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ORIGINAL

Can acetabular fractures be successfully treated outside the trauma centre?

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ABSTRACT

Purpose. Acetabular fractures are severe injuries with an uncertain final functional outcome. Methods. We retrospectively analysed 63 patients from 2008. to 2018. We followed complications of surgical treatment for acetabular fractures in 52(82.53%) men and 11(17.46%) women, average age of 45.06 years- old (from 14 to 77). Results. Road traffic accidents were the cause of fractures in 51(80.95%) patients. According to Letournel and Judet 37(58.73%) patients had elementary acetabular fractures, whereas 26 (41.26%) patients had complex fractures. The average follow- up time was 6.15 years (from 2 to 10). Traumatic sciatic/ peroneal nerve injury was present in 9 (14.28%) patients and iatrogenic in 2(3.17%) patients. Early revision osteosynthesis was done in 1 (1.58%) patient, 3 (4.76%) infections and 3(4.76%) patients with deep venous thrombosis (DVT) were present. Heterotopic ossification (HO) was present in 11(17.46%) patients, AVN of the femoral head was diagnosed in 9 (14.28%). Average time of definitive acetabular osteosynthesis was 5.09 days from the injury (from 1 to 21 days). Anatomical reduction of fracture was achieved in 54 (85.71%) patients. Post- traumatic OA was present in 14 (22.22 %) patients. Final functional outcomes, according to Merle d'Aubigné score were: excellent in 20 (31.74%), good in 28 (44.44%), moderate in 11 (17.46%), poor in 4(6.34%) patients. Due to post- traumatic OA and AVN of the femoral head 23 (36.5%) patients underwent THA. Patients underwent THA after the average of 4.28 years (from 1 to 8) after previous acetabular fracture osteosynthesis. Conclusion Complications and results suggest that in addition to the urgent hip reduction in dislocated fractures, early definitive acetabular osteosynthesis and anatomical reduction, the severity of initial trauma significantly have an effect on results. Given the specifics, acetabular fractures require surgical experience and treatment in tertiary care facilities.

KEYWORDS: Acetabulum, Fractures, Treatmnent, Trauma Center

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Introduction

Acetabular fractures have always been drawing orthopaedic's attention and their treatment has always been a real challenge with often an ucertain course of the treatment and the final outcome. The revolution of acetabular fractures treatment started in 1950s by Letournel and Judet [1]. Their acetabular fracture classification is widely accepted and is still used today worldwide [2,3]. The treatment principles which were founded by them are still valid today and those are early open acetabular reduction of fracture and stable internal fixation, early activation [4]. This method of treatment gives good results, but despite adequate surgical work by an experienced surgical team, these fractures are followed by numerous complications such as, traumatic and iatrogenic injury of sciatic/ peroneal nerve, infection, deep venous thrombosis (DVT), heterotopic ossifications (HO), avascular necrosis of femoral head (AVN), post- traumatic arthritis of the hip (OA)[5,6]. Complications such as AVN and OA may require further THA [7,8]. Surgery of acetabular fractures requires extensive experience, which is achieved through special training in national referral institutions or in specialized foreign trauma centres where acetabular fractures are frequent, under the supervision of experienced surgeons. Upon completion of education, in order to maintain a "surgical routine", the surgeon must have a certain number of surgeries in order for the treatment results to be satisfactory. The aim of the study is to analyze the results of surgical treatment of acetabulum fractures and to compare them with the average literature results in trauma centers and to determine whether such operations, which have a low incidence and require additional education and surgical experience, are performed in institutions that are tertiary centers.

Subjects and Methods

Data of patients with an acetabular fracture who were surgically treated in University hospital Nis, Republic of Serbia, a tertiary institution from 2008 to 2018 were analyzed. The study is retrospective, acetabular fractures are classified according to Letournel and Judet [1] classification, early and late complications have been followed as well (Table 1). From surgical approaches, Kocher- Langenbeck approach, anterior Ilio - inguinal, combined, anterior Iliofemoral, lateral- Watson-Jones for total hip arthroplasty (THA) were used. Final functional outcomes of acetabular fractures were determined according to modified Merle d'Aubigné score [9]. Cause of trauma, sex distribution, frequency of nerve injury, infections, DVT, heterotopic ossification (HO), AVN of the femoral head, degree of postoperative reduction were analyzed. Average time of follow-up was 6.15 years (range from 2 to 10 years).

