

Chapter 2

The Pelvis at War

Pelvic traumas can be studied from remains by osteoarcheology and by records of modern warfare. Both approaches show that pelvic stability is a prerequisite to survive in war situations but also in vehicle injuries.

2.1 Introduction

Pelvic remains have been collected from historical war graves and other archeological sites. Archeologists have studied these remnants. The pelvic results are so to say “buried” into large overviews of all kind of skeletal rests of corpses. It is therefore easily understandable that this chapter will miss several of the results currently present in the literature and our treatment will not be complete. Moreover, the word “war” should not be taken too literally: civilian hostilities, fights with animals are included, and some history is inevitable.

Bone cuts on skeletal remains have to be divided into knife and sword marks. “Swords have been one of the major weapons used in violent conflicts for much of human history. Certain archeological situations, especially those dealing with the recovery and analysis of battle casualties, may raise questions about what type(s) of bladed weapon was used in a particular conflict” [1]. It is easy to discern knife marks from sword marks, but even the type of sword can be traced, due to differences in blade weight, grip, and sharpness [1]. Thus, osteoarcheology has the means to determine the type of bladed weapons used.

Nowadays, damage of the bony pelvis in daily life is mostly due to high-energy blunt traumas among which traffic accidents and falls are the most prevalent. In nearly 20 % of such cases, the pelvis or acetabulum is fractured, and in half of the cases, the patient needs surgical stabilization. Pure sacrum fractures accounts for 11 % of pelvic ring injuries. Pelvic trauma and pelvic fracture does affect genitourinary function in 7–14.5 % and reproductive function in 46.5–60 % (dystocia) in women. More studies on female pelvic trauma effects can be found in the literature [2B]. Pelvic fracture is not the main cause of death, but combinations with other injuries, such as head, thorax, or abdominal traumas are in [2]. Some studies have reported a mortality rate of 13.9–24 % after acute pelvic fracture.

Severe bleeding from pelvic trauma produces mortality [2A], but in historical cases, cause and effect are nevertheless, difficult to separate, especially in the absence of good medical care.

2.1.1 Neanderthals

Remains of Neanderthals contain bony lesions, of which head and neck injuries are the most reported. These traumatic lesions together with posttraumatic degenerative changes were studied by their anatomical distribution in the human body: head, neck, thorax, abdomen, extremities, and pelvis. They were compared to human archeological samples, modern clinical samples and to injuries of Rodeo performers in North America. Pelvic lesions were present only in 3.7 % of the cases and belonged to the posttraumatic degenerative changes among Neanderthals. To make a long statistic story short, Neanderthal lesions were comparable to those found in the Rodeo performers. “It appears more likely that behavioral patterns paralleling those of Rodeo athletes explain the Neanderthal injury patterns. This is not meant to imply that Neanderthals would have met the behavioral qualifications for membership in the Professional Rodeo Cowboy Association. More likely, it relates to their normal means of predation” [3] and “Given the tendency of ungulates to react strongly to being impaled, the frequency of head and neck, as well as upper limb, injuries seen in the Neanderthals should not be surprising” [3].

Mobility is an essential survival quality in hunters. Head and neck injuries can be overcome, but it is surprising that the number of pelvic traumas found among the Neanderthals is so small. One would imagine that bull fighting should produce more pelvic traumas. But it is not that case: the statistic incidence is the same as that for Rodeo cowboys, 3.3 %. “Those no longer capable of keeping up with the social group, whether as a result of age or serious lower limb trauma, may have simply been left behind, to die in localities where their remains were not preserved and recovered” [3]. Walking and running are also dependent on the pelvic integrity. Could it be that Neanderthal pelvic victims were left behind and therefore their incidence among the known skeletal remains is low?

2.1.2 Pazyryk Mongolian War Skeletons

Pazyryk is the name given to Indo-European tribes that spread across the Eurasian steppes. Their presence between the third and fifth centuries BC is characterized by stone tumuli in the Altai region (Central Asia, near Kazakhstan). The warriors were buried in these tumuli together with their horse and weaponry. These nomads carried out cruel rituals like: “human sacrifices, scalping of enemies, and cannibalism” [4]. Their warfare and violence can be studied by the traumatic injuries on skeletal bony parts.

