

The Main Biomechanical Risk Factors for the Prevalence of the Left Hip Joint Traumatic and Degenerative Changes

Ivan Lovrić¹, Bruno Splavski², Savo Jovanović³, Ivan Soldo⁴, Slavica Kvolik⁵ and Borislav Has¹

¹ Department of Surgery, University Hospital Center Osijek, Osijek, Croatia

² Department of Neurosurgery, University Hospital Center Osijek, Osijek, Croatia

³ Division of Orthopedic Surgery, University Hospital Center Osijek, Osijek, Croatia

⁴ Department of Infectious Disease, University Hospital Center Osijek, Osijek, Croatia

⁵ Division of Anesthesiology and Reanimation, University Hospital Center Osijek, Osijek, Croatia

ABSTRACT

The aim of this paper is to examine characteristic biomechanical features leading to the acetabular fracture and hip joint arthrosis, and to explain the prevalence of the left side traumatic and degenerative pelvic pathology that is usually seen in diverse groups of patients. A total of 253 patients were analyzed in a retrospective case-control study during a six-year period. The patients were divided into the case group of 103 patients suffering traumatic acetabular fractures and into the control group of 150 patients with hip joint arthrosis, where operative aloarthroplasty was not yet performed. The data of the affected hip joint range of motions in the case and control group of patients were statistically analyzed correlating the difference in frequency of the left and right hip joint pathology. The left acetabulum was affected more commonly in both groups of patients, while arthrosis of the left hip joint was more commonly recorded in the control group. More frequent pathology of the left hip joint, found in both groups of patients, was probably due to weaker neuromuscular function of the left pelvic side, which was also more exposed to injury due to the greater input of forces to the left hip joint during a traffic accident.

Key words: pelvic pathology, biomechanical risk factors, left hip joint, leg dominance

Introduction

The aim of the paper was to examine the causes and other biomechanical characteristic features leading to the acetabular fracture and the hip joint arthrosis in diverse groups of patients and to find out, from the epidemiological point of view, if the prevalence of the left pelvic pathology may be explained by various etiologic factors involved.

Our main hypothesis was that a neuromuscular function of the left body side is habitually weaker, making the left hip joint more prone to traumatic and degenerative changes.

Characteristic injury mechanism leading to acetabular fracture that occurs during traffic accidents may be explained by the posterior direction of major impact forces¹. Consequently, near-side lateral impact is usually

the main cause of such a fracture², since the lateral crashes are more likely to produce a pelvic injury.

Degenerative hip joint changes also usually appear at the particular side of the body where neuromuscular function is less powerful and loading forces are stronger.

Materials and Methods

During a six-year period, 253 patients with the hip joint pathology were analyzed. The patients were divided into the case group of 103 patients suffering traumatic acetabular fractures, and the control group of 150 patients with hip joint arthrosis who were not operated on yet.

TABLE 1
DIVISION OF THE PATIENTS ACCORDING TO THE SEX AND THE CAUSE OF INJURY

Cause of injury	Males		Females		Total	
	n	%	n	%	n	%
Traffic accident	65	63.11	12	11.65	77	74.76
Fall	14	13.59	10	9.71	24	23.30
Other	0	0.00	2	1.94	2	1.94
Total	79	76.70	24	23.30	103	100.00

TABLE 2
PREVALENCE OF THE LEFT HIP JOINT PATHOLOGY IN BOTH GROUPS OF PATIENTS

	Case group		Control group		Total	
	n	%	n	%	n	%
Left hip joint	56	54.4	95	63.3	151	59.7
Right hip joint	47	45.6	55	36.7	102	40.3
Total	103	100	150	100	253	100

The radiographic signs and grade of femoral head entopic ossification found on the control pelvic plain X-ray examinations and assessed by the Brooker score³ were used as the outcome measure.

The clinical outcome of the case group dealing with the hip joint motion data was assessed at a two-year follow-up. The side and position of the patient's leg at the moment of acetabular injury were determined by anamnestic questionnaire.

The clinical outcome in the control group was assessed at the hospital admission.

The motion data between the left and the right hip joint for a total of 232 samples were compared and statistical one-dimensional analysis of variances was performed, regardless of which group they belonged to. The hip joint active movements of adduction, abduction, inner rotation, outer rotation, and anteflexion were analyzed.