Results

Retrospectively, 63 patients with dislocated acetabular fracture, who required surgery were analysed, 52(82.53%) men and 11(17.46%) women, average age of 45,06 years (range from 14 to 77 years). Road traffic injury was the cause of fractures in 51(80.95%) patients. According to Letournel and Judet 37(58.73%) patients had an elementary acetabular fracture whereas 26 (41.26%) patients had complex acetabular fracture. All of the acetabular fractures were fixated with pelvic and acetabular reconstructive plates. The traumatic sciatic nerve injury was present in 2(3.17%) patients, whereas traumatic peroneal nerve injury was present in 7(11.11%) patients. In total, traumatic nerve injury was present in 9 (14.28%) patients (Fig.1). All of the patients with traumatic sciatic nerve injury or its peroneal division had an acetabular fracture associated with posterior hip dislocation. Iatrogenic peroneal nerve injury was present in 2(3.17%) patients (Fig.2). In 1 (1.58%) patient, early revision surgery of osteosynthesis was done. In this series 3 (4.76%) infections were present after acetabular osteosynthesis, 2 deep and 1 superficial. In 3 (4.76%) patients deep venous thrombosis (DVT) was present. Heterotopic ossification (HO) was present in 11(17.46%) patients, all Broker I, II. AVN of the femoral head was present in 9 (14.28%) patients, in 1(1.58%) patient who had a transverse acetabular fracture and in 8 (12.69%) patients with posterior fracture- dislocation. In 3 (4,76%) patients with AVN of the femoral head, hip reduction was done in the time interval up to 24h from the injury, whereas in 5 (7.93%) patients with AVN, hip reduction was done in the time in-

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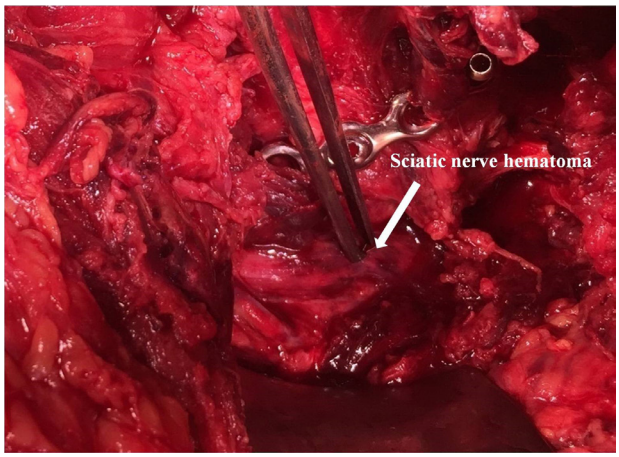

Figure 1. *Intraoperative view after traumatic injury of the sciatic nerve shows sciatic nerve*

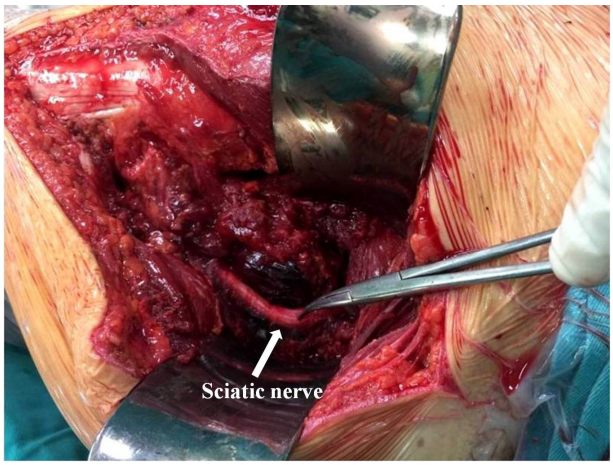

Figure 2. *During the surgical procedure, sciatic nerve needs to be clearly identified and protected.*

TABLE 1.

The rates of complication after acetabular surgery treatment

Traumatic nerve injury	Iatrogenic nerve injury	Infection	DVT	HO	AVN	OA	Revision surgery	THA
9(14.28 %)	2(3.17%)	3(4.76%)	3(4.76%)	11(17.46%)	9(14.28%)	14(22.22 %)	1(1.58%)	23(36.5 %)

terval after 24h from the injury. The average time interval from the injury to definitive osteosynthesis of acetabulum was 5.09 days (range from 1 to 22 days). Anatomical reduction of acetabular fracture, ≤ 2mm, was achieved in 54 (85.71%) patients (Fig. 3,4). Post- traumatic arthritis (OA) was present in 14 (22.22 %) patients. Final functional outcome, according to Merle d'Aubigné score were excellent 20(31.74%), good, 28(44.44%), moderate 11(17.46%), and poor 4(6.34%) (Fig.6). Average time of follow-up was 6.15 years (range from 2 to 10 years). Due to post- traumatic OA or avascular necrosis of femoral head (AVN), 23 (36.5 %) patients required further total hip arthroplasty (THA) (Fig.7,8).