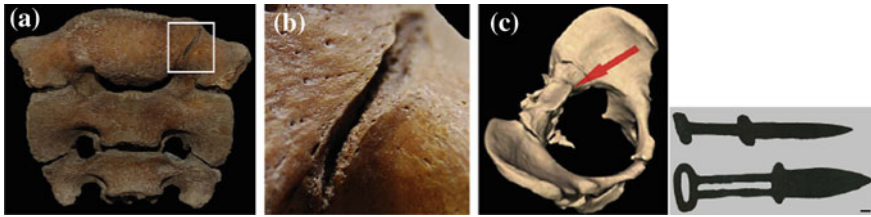


Fig. 2.1 Cut mark on the left lateral anterior side of the first sacral vertebra from a child (numbered TSK/T2B). **a** Location of the cut mark, **b** defect detail, and **c** the direction from which the blow was delivered and the Scythian dagger: bar is 1 cm (reproduced with permission from Jordana et al. [4])

“Pelvic injuries exhibited by individuals BTG-VI/T12 and TSK/T2B (see Fig. 2.1) would involve vascular iliac structures besides pelvic viscera causing fatal hypovolemic shock. These deadly injuries could be compatible with the action of the Scythian dagger” [4]. From the 10 skeletons with several injuries each, two had perimortem pelvic injuries, indicating a far higher percentage than was found in the Neanderthal study. Healing had occurred, mainly in injuries of hand bones, skull, ribs, and clavicle, but not in pelvic structures.

2.1.3 Trojan Siege

“The other information that we have of the Trojan siege is derived mainly from Homer’s *Iliad* in which the author gives detailed accounts of the wounds. Frolich has analyzed Homer’s work and demonstrated that there was a variation in the number of wounds caused by each weapon and the percentage of fatalities” [5]. It is inevitably that spears had the greatest chance of hitting with a fatality rate of nearly 80 %. Blows with the swords were very accurate with 100 % fatality. “Slingshots and arrows had a very low hit rate and medium fatality with arrows at the worst” [5]. Of course, one knows that Homer’s *Iliad* is a folk-tale, perhaps based on historical events. Nevertheless, it well illustrates the effectiveness of ancient weaponry, the more so because Homer may have had a medical education and perhaps performed dissections [5A]. Pelvic casualties are also described in the *Iliad*. Meriones, the Cretan, hits Phereclus: “He struck him in the right buttock, and the spear point went right on through under the bone into his bladder.” The salient detail is, of course, that in Homer’s *Iliad*, the pelvic acetabulum/hip fracture of Aeneias is caused by a stone thrown by Diomedes not by a weapon. The twelve cases with pelvic related injuries in Homer’s description are shown in Table 2.1

Table 2.1 The pelvic and urogenital injuries in Homer’s iliad (table is from Poulakou–Rebelakou et al. [5A] with permission)

No	Text. Ref	Weapon	Location	Result	Victim
1	Il IV, 489–493	Spear	Groin	Immediate death	Leucus
2	Il V, 65–68	Spear	Bladder	Immediate death	Phereclus
3	Il V, 516–519	Spear	Abdomen	Immediate death	Deicoon
4	Il V, 615–617	Spear	Abdomen	Immediate death	Amphius
5	Il V, 855–858	Spear	Abdomen	Miraculous healing	God Ares
6	Il VI, 63–65	Spear	Flank	Immediate death	Adrastus
7	Il XIII, 567–569	Spear	Between privy parts and navel	Painful death	Adamas
8	Il XIII, 650–655	Arrow	Bladder	Immediate death	Harpalion
9	Il XIV, 446–447	Spear	Flank	Immediate death	Satnius
10	Il XVI, 317–319	Spear	Flank	Immediate death	Atymnius
11	Il XVI, 463–465	Spear	Abdomen	Immediate death	Thrasymelus
12	Il XVII, 516–519	Spear	Abdomen	Immediate death	Aretus