The indications for surgery in the case group of patients were established according to the grade of bone fragments dislocation and pelvic fracture location⁴. The majority of non-surgical case group of patients were treated conservatively by skeletal traction, active muscle tonization and by weight bearing dome.

All patients from the control group were prepared for the hip joint operative aloarthroplasty, but were not operated on at the moment of the examination.

The standard MS Excel 6.0 program package was used for the data statistical analysis. A one-dimensional analysis of variances (ANOVA) was employed to compare quantitative variables between the samples. χ^2 -test was used to analyze the difference in frequency of the left and the right hip joint pathology between the case and the control group. The level of significance was set at $p < 0.05$.

TABLE 3
DIFFERENCE OF THE HIP JOINT MOTION DATA BETWEEN THE RIGHT AND THE LEFT SIDE REGARDLESS OF THE GROUP

Inner rotation		
Hip joint side	Number of samples (n)	Average value
Right	92	11.511
Left	140	8.957
Stat. significance		1.700 ($p < 0.05$)

Results

Traffic accident was the most common mode of injury. It was recorded in 77 (74.8%) out of 103 patients from the case group. Falls were less frequent and were recorded in 24 (23.3%) cases. The patients were predominantly males and the average age of the case group was 43.7 years, while it was 65.9 years for the control group of patients (Table 1).

The left side acetabular fracture was recorded in 56 (54.4%) out of 103 patients from the case group, while 47 (45.6%) patients suffered the right side fracture.

The degenerative hip joint changes in the control group occurred in 115 (76.7%) out of 150 patients. Osteophytes appeared on the left pelvic side in 73 (63.5%) out of 115 patients, compared to 42 patients (36.5%) with the right side osteophytes. Arthrosis mainly emerged at the femoral head medial parts (Table 2) (Figure 1).

The left hip joint pathology was observed in 151 (59.7%) out of 253 patients from both groups, while the right hip joint fracture was noticed in 102 (40.3%) cases (Table 2).

When the motion data between the left and the right hip joint were compared, regardless of the group, a statis-

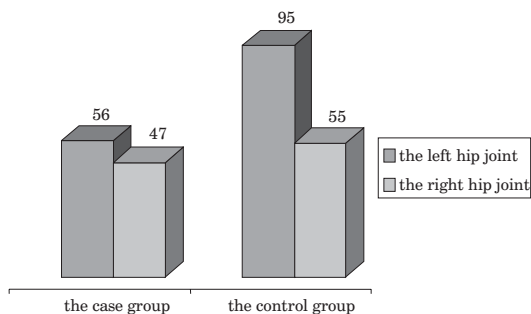


Fig. 1. Division of the patients according to the damaged hip joint side.

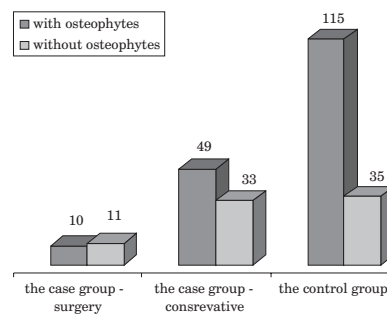


Fig. 2. Division of the acetabular fractures according to the leg position during injury.

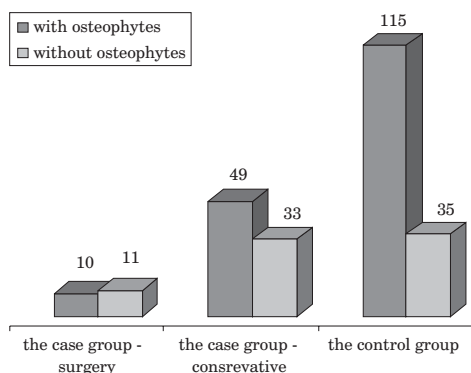


Fig. 3. The appearance of osteophytes in both groups of patients.

tically significant difference was found for the inner rotation ($p < 0.05$), since the difference between average left and right side values was 1.700 (Table 3). During injury, the main lower limb position was the external rotation in 41 patients (39.8%), followed by the adduction in 37 patients (35.9%) (Figure 2).