Discussion

Acetabular fractures are followed by numerous complications, which says enough about their specificity and severity [5]. It is thought that Letournel and Judet set the foundation for surgical treatment of acetabular fractures in the 1950s. Their principles are still valid today and their classification into elementary and complex is widely accepted and used [1-4]. Acetabular fractures represent a real challenge for surgeon and their treatment is accompanied by uncertainty, regarding complications and final functional outcome. It is well- known that acetabular fractures are caused by high- energy trauma, by action of the axial force over femoral diaphysis, which can cause different types of fractures depending on the intensity and position of the femoral head in the acetabulum in the moment of impact. The second way in which acetabular fractures can occur is by action of lateral force over the greater trochanter. Acetabular fractures mostly occur in road traffic accidents, according to our results 80.5% of them, and are much more frequent in the male working age population. Scheinfeld et al., Jindal et al., Dakin et al., and Sahu, reported similar results [10]. Our small sample supports the above results. Literature and clinical practice clearly indicate to traumatic injuries of sciatic nerve, most commonly in the peroneal division as a result of dislocated acetabular

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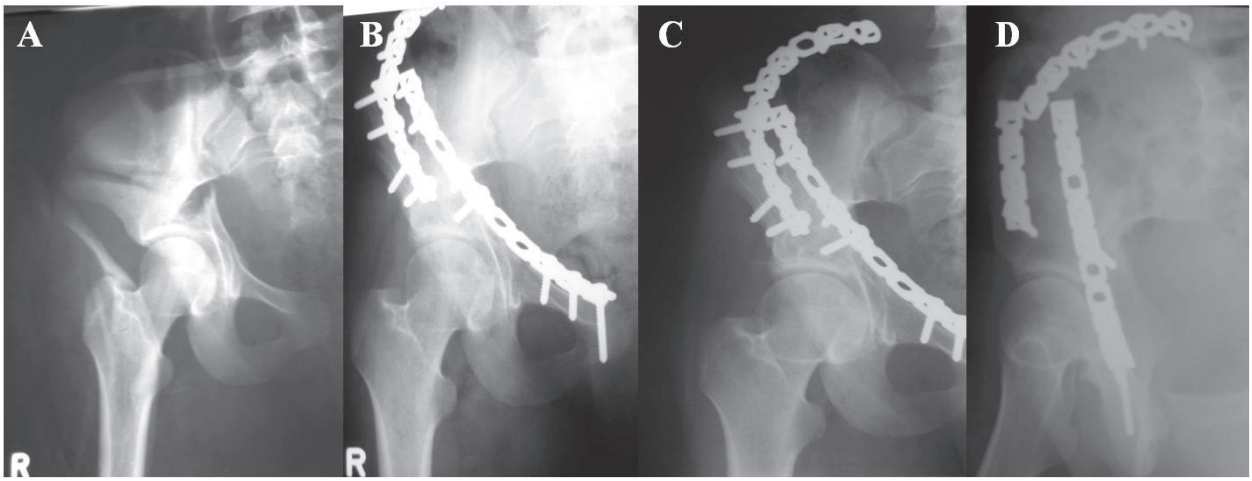

Figure 3. (A-D) *Transverse acetabular fracture associated with iliac wing fracture. A- Preoperative X- ray; B-D- Postoperative X- rays.*