2.1.4 Modern Weapons

The approach used by archeologists has also been used for victims of modern weapons of war. X-rays results have been published for victims in Vietnam, Croatia, Serbia, Bosnia, Chad, Iran, Afghanistan, the USA, Great Britain, France, Israel, Palestine, and Germany, and these were used to relate wounds to weapons. “Radiograms of injuries due to hand grenades show their content (globes) and cover fragments. The globes are localized regionally in the victim’s body. Survivors of cluster bombs show singular or few globes having been hit by many globes would have been lethal. Shotguns produce characteristic distributions of the pellets and depth of penetration different from those of hand grenades and cluster bombs; cover fragments are lacking. Gunshot wounds (GSW) can be differentiated in those of low velocity bullets, high velocity projectiles, and projectiles, which disintegrate on impact” [6]. And: “Radiographs may show, which weapon has been employed; they can be read as war reports” [6].

While the scars and trauma from the past can be considered from a distance, those of recent wars are nearer and more disturbing to our minds. But let us try to treat these in the same way as we did with the Trojan results. What are the effects of this modern weaponry on the pelvis. In Fig. 2.2, the effects of injuries inside vehicles in Afghanistan are given.

The percentages of pelvic injury are low for vehicle injuries (2.8 %). “Many para-axial injuries involve the thorax and abdomen, with accompanying trauma to vital structures which is rapidly fatal if not treated immediately. Few such patients survive the arduous trip across the mountains to our hospital” [6]. The para-axial injuries include the pelvic ones. Thus, the 2.8 % is low, and this is presumably due to the seats of the vehicle, which provide protection.

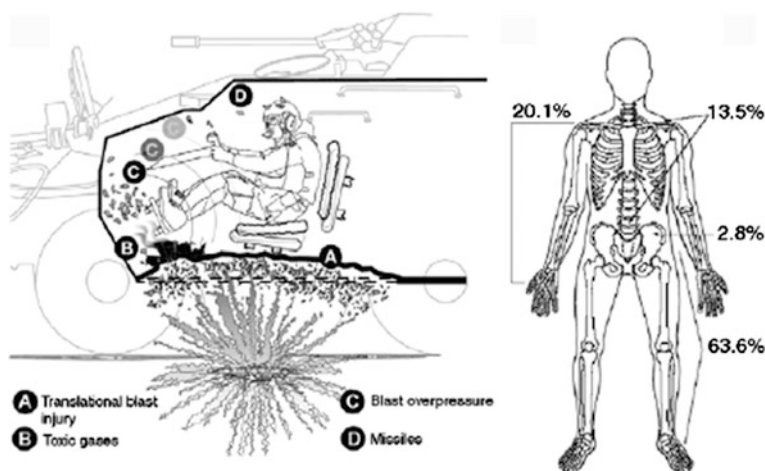


Fig. 2.2 Vehicle injuries after blasts and missile attacks (figure is reproduced with permission from Vogel and Dootz [6])

Soft tissue results from the Vietnam war and World War I and II show far higher percentages for pelvic wounds: for the bladder 18 % on average and for the urethra 9 % with significant differences for each war and each researcher [7]. The scud missile launched from Iraqi territory into the city of Al-Khobar in Saudi Arabia that killed 28 and injured 100 USA soldiers shows that if a hospital is near (King Fahd Hospital is 2 km away), the number of pelvic injuries was rather high, up to 20 % of fractures [8]. Thus indicating that pelvic injuries are often related to immediate death.

In the Aden war from 1964 to 1967, the rate of lethal pelvic injuries: acute, survival of a few moments and despite first aid treatment was 15.5 %. Of those who died despite First Aid Treatment, the pelvic iliac vessels were involved in 29 % of the soldiers [9]. For the Northern Ireland hostilities, it was found that of total vessel damage 11 % concerned pelvic vessels and 10 % of the pelvic injuries were skeletal. A total of 12.5 % of the patients died from pelvic related wounds [10].