At the follow-up examinations, the femoral head osteophytes were not recorded in 11 (57%) out of 21 surgical patients from the case group, while 49 (59.7%) out of 82 conservatively treated patients from the same group developed the femoral head ectopic ossifications, which also appeared more commonly at the left femoral head medial parts (Figure 3).

Discussion

The patients who suffered the acetabular fracture in our series were predominantly middle aged males. Severe trauma was the main cause of the injuries which were predominantly due to traffic accidents (Table 1). Such an injury was generally caused by high energy trauma and mostly merged with associated injuries^{5,6}. Simultaneously, pelvic fractures caused by motor vehicle collisions remain a considerable cause of mortality, morbidity and functional disability².

Considering biomechanical risk factors associated with the acetabular fractures, it is known that the type of fracture is strongly correlated with the impact direction⁷. Since lateral crashes are more likely to result in a pelvic

fracture, near-side lateral impacts are more often cause of the acetabular fracture². Therefore, the initial trauma itself and secondary acetabular arthritic changes are often responsible for severe loss of the afflicted hip joint function⁸. The left pelvic side and the left acetabular socket were more frequently injured in our series patients. The majority of patients (54.4%) from the case group sustained the left side fracture compared to 45.6% of patients who suffered the right side fracture.

The degenerative hip joint changes in the control group also occurred more frequently on the left side (63.3%) compared to the right side (36.7%) (Table 2) (Figure 1).

The position of the patient's leg in the instant of the acetabular injury was determined by the anamnestic questionnaire of the case group patients. The position of the lower limb during the injury was mainly the external rotation (39.8%), followed by the adduction (35.9%) (Figure 2).

Since the left acetabulum was injured more frequently, while the upper leg was mainly in the position of external rotation and adduction during the injury, it can be concluded that weaker neuromuscular function of the body's left side and stronger loading forces onto the left acetabular socket are responsible for the prevalence of the left pelvic side pathology.

Adult weight change and height are dominant body size risk factors for the hip fracture⁹. When examining the hip muscles weakness after overuse injuries in recreational runners, it was found that the injured side hip muscles were significantly weaker than the non-injured side¹⁰. However, it seemed that the leg dominance did not influence the leg of injury¹⁰, since some goniometric measurements showed no statistically significant differences between the injured and non-injured side of the body¹¹. On the contrary, it is well known that in the majority of the population the body's right side is the dominant one. Therefore, the left lower limb muscles are less developed, making the loading forces at the left hip joint stronger during lifetime. Accordingly, fractures of the left femoral head were more common, due to the body's left side muscular weakness making it more exposed to injury¹².

More frequently expressed degenerative changes of the left pelvic side, found in both the case and the control group of patients in our series, appeared at the side of the

body where neuromuscular function was less potent and loading forces were more physically powerful. Consequently, particular attention must be paid to recovery muscle strengthening protocols¹³.

When the motion data between the left and the right hip joint were compared regardless of the group, a statistically significant difference was found between the left and the right hip joint inner rotation ($p < 0.05$) (Table 3).

Post-traumatic hip joint arthrosis is the most frequent complication of the acetabular fracture. Less frequent post-traumatic complications involve the femoral head osteoarthritis, osteonecrosis and heterotopic ossification^{6,14}.

The femoral head osteophytes were not recorded in the majority of patients (57%) from the case group who were treated surgically. Concurrently, the majority of conservatively treated patients (59.7%) from the same group developed the femoral head ectopic ossifications. In both surgically and conservatively treated patients

from the case group the osteophytes were mostly situated at the left medial pelvic side. The degenerative hip joint changes developed in the majority of patients (76.7%) from the control group too. They appeared more often medially, at the left femoral head compared to the right one (Figure 3).

In conclusion, fractures and arthritic changes in both groups of patients in our series emerged mostly at the left medial pelvic parts, at the regions where loading forces were the strongest. The main biomechanical risk factor for the prevalence of the left pelvic side pathology was the weaker neuromuscular function of the left body side, which was more exposed to damage due to the greater input of forces to the left hip joint. Therefore, our main hypothesis was confirmed by the result of this paper.

Concerning our results, it is necessary to remind of particular limitations of this study that occur from its retrospective character. Therefore, supplementary prospective investigations are required to support our findings.