fractures [11]. The cumulative average incidence of sciatic nerve injury reported in the literature is 10% [12]. We had 9 (14.28%) patients with traumatic sciatic and peroneal nerve injury, which was clinically diagnosed immediately after admission. In 3 (33.33%) patients complete nerve recovery was achieved, in 4 (44.44%) partial recovery, whereas in 2 (22.22%) patients there was no neurological recovery. We had 2 (3.17%) iatrogenic peroneal nerve injuries, in both cases complete recovery was achieved. Iatrogenic sciatic/ peroneal nerve injuries are described in literature and can be avoided with careful surgery, nerve identification during surgery and its protection, careful handling of elevators and retractors, setting the knee in flexion during reduction and fracture fixation, hemostasis and postoperative drainage. Giannoudis' meta-analysis of 2426 fractures had an incidence of approximately 4.7% iatrogenic sciatic nerve palsy [13]. Haidukewych et al. published 7.9% traumatic and 5.6% iatrogenic sciatic/ peroneal nerve injuries in a series of 252 patients [14]. Lehmann et al. published that acetabular fractures with the involvement of posterior wall were most commonly accompanied by nerve injuries [15]. According to Simske et al. traumatic sciatic/peroneal nerve injuries occur after posterior fracture-dislocation, transverse fractures, and posterior wall fractures. Peroneal division is usually affected 65%, 50% of patients have partially recovered, 22% of patients had a complete recovery, whereas in 24% of patients with sciatic or peroneal injuries had no recovery. According to the same authors 25% of injuries are iatrogenic [11]. Occurrence of traumatic sciatic nerve injuries cannot be affected on, but urgent reduction of dislocated hip is of utmost importance in order to reduce the femoral head pressure or dislocated bone fragment pressure on the nerve, which latter has a better chance for recovery. Also, early definitive osteosynthesis of acetabulum may play an important role in neurological recovery. Early revision hip surgery is mainly related to debridement and irrigation in infections after osteosynthesis of the acetabulum and reosteosynthesis in loss of fixation [16]. We had 1(1.58%) revision of osteosynthesis and 3(4.76%) patients with infection- 2 deep and 1 superficial. Duration of surgery, obesity, long- term wound exposure, intraoperative hemorrhage are factors which increase the chance of infection. Similar results were published in literature [17,18]. DVT, PTE are described and they accompany this type of surgery, despite prophylaxis. Early definitive osteosynthesis of acetabulum, early mobilization and thromboprophylaxis are important factors for reducing DVT in acetabular surgery [19]. We had 3 (4.76%) cases of deep venous thrombosis (DVT). Wang et al. published that DVT after pelvic and acetabular fracture amounts 29.09% in a series of 110 patients, 48 pelvic fractures and 62 acetabular fractures. Ages 60 and up, associated injuries, complex fractures and postponed osteosynthesis of acetabu-

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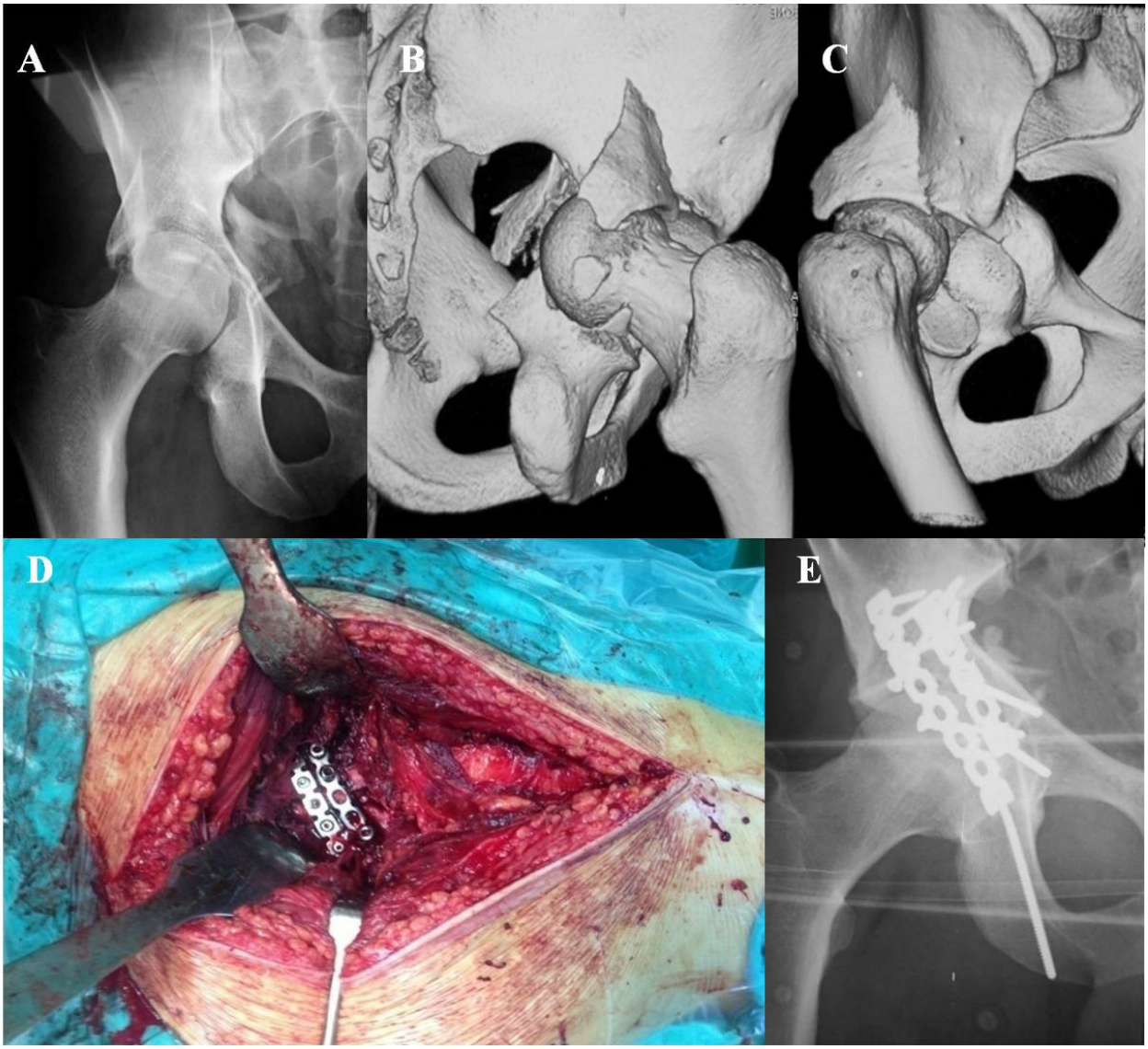