The database of the International Committee of the Red Cross indicates that 8.2 % of the wounded in several wars had wounds of the pelvis and buttocks, with one-third pure pelvic wounds, while of the total wounds 10–20 % belonged to abdominal wounds, administered for those patients who could *reach a hospital* of the Red Cross in five different war zones. It should be noted that abdominal wounds by cluster bombs nearly always contain pelvic damage too, but these are not always separately registered. For GSW, bleeding after pelvic fractures is responsible for 5–30 % mortality, while in 18–64 % rectal, and in 24–57 % genitourinary wounds are involved [10].

Real statistics are difficult to compile, since the conditions of civil hostilities and of different wars are hardly comparable. A “bad,” rough, conservative, estimate is that 10 % casualties for civilians and 15–20 % for soldiers are caused by

wounding of the bony pelvis and/or pelvic soft structures which is 1 in 10 for civilians and 1 in 7 till 1 in 5 for soldiers. Pelvic vessel damages, but even pelvic fractures, have the lowest survival rate. No distinction was made among fragment wounding, bullets, or mines in this part.

2.1.5 Pelvic Stability and Pelvic Fractures

To understand the following part on the siege of Sarajevo stability and fractures of the pelvis have to be considered. Historical overviews show that before the introduction of X-rays (after the discovery in 1895) pelvic fractures were hard to diagnose. “J. F. Malgaigne (1806–1865) described pelvic fractures in Paris. His explanations of the pattern of fractures of the pelvis were based initially on the history and clinical examination of patients and then on their *autopsies* (emphasis ours)”. In 1847, he published an atlas of traumatology, in which he characterized ten patterns of pubic ramus fractures with a vertical fracture of the iliac bone (Malgaigne injury) [12]. In the 1950s, the Canadian surgeon George F Pennal (1913–1976) made the breaking through. He started with anatomical studies on compressions of the pelvis: anteroposterior and lateral compression, and vertical shearing forces were studied. Improvements of X-ray projections of the pelvis and the use of the external fixator in the multi-fractioned pelvis improved the clinical approach. His classification of pelvic fractures is still at the base of the modern ones. His students continued his research and Marvin Tile and his colleagues produced the classical book “Fractures of the pelvis and acetabulum.” So far, this historical synopsis leaves out a series of important contributions of surgeons and of researches that advanced the pelvic treatment before Pennal started his studies.

Let us start with pelvic stability. In an anterior–posterior view of the pelvis, the sacrum functions like a key stone as in classic arcades. However, when the sacrum is viewed from above, the sacroiliac joint looks like a straight line, although we know that its surface is not flat but contains protuberances and is tightly fixed by ligaments. Forward shifting of the sacrum is stopped by the protuberances within the joint and the sacroiliac ligaments (see Chap. 1). Thus, stability of the pelvic ring is organized by a key stone mechanism and fixation to the iliac blades of the sacrum. One should note that the pubic bones are hardly involved in the stability of the pelvic ring. “The anterior pubic rami act as a support to prevent anterior collapse of the pelvic ring during weight bearing. However, congenital or traumatic absence of the anterior structures has little effect on pelvic stability” [13]. So, pelvic stability is mainly disturbed by fractures that engage bony parts of the sacrum or ilium or disruption of sacroiliac ligaments.

Pelvic fractures are classified according to their effect on the stability of the pelvic ring: stable, partial unstable, and unstable ones [14]. Description of the whole classification is beyond the scope of this chapter. Here, we treat a few categories. To the stable ones belong the fractures that have no influence on the pelvic ring and those that do eventually: avulsion of small parts of bones like an

