management of this complex surgical problem and suggest the need of prospective and comparative multi-institutional studies to obtain more robust clinical recommendations.[22]

Hemorrhage control is a significant priority in the initial management of CPI. Exsanguination represents the first cause of early mortality.[20-22,25,26,35] Anatomical basis of the pelvis and the high kinetics energy transfer of force related to the traumatic incident are responsible for the genesis of significant hemorrhage. The fractured pelvis and retroperitoneum are estimated to have the capacity to hold up to 4 liters of fluid. Violation of the pelvic space by abdominal surgery can increase pelvic volume by 15%, with loss of the tamponade effect provided by the peritoneum. Retroperitoneal hematoma can expand out of the pelvis into the abdomen or anteriorly through the surgical abdominal wound. Open perineal wounds in the patient with an open-book pelvic fracture allow an additional route of decompression of pelvic hemorrhage, potentially circumventing the tamponading tissue effects that assist in hemorrhage control in patients with closed fractures.[22,25]

Additionally, bleeding sources may be multiple in CPI.

The sequencial approach to hemorrhage control outlined in the ATLS protocol is adopted in our service.[17]

Use of pelvic compression methods, such as placement of a pelvic orthopedic device (POD) or binders to control pelvic fracture hemorrhage in the trauma room, have been reported to reduce transfusions and length of hospital stay, and represent an additional therapeutic option.[20-22,25,26] In the specific situation of CPI, another source of bleed is perineal laceration and the application of antiseptic pressure dressings to obvious bleeding sites in the trauma room is also advised.[7] If intra-peritoneal bleeding is identified, immediate laparotomy is prioritized.[7,19,26]

Concomitance of CPI and intra-abdominal hemorrhage is an expected event. Associated visceral injuries were present in 55% of patients and these data are similar to other recent series.[21] In six patients, visceral resections or packing were required to stop major bleeding.

Pelvic packing is strongly considered by the staff when Zone III retroperitoneal hematomas are identified during laparotomy, representing a valuable maneuver of surgical damage control in patients with hypothermia and coagulopathy. This maneuver has been advocated by other groups in damage control surgery.[19,22,25]

After control of the intraperitoneal source of bleeding, immediate external pelvic fixation is performed when unstable pelvic ring fractures are present. Improved outcome has been demonstrated with early pelvic stabilization.[19,20-22,25] Open pelvic fractures are very common injuries associated in patients with CPI. In the present series, 66.6% of the patients had associated pelvic fractures and the overall mortality in open pelvic fractures patients were 42%. In other reported series, presence of open pelvic fracture represents a factor for high mortality rates in the population of patients with CPI.[19,20,25] In the most recent publication reviewed, overall mortality due open pelvic fractures varies between 13 to 50% essentially were caused by exsanguinations or sepsis.[26,27]

Substantial high kinetic energy transfers results in shear forces responsible for degloving soft tissue injuries, lacerated vessels and fractures of pelvic bones commonly observed in CPI. Pedestrian struck by a motor vehicle causes devastating perineal injury when an individual is trapped between a fixed surface and a moving vehicle. In the present study, pedestrian struck by a motor vehicle was responsible for 60% of CPIs. Pedestrian struck by car was the predominant trauma mechanism in other recently published series.[21] In 41 patients with open pelvic fractures and perineal soft tissues injuries, pedestrian struck by car was the causative factor in 20%.[19] Hanson at al stated that half of their 43 patients with open fractures were pedestrian involved in collisions with motor vehicles.[22,28]

Motor vehicle and motorcycle collisions were also responsible for devastating injuries of the perineum. Extremely hazardous injuries may result when unrestrained individuals are ejected from the car and one leg is trapped into the car compartment.[22] One of our patients suffered this kind of mechanism with resultant traumatic hemipelvectomy reflecting how extensive bone injuries can be present. In a series recently reported of by Dente et al, one patient also presented in emergency department with traumatic hemipelvectomy.[29] When a hypotensive patient presents with traumatic hemipelvectomy and the leg is not completed separated from the pelvis, amputation is necessary if major nerves were severely injuried and ischemia of the member was identified. This is a formidable example of a damage control rationale. Limb-sparing procedures in this setting may result in septic complications and death.[20,22] Rieger et al (1998) published a comprehensive literature report on 67 survivors of this injury, demonstrating that these severely injured patients have a good chance of being successfully rehabilitated to an active and productive role in society.[30]