Figure 4. *Transverse acetabular fractures associated with posterior wall fracture- dislocation of the acetabulum. A- X- ray after the injury; B,C- 3D- CT; D- Intraoperative appearance ; E- X-ray after the open reduction and internal fixation.*

lum after 14 days, increase the risk of DVT occurrence [20]. Heterotopic ossification (HO) is also clearly described and it accompanies this type of surgery. In many centres, indomethacin or low- dose radiotherapy is administered as prophylaxis to prevent the development of HO. We did not apply HO prevention in our clinical material. The incidence of 17.46% HO is in correlation with results from the literature [21. The importance of the urgent reduction of the hip is reflected in prevention of AVN of the femoral head. In our series of 63 patients, we had 14.28% cases with AVN of the femoral head, in 1(1.58%) patient who had a transverse acetabular fracture and in 8 (12.69%) patients with posterior fracture- dislocation (transverse/posterior wall, posterior wall, posterior column/posterior wall). In 3 (4.76%) patients with AVN of the femoral head hip reduction were done in the time interval up to 24h from the injury, whereas in 5 (7.93%) patients hip reduction was done in the time interval of 24h after the injury. There are numerous data in the litera-

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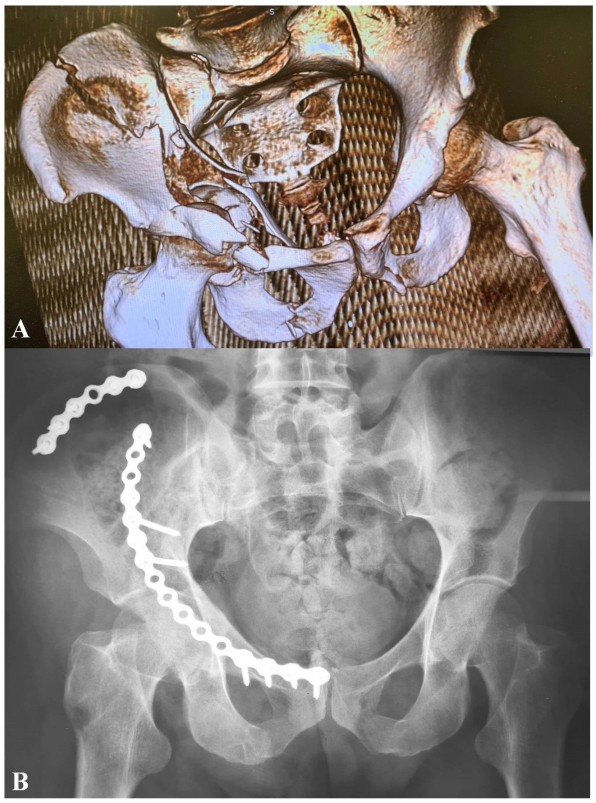