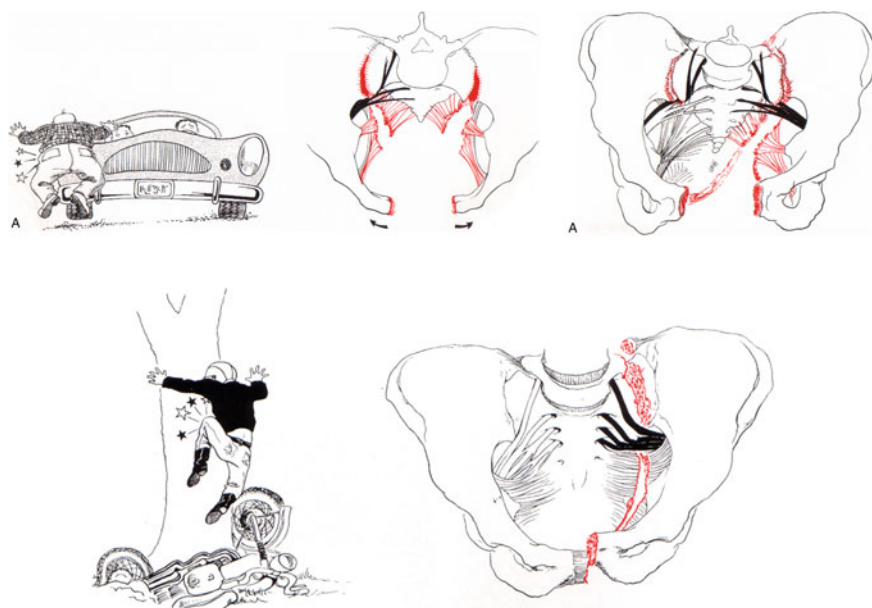


Fig. 2.3 *Upper figures* open book pelvic fracture, showing a bilateral and a unilateral open book fracture, *lower figures* Malgaigne fracture. The fractures and tears are indicated in red. Reproduced from “fractures of the pelvis and acetabulum,” by Tile M, Helfet DL, Kellam JF (2003) with permission for their figures Ch 12: 12–18, 12–22, and 12–33 (Courtesy Marvin Tile [13])

edge of the ilium (isolated iliac wing fractures) has no effect on the pelvic ring and a fracture of all 4 pubic rami (superior and inferior ones), called the straddle or butterfly fracture, can effect the whole pelvic ring, although instability will not directly be noticed [14]. Fractures of the coccygeal bones do not disturb the pelvic ring stability, but can especially induce long-lasting pain [14].

The so-called open book injury (see Fig. 2.3) belongs to the partial unstable ones: The symphysis is disrupted, the pelvis opens like a book and tearing of parts of the sacroiliac ligaments and joint (but not the entire sacroiliac joint) occurs together with disruption of the sacrospinous ligament and pelvic floor, often inducing visceral injuries [14]. To the unstable ones also belong the Malgaigne vertical shear (indicated above, see Fig. 2.3): A unilateral fracture of symphysis over the sacrum or ilium, disrupting the sacral ligaments, pelvic floor, and the pelvic soft tissues. It is a “complete disruption of the posterior sacroiliac complex” [14]. Most of these fractures are caused by traffic incidences. An analogous subdivision of acetabular fractures is present, but not discussed here.

Open pelvic fractures, that occur during war, together with complex fracturing will result in an average mortality of 25–30 %, while those that survive “become severely disabled and have a long and difficult course, battling pelvic sepsis to survive” [15]. Complication rates for external fixation of pelvic fractures in normal hospitals are estimated on 47 % [15].

Open also means laceration of perineal or gluteal areas. Disruption of pelvic soft tissue, especially damage to rectum or colon is related to serious infection. Open pelvic fractures are the most feared by the surgeon. Age is also an important factor: persons older than 40 years have a survival chance of 22 %, while younger ones show 82 % survival [15].

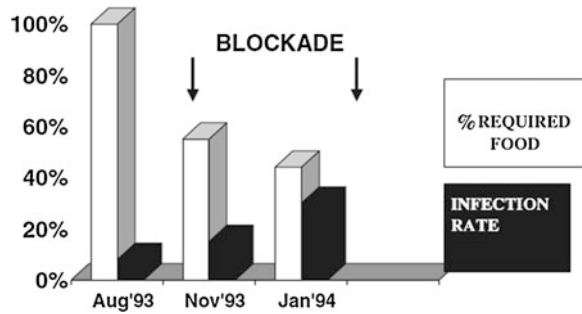
The current approach of dealing with unstable fractures is internal fixation of the unstable pelvic ring. Before 1980, external fixation was the main choice. Internal fixation reduces malunion, nonunion, and leg length discrepancies. Moreover external fixation provides insufficient stability. Due to modern guidance techniques, minimally invasive approaches are needed, and under certain conditions, the patient can be mobilized earlier [16].