Another interventional therapy to hemorrhage control is transcatheter embolization. Although the management tenets for pelvic fractures have not changed greatly in the last 10 years, widespread availability of angiography has

given the trauma surgeon another option when dealing with these critically injured patients.[20,25]

Selective pelvic angiography and transcatheter embolization is indicated when injuries of the major branches of the iliac arteries are present.[23,25] Although transcatheter embolization is a minimally invasive intervention, this is usually indicated in CPI after control of more obvious sources of bleeding and may result in serious complications when bilateral internal iliacal embolization is necessary.[20]

It is noted that the majority of patients who are bleeding from the pelvis have venous injuries, for which angiography is not helpful. The need for therapeutic angiography in a patient with an open pelvic fracture is associated with poor outcome.[20,25]

After bilateral internal iliac embolization one of our patients developed bilateral buttock necrosis. The above mentioned patient already had a profound perineal laceration grossly contaminated and developed a progressive soft tissue pelvic necrosis resulting in lethal sepsis.

The second step in the damage control surgical intervention is limitation of the contamination of peritoneal cavity, pelvis and perineum.

Traditionally, diversion of the fecal stream was a paradigm treatment of CPI since Raffa and Christensen reported in 1976 a decrease in mortality from 58 to 25% if colostomy was performed early 22.

Mandatory diverting colostomy is an example of interventional therapy conceptualized as a surgical dogma on the management of CPI in the eighties.[1-3,22] Maull and Sachatello advocated the use of diverting colostomies with intent to ameliorate the incidence of pelvic sepsis.[1,22]

Clinical retrospective studies published in the nineties questioned the role of mandatory diversion of the fecal stream recommending the procedure in a selective basis, according to the anatomic location of the perineal wound.[14,22] Woods et al found that diverting colostomy does not necessarily reduce the incidence of local infective complications. They noted abdominopelvic infections in 27% of patients who underwent fecal diversion, compared with 29% in patients who did not.[31] In 1998, Woods questioned the role of colostomies to reduce pelvic infection recommending only when transmural laceration of the rectum and large perineal soft tissue injuries were present.[22,31]

After years of debate mandatory colostomies has been part of a multidisciplinary approach to protect the perineal wound independent of the presence of rectal transmural laceration. Duschene et al published in a series of patients with open-book pelvic fractures and open perineal wounds significant higher incidence of pelvic sepsis was observed despite the mandatory indication of diverting colostomies.[21]

In our current series, diversion of the fecal stream was performed selectively. Mortality rates were not significant different when comparisons were made with the older series where colostomies were performed mandatorily.[22]

The selective use of diverting colostomy is now addressed according the stratification of perineal injury location as proposed by Faringer et al[14] and presence of anoretal injury, transverse loop colostomy were the standard approach. Although no comparative studies address the advantage of loop transverse colostomy over other enteric stomas, the location of the stoma in the upper right abdominal quadrant is distant of the external orthopedic device when unstable open fractures are present facilitating the care of the stoma. In some patients, extension of the soft tissue injuries to the lower abdominal quadrants or exposition of the fractured bone (iliac crest, pubic) may preclude the choice of a loop sigmoidostomy. Colonic diversions are preferred over ileostomy. High outflow of enteric juice by ileostomy may influence the nutritional recovery. Also, when colonic decompression is necessary and a colostomy is preferred. Although there is no evidence of the benefit of distal colonic irrigation, this is possible by a loop colonic stoma.