Figure 5 (A,B). *Complex acetabular fracture. A- 3D CT after the injury; B- X- ray after the surgery.*

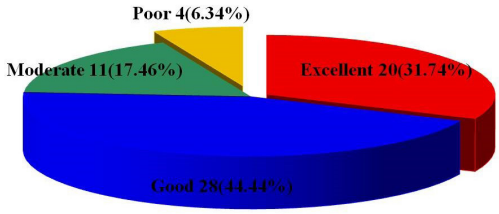

Figure 6. *The end functional outcomes according to the Merle d'Aubigné score.*

ture concerning the importance of urgent hip reduction in acetabular fractures associated with hip dislocation in preventing the occurrence of AVN of the femoral head [22]. In dislocated acetabular fractures, femoral head chondral injury is possible, abrasions, lacerations in the moment of impact. Initial femoral head injury can later significantly increase the chance of AVN of the femoral head occurrence, despite the urgent reduction of the hip. In a small number of cases, orthopaedic reduction of the dislocated hip is not possible due to bone or soft tissue interposition, loose bodies in the hip joint, which is why urgent open reduction of hip and simultaneous osteosynthesis of acetabular fracture are recommended. Upon head impact into the acetabulum, and considering the position of the head during the impact, different types of fractures can occur - elementary or complex. When an acetabular fracture occurs, smaller or larger degree of comminution, impaction, damage of the weight- bearing area of acetabulum, loose bodies in the hip joint are possible. Degree of acetabular dislocation which occurs upon fracture is different, smaller or larger than 20mm. All of these factors have a negative effect on the final outcome, on which we do not have an influence and they indicate that initial trauma can determine final functional outcome [23,24]. Early surgery, right surgical approach, anatomical reduction of fracture, stable internal fixation, experienced surgical team, are crucial factors in acetabular fracture treatment. Early definitive osteosynthesis of the acetabulum is crucial for achieving anatomical reduction of fracture [25,26]. We had an anatomical reduction in 85.71% cases after definitive osteosynthesis of acetabular fracture which was done in a time interval average of 5.09 days from the injury. Two weeks after the injury, it is considerably harder to achieve anatomical reduction, which is crucial for good treatment. Cahueque et al. recommend definitive osteosynthesis of acetabulum up to 7 days from the injury. Same authors describe incidence of 48% of post- traumatic OA within 2 years from the injury [27]. Steven et al, report about the importance of early definitive osteosynthesis of acetabulum as well [28]. Post- traumatic OA accompanies acetabular fractures and is usually associated with nonanatomical fracture reduction [29]. Meena et al. published that not achieving anatomical reduction, associated injuries, initial dislocation, > 20mm, hip dislocation, late definitive osteosynthesis of acetabulum, age, can negatively affect the achievement of good outcome [25]. According to the Matta, the number of anatomical reductions decreased as time to surgery increased [30]. AVN of the femoral head causes latter fragmentation and collapse of the

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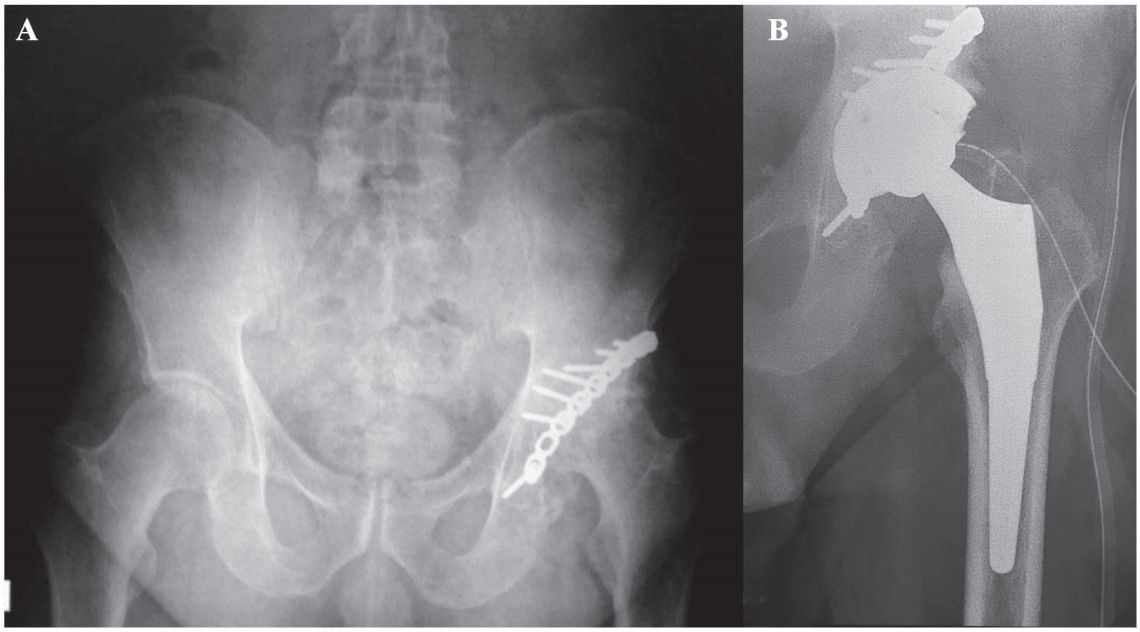