2.1.6 Sarajevo

Since its foundation in 1461 by the Ottomans, Sarajevo has always been a contested city. In every political instability in the region, it has been involved, besieged, or occupied. World War I started with the assassination of the Austrian Archduke Franz Ferdinand of Austria and his wife Sofie in Sarajevo on June 28, 1914, because of Serbian-Bosnian political instability. During World War II, it was part of a German puppet state, lead by Tomislav II. The whole Jewish population of the city was eradicated. On April 6, 1945, Sarajevo was liberated and was integrated in Tito's Yugoslavia, officially the Socialist Federal Republic of Yugoslavia. After the disintegration of the Republic of Yugoslavia and the independence declaration of Bosnia-Herzegovina, the city was besieged from April 5, 1992, till February 29, 1996, by the Yugoslav army under Ratko Mladic, called the butcher of Sarajevo, who was arrested as this chapter was being completed.

Sarajevo was thus besieged for 4 years: 1992–1996. “The siege of Sarajevo was the longest in modern times. It was an example of a method of warfare as old as recorded history, in which attrition is focused on the civilian population with the ultimate aim of attacking the citizens psychologically and physically. As well as wounding and killing, the weapons used are those of fear, uncertainty, and deprivation. All will suffer, but the sick and elderly, the unborn children and infants, and the wounded are particularly vulnerable to starvation and loss of basic amenities” [5]. Indeed for the Dutch population with its memories of five-year occupation by Germany (1940–1945), the bombardment of Rotterdam, the Jew deportation and near the end of the war, serious starvation in “fortress Holland” the siege of Sarajevo was a “dramatic recollection” of World War II, especially so when the Dutch troops could not protect the Bosnian Muslim population of nearby. In the massacre of Srebrenica (July 11–22, 1995), over 8,000 men and boys were murdered and numerous women raped and/or sexual assaulted by Ratko Mladic's army.

Fig. 2.4 Relationship between reduction in available food for the wounded patients in the State Hospital Sarajevo and the pin track infection from August 1993 to January 1994 [11]. Text and figure reproduced with permission from Beavis [11]



From the siege of Sarajevo comes the device known as Sarafix. Within a few weeks to months after the start of the siege of Sarajevo devices for fixing fractures (internal and external ones) were no longer available. Within the city, a device called Sarafix was developed by an engineer and surgeons and applied in 3,000 cases. “HMD Response International provided a critical component of the fixture—its surgical steel pins—as part of its support programme for the surgical development” [5]. As we have seen above fixing pelvic fractures is an effective procedure in healing.

The Sarafix is an iron rod or several coupled rods, on which one can slide and fasten smaller steel rods that are secured to the damaged bony parts with steel pins. The rod and the smaller ones are outside the body, only the ends of the smaller rods enter the damaged area together with the pins. The system is not new and is known as “fixateur externe” or external fixator, but made from inert metal alloys such as vitallium and is used for osteosynthesis. Since pelvic fracture healing takes 3–6 months, reaction to the iron, so-called metallosis, will occur with increased pain and a possible rejection of the fixator from the tissue involved.

Sophisticated materials were not available, but the simple Sarafix device worked also very well for pelvic fractures: “The device was used at many sites including complex pelvic injuries with bowel and vascular damage” [5], and in 82 % the knitting of fractures was achieved [11].

Threats to the patients were infection, osteomyelitis, and the starvation that set in after first year of the siege. Infection and malnutrition were coupled. “A direct relationship was observed between the reduction in food supplies and an increase in wound infection when the pin track sites of the Sarafix device were inspected” [5] (see Fig. 2.4).