REFERENCES

1. PETSATODIS G, ANTONARAKOS P, CHALIDIS B, PAPADOPOULOS P, CHRISTOFORIDIS J, POURNARAS J, *Injury*, 38 (2007) 334. — 2. STEIN DM, O'CONNOR JV, KUFERA JA, HO SM, DISCHINGER PC, COPELAND CE, SCALEA TM, *J Trauma*, 61 (2006) 21. — 3. BROOKER AF, BOWERMAN JW, ROBINSON RA, RILEY LH JR, *J Bone Joint Surg (Am)*, 55A (1973) 1629. — 4. LETOURNEL E, JUDET R, Classification. In: ELSON RA, (Ed) *Fractures of the acetabulum*, 2nd ed. (New York, Springer-Verlag, 1993). — 5. LIEBERGALL M, MOSHEIFF R, LOW J, GOLDBVIRT M, MATAN Y, SEGAL D, *Clin Orthop*, 366 (1999) 205. — 6. MATTA JM, *J Bone Joint Surg (Am)*, 78A (1996) 1632. — 7. DAKIN GJ, EBERHARDT AW, ALONSO JE, STANNARD JP, MANN

KA, *J Trauma*, 47 (1999) 1063. — 8. HENLE P, KLOEN P, SIEBENROCK KA, *Injury*, 38 (2007) 478. — 9. FARAHMAND BY, MICHAËLSSON K, BARON JA, PERSSON PG, LJUNGHALL S, *Epidemiology*, 11 (2000) 214. — 10. NIEMUTH PE, JOHNSON RJ, MYERS MJ, THIEMAN TJ, *Clin J Sport Med*, 15 (2005) 14. — 11. VAN MECHELEN W, HLOBIL H, ZIJLSTRA WP, DE RIDDER M, KEMPER HC, *Int J Sports Med*, 13 (1992) 605. — 12. HAS B, NAGY A, HAS-SCHÖN E, PAVIĆ R, KRISTEK J, SPLAVSKI B, *Coll Antropol*, 30 (2006) 823. — 13. BORRELLI J JR, RICCI WM, ANGLE JO, GREGUSH R, ENGSBERG J, *J Orthop Trauma*, 20 (2006) 388. — 14. WRIGHT R, BARRETT K, CHRISTIE MJ, JOHNSON KD, *J Orthop Trauma*, 8 (1994) 397.

B. Splavski

Department of Neurosurgery, University Hospital Center Osijek, Huttlerova 4, 31000 Osijek, Croatia
e-mail: splavuno@hotmail.com

GLAVNI BIOMEHANIČKI FAKTORI RIZIKA UČESTALOSTI TRAUMATSKIH I DEGENERATIVNIH PROMJENA LIJEVOGA KUKA

SAŽETAK

Cilj ovoga rada je ispitati karakteristične biomehaničke pokazatelje koji uzrokuju prijelome acetabula i artrozu zgloba kuka, kao i razjasniti prevalenciju ljevostrane traumatske i degenerativne zdjelične patologije, često zastupljene u različitim grupama bolesnika. Tijekom šestogodišnjega razdoblja provedeno je retrospektivno istraživanje 253 bolesnika sa zdjeličnom patologijom. Bolesnici su bili podijeljeni u oglednu skupinu koju je sačinjavalo 103 ispitanika s traumatskim prijelomima acetabula i u kontrolnu skupinu od 150 ispitanika s artrozom zgloba kuka u kojih još nije bila učinjena operacijska aloartroplastika kuka. Statistički su analizirani podaci o stupnju pokretljivosti lediranoga zgloba kuka u oglednoj i kontrolnoj skupini ispitanika, te je uspoređivana razlika u učestalosti ljevostrane i desnostrane pelvične patologije. U obje je skupine ispitanika lijevi acetabul bio učestalije lediran, dok je artroza lijevoga kuka učestalije zabilježena u ispitanika kontrolne skupine. Mogući razlog razlici u učestalosti ljevostrane i desnostrane patologije zgloba kuka, koja je uočena u obje skupine ispitanika, je slabija neuromuskularna građa i funkcija lijeve strane zdjelice, koja je također više izložena ozljedama uslijed djelovanja jačih udarnih sila na lijevi kuk tijekom prometne nezgode.