Figure 7 (AB). *THA after previous acetabular surgery. A- X- ray, male 56 years- old ,4 years after the posterior fracture- dislocation of the acetabulum, shows the post- traumatic OA; B- X- ray after uncemented THA.*

head and post- traumatic OA with severe problems which are manifested in the form of severe pain, hip contracture, requires further surgery - total hip arthroplasty (THA). According to Rollmann et al. about 20% of the patients with acetabular fractures require THA [7]. Pavelka et al. published 32.81% post- traumatic OA, 24 months post acetabular fracture [31]. Cahueque et al. published 48% OA, after 2 years from the acetabular fracture [27]. According to Dunet et al., 34.7% of the patients after acetabular fracture required latter THA [32]. Our results show that 36.5 % of the patients required THA due to post- traumatic OA and AVN of the femoral head. Although in 85.71% of the cases we had achieved an anatomical reduction of fracture, we achieved excellent and good final functional results in 76.18%. There are other authors who believe that post- traumatic OA occurs several years after the injury, despite anatomical reduction, which only confirms the importance and severity of acetabular fracture and the anatomical specificity of acetabulum and hip joint [33]. Acetabular surgery will still represent the challenge for surgeons in the future with an uncertain final outcome. The future of the acetabular trauma will still remain in understanding the fundamental principles of acetabular surgery. The principles introduced by Judet and Letournel have yielded positive clinical results and have stood the test of time. In this particular specialty of surgery, no technology can substitute for the human brain - the surgeon's 3- dimensional understanding of the biological approach, the bony anatomy, the fracture pattern, and the reduction and fixation techniques via the exposure. Despite the increase in education, there is no substitute for experience in treating these injuries [6]. Unfortunately, although we have increased the number of orthopaedic surgeons, there is a still small number of orthopaedic surgeons who are familiar with acetabular trauma. Additional continuing education and surgical experience are crucial in the treatment of acetabular fractures. Matta and Merritt have shown that surgical experience is in direct correlation to achieving excellent and good results in the treatment of acetabular fractures [34].The question is, how many acetabular fractures should be surgically treated on a monthly basis, by one experienced surgeon in order to maintain a "surgical training"? Acetabular fractures are not very common. According to Rinne et. al. the incidence of acetabular fractures in Finland was