Immobilization of the pelvic fracture in order to heal is the method of choice, and in Sarajevo due to starvation, the increasing risk of infection was fought by open wound care. “War wounds are complex and inevitably get infected. In the early months of the World War I, British Army Medical Officers were inexperienced in treating such terrible wounds, and a massive number of lethal infections occurred. In 1915, orders were given to remove all dead and foreign material and

Fig. 2.5 The Sarafix at “work.” Patient with open hip and open perineal wounds and the external fixator Sarafix in place (figure reproduced with permission from Beavis [11])



to never primarily close wounds. The technique is known as debridement, from the French *to unsaddle or release*. This tested method was employed in Sarajevo with great success with the addition of an anti-tetanus toxin and antibiotics. Injuries near the buttocks were particularly at risk of such infection” [5]. It worked, but as one can imagine a pelvic fracture fixed by the Sarafix with open wound(s) (see Fig. 2.5) must have been a terrible ordeal. And the same conditions which made this procedure necessary are present today in other areas on the globe too.

From experience with pelvic stability and pelvic fractures, it was concluded that the internal fixator is the better approach for reunion and pelvic stability. Pelvic multi-fractures are difficult to treat and heal. Moreover, all war wounds are infected. The surgeons in Sarajevo only had the external fixator possibility due to the war conditions. The results are amazing: 82 % reunion; 3 % malunion, and 5 % nonunion. In 6 % of the cases bridging occurred but a defect remained and amputation was necessary in 3 % of the patients treated. Of course, “simple” fractures were among these cases (tibia 37 % and femur 25 %) [11], but 10 % or even more must have belonged to pelvic injury. Nevertheless, the outcome under these conditions is unbelievably good, and the quote above demonstrates that it also worked for pelvic fractures with soft tissue damage. The war surgeons in Sarajevo earn our “pelvic” respect!

In conclusion, the pelvis is involved in 10–20 % of war casualties, of which 25–30 % will not survive, meaning that of 100 soldiers from 3 to 5–6 will die from pelvic wounding. Figures may be higher, since not all casualties are registered for their type of wounding during war. Bleeding from pelvic vessels is a serious threat, but pelvic multi-fractures are an equally serious menace. If pelvic wounding is present in multi-trauma situations mortality rates increase. Survival during war or civil hostilities is dependent on stopping pelvic vessel bleeding, immobilization of fractures, stopping infection, debridement and nutrition, and adequately restoring soft tissue tears in the pelvic organs and pelvic ligaments.

Literature

Literature has been grouped in reference lists of several chapters in those cases where arguments are difficult to entangle or published over several articles or books. In cases of citation the article or book involved is indicated by the reference number together with a capital Arabic letter.