Another interventional procedure used to limit contamination is suprapubic cystostomy. Unequivocal clinical evidence of urethral injuries mandates temporary urinary diversion until definitive repair. Otherwise, if retrograde cystourethrogram is positive for a urethral injury suprapubic cystostomy tube needs to be inserted during the emergency operation, to ensure diversion of the urinary flow, in order to prevent sepsis from infected urine.[20,22,32] No attempt of definitive primary repair of anorectal and genitalia is advised. The role of the multi-specialty approach is necessary to the definitive repair of the multiple injuries but should not take the place of addressing early causes of death, such as severe acidosis, secondary hypothermia and recalcitrant coagulopathy.

Refinements in the definition and classification of the perineal injuries secondary to blunt trauma from previous studies offer information about the clinical relevance of the perineal injury itself in the context of multisystemic trauma.[20,22] Current series now adopt the classification of location of perineal injuries proposed by Faringer to stratify severity, predict complications and as additional criteria to indicate diversion of the fecal stream.[14] The perineal region (zone I) is the most common area of open soft tissue injury reported in the literature.[22,33] In the current series, 20 patients presented with Zone I CPI.

A meticulous examination of rectum, anus and genitalia is crucial. Missed injuries are not uncommon. Numerous case reports in the literature focus on missed open injuries in pelvic fractures, possibly resulting in damaging complications, such as vesicovaginal fistulae.[7,22,33] In the current series, 42.8% patients presented with urogenital injuries and 35.7% presented with anorectal injuries.

Incidence of anorectal and urogenital injuries in the literature range from 18 to 64% and 24 to 57% respectively.[7,20,22]

Maintenance of the pelvic wound open and periodic debridements in the operating room using generous irrigation of warm saline and packing the exposed areas with burns dressings is recommended to keep the wound clean and allow the development of granulation tissue. Except in one case of traumatic hemipelvectomy with loss of pelvic floor and potential risk of evisceration, we used a polypropylene on lay mesh to cover the defect. Actually vacuum sealed dressings, which allow adequate drainage of the wound have been used as proposed by several series.[20,22]

Debridement margins are determined by dermal capillary bleeding witnessed at the time of graft harvest, as has been established in other regions of the torso and extremities. Application of full, or split, thickness skin graft, harvested from the excised flap.[20,22,34]

Scoring trauma patients by anatomical injuries can offer prognostic relevant information defining severity. Of note in this series, high values of ISS reflect the clinical severity of the group studied. The average ISS was 36 for the all group studied (13–70). The overall ISS of patients with open pelvic fractures is reported to range between 25 and 48 11, 22, 23, 28.

Septic complications were the most commonly observed complication with hemodynamic compromised in 17% patients of the current series. Of note, one of the patients developed meningitis which has been reported in the literature as a potential septic complication when extensive compromise of sacral plexus occurs.[22] Prophylactic administration of broad-spectrum intravenous antibiotics is introduced in the early management in the trauma room and was later be adjusted according to microbiological sensitivity testing.

CONCLUSION

In conclusion, we document our recent experience with CPI in a level I trauma center. This entity, although rare, continues to a significant source of morbidity in trauma patients.

Despite some differences in the protocol of assessment and management adopted in our previous series, the essentials are still the same and the results on mortality are similar. Our current data reveal a slight reduction in late mortality rate. In the present series, development of serious infection with hemodynamic compromise occur in 16.6% of the patients against 22.9% in the previous series although it does not have statistical significance.

The need for different specialists as urologists, orthopedists, plastic surgeons and others are inherent but the coordination of therapeutics procedures according to priorities must be done by the trauma team staff. Definitive repair of anatomical structures in the initial setting of treatment may be deleterious because physiological deterioration due to hemorrhage is common. In addition, the progressive inflammatory response due to massive blunt trauma and the superimposed sustained infection trigger a complex cascade of immunologic and metabolic events and represent the typical panorama of traumatic shock.

Complex perineal injuries should be viewed as a continuing challenge in which the staged physiologic surgery proposed in accordance with the damage control principles represents until now the best way of treatment. New modalities of treatment and prospective controlled trials are need.

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