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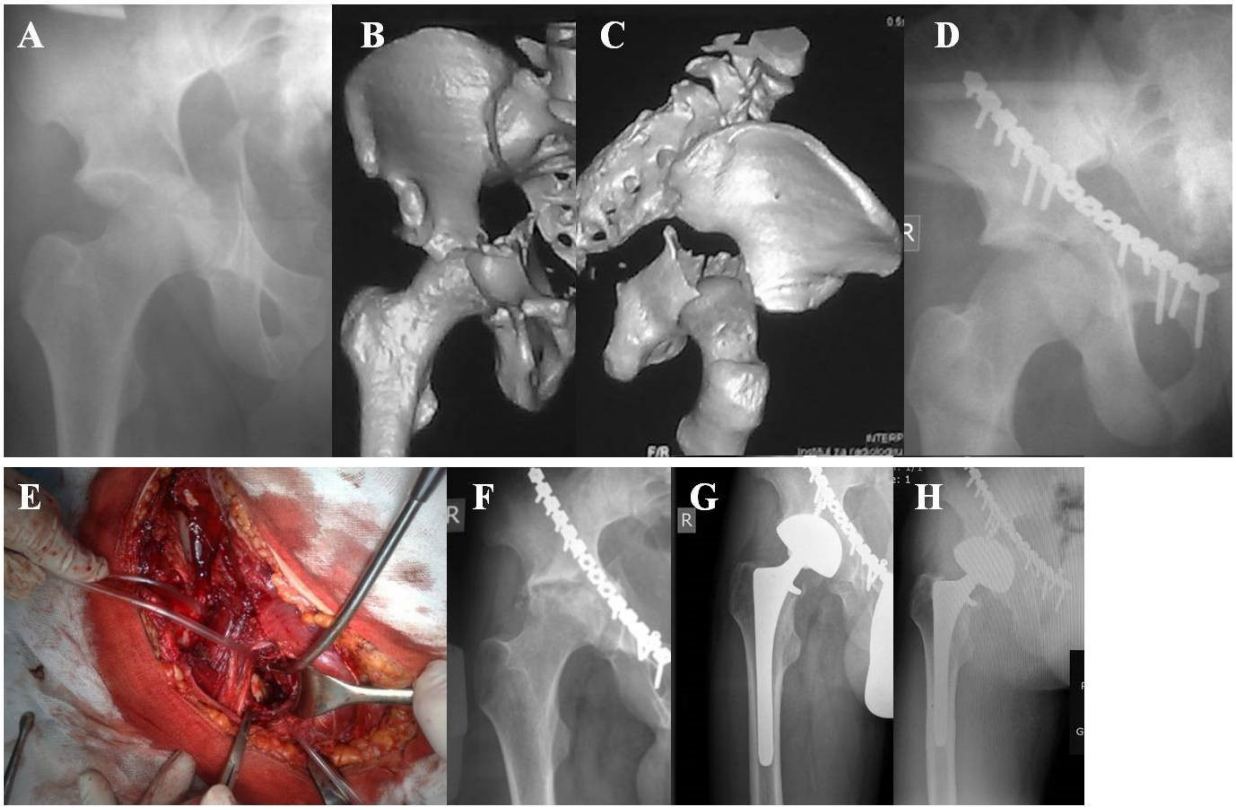

Figure 8(A-H). *THA after previous acetabular fracture and osteosyntheis. A- Transverse acetabular fracture- X- ray; B,C- 3D- CT; D- X- ray after acetabular osteosynthesis; E- Intraoperative view- Ilio-inguinal surgical approach; F- AVN of the femoral head and seondary OA, 4 years after acetabular surgery- X- ray; G- Uncemented THA , 4 years after the injury- X- ray; H- X-ray, 7 years after surgery.*

6.4/100 000 persons/year to 8.1/100 000 persons/year from 2007 to 2014 [35]. According to Laird and Kaeting, it was 3 patients/100 000/year [36]. Mauffrey et al. published similar results [37]. City of Nis is the largest city of the Nisava district, with a population of about 350 000 inhabitants and a tertiary health institution where patients with acetabular fractures are being taken care of. An incidence of about 4 patients /100 000/ year, requires the existence of an experienced surgical team for the treatment of acetabular fractures due to the fact that about 2 500 000 inhabitants of Southern and Eastern Serbia gravitate towards this institution.

Conclusions

Acetabular fractures are uncertain when it comes to the final outcome. Urgent reduction of a dislocated hip, early osteosynthesis of acetabulum, anatomical reduction and surgical experience is crucial for achieving good outcome. Unfortunately, despite following the principles of modern treatment, these severe injuries are followed by complications and will continue to be in the future. Although they cannot be avoided, by continuous learning and improving on the acetabular surgical field, we can achieve more of the excellent and good treatment results and less complications. We do not have an influence on the severity of the initial trauma, general condition of the patient and age, bone quality, and those are just some of the factors which have an effect on the final functional outcome and complications. Given the specifics, acetabular fractures require treatment only in tertiary care facilities.

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Author Contributions

Sasa Milenkovic: conceptualization and writing of the manuscript. Nenad Ilic: data collection, analyzed, interpreted the data and revised the manuscript. Milan Mitkovic: conceptualization, review, and supervision. All authors have reviewed, revised, and approved the final manuscript.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

All patients gave written informed consent.

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