1. Lewis JE (2008) Identifying sword marks on bone: criteria for distinguishing between cut marks made by different classes of bladed weapons. *J Archeol Sci* 35:2001–2008
2. Woltmann A, Eckardt H, Gaul L (2010) Management der Beckenverletzungen beim Polytrauma. *Trauma Berufskrankh* 12 [Suppl 2]:183–187; Eid K, Keel M, Keller A, Ertel W, Trentz O (2005) Einfluss der Sakrumfraktur auf das funktionelle Langzeitergebnis von Beckenringverletzungen. *Unfallchirurg* 108:35–42; Zannis VJ, Wood McD (1980) Laparotomy for pelvic fracture. *Amer J Surg* 140: 841–845
- 2A. Peiniger S, Maegele M (2010) Traumaassoziierte Blutung beim Schwerverletzten Relevanz, Risikostratifizierung und aktuelle Therapieansätze. *Der Unfallchirurg* doi:[10.1007/s00113-010-1860-2](https://doi.org/10.1007/s00113-010-1860-2)
- 2B. Copeland CE, Bosse MJ, McCarthy ML, MacKenzie EJ, Guzinski GM, Hash CS, Burgess AR (1997) Effect of trauma and pelvic fracture on female genitourinary, sexual, and reproductive function. *J Orthop Trauma* 11:73–81 and Copeland CE (2003) Pelvic ring disruption in women: genitourinary and obstetric implications, Ch 18:329–341. In: Tile M, Helfet DL, Kellam JF (eds) *Fractures of the pelvis and acetabulum*. Lippincot Williams and Wilkins, Philadelphia
3. Berger TD, Trinkhaus E (1995) Patterns of trauma among Neandertals. *J Archeol Sci* 22:841–852
4. Jordana X, Galtés I, Turbat T, Batsukh D, Garcíá C, Isidro A, Giscard P-H, Malgosa A (2009) The warriors of the steppes: osteological evidence of warfare and violence from Pazyryk tumuli in the Mongolian Altai. *J Archeol Sci* 36:1319–1327
5. Beavis JP, Ryan JM (2002) High energy transfer missile wounds in the siege of Sarajevo and their relation to mine injuries. *J Mine Action* 6.3 Victim Assistance
- 5A. Poulakou-Rebelakou E, Rebelakos AG, Marketos SG (1998) Urologic references in the Homeric epics. *De Historia Urologiae Europaeae* 5:249–257
6. Vogel H, Dootz B (2007) Weapons and wounds. *Eur J Radiol* 63:151–166
7. Selikowitz SM (1977) Penetrating high-velocity genitourinary injuries. Part I and Part II *Urol* 9:371–376 and 493–499
8. Ahlberg A, Corea JR, Sadat-Ali M, Al-Habdan I, Marwah S, Moussa M, Al-Othman A, Basyuni A (1994) The scud missile disaster in Al-Khobar, Saudi Arabia, 1991: the orthopaedic experience. *Injury* 25:97–98
9. Brown RF, Binns JH (1970) Missile injuries in Aden, 1964–7. *Injury* 1:293–302
10. Barros D'Sa AAB, Hassard TH, Livingston RH, Irwin JWS (1980) Missile-induced vascular trauma. *Injury* 12:13–30 and Whitfield C, Garner JP (2007) The early management of gun shot wounds: Part II, the abdomen, extremities and special situations. *Trauma* 9:47–71
11. Beavis JP (2005) Ballistic missile injuries in the siege of Sarajevo 1992–1995. *Ballistic Trauma Sect* 4:569–575, Springer Verlag doi:[10.1007/1-84628-060-5.29](https://doi.org/10.1007/1-84628-060-5.29); Beavis JP (2002) Some medical consequences of siege warfare in a modern city, Sarajevo 1992–1995. *Diss Dipl Med Care Catastrophes Soc Apothecaris and Salihefendic R et al* (1997) Sarafix, external fixator in the treatment of extensive war injuries of limbs. *Proc Br Trauma Soc; Injury* 28:242–243
12. Prevezas N (2007) Evolution of pelvic and acetabular surgery from ancient to modern times. *Injury* 38:397–407

13. Tile M, Hearn T, Vrahas M (2003) Biomechanics of the pelvic ring, Ch 4: 32–45. In: Tile M, Helfet DL, Kellam JF (eds) *Fractures of the pelvis and acetabulum*. Lippincot Williams and Wilkins, Philadelphia
14. Tile M (2003) Describing the injury: classification of pelvic ring injuries. Ch 12:130–167. In: Tile M, Helfet DL, Kellam JF (eds) *Fractures of the pelvis and acetabulum*. Lippincot Williams and Wilkins, Philadelphia
15. Barla J, Powell JN (2003) Open pelvic fractures. Ch 17: 321–328. In: Tile M, Helfet DL, Kellam JF (eds) *Fractures of the pelvis and acetabulum*. Lippincot Williams and Wilkins, Philadelphia and Palmer S, Fairbank AC, Bircher M (1997) Surgical complications and implications of external fixation of pelvic fractures. *Injury* 28: 649–653
16. Moed BR, Kellam JF, McLaren A, Tile M (2003) Internal fixation for the injured pelvic ring. In: Tile M, Helfet DL, Kellam JF (eds) *Fractures of the pelvis and acetabulum*. Lippincot Williams and Wilkins, Philadelphia

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