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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Analysis of epidemiological characteristics and surgical treatment of patients with pressure ulcer

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SUMMARY

Introduction/Objective A pressure ulcer is a localized injury to the skin and/or underlying tissue, usually over a bony prominence. It appears as a result of pressure or the combination of pressure and shear. Pressure ulcers can be identified within a wide variety of patient subpopulations and epidemiological and etiological aspects play a major role in their treatment.

Methods A retrospective study of data analysis included 72 patients with pressure ulcers that were hospitalized and surgically treated in our institution over a five-year period. Main data features used in the analysis were sex, age, principal diseases, comorbidities, and biochemical indicators of malnutrition. The patients' data was obtained from the existing patients' records. Additionally, the study analyzed the method of treating pressure ulcers, types of reconstructive methods in surgical treatment, as well as the incidence rate of partial osteotomy.

Results A total of 72 patients with pressure ulcers were included in this study, with a mean age of 54.7 ± 16.1 years. Three times more patients injured in traffic accidents were male (75% *vs*. 25%), while most of the patients with multiple sclerosis were female (85.7%). More than 95% of patients who had pressure ulcers of stage III or IV were treated surgically with a reconstructive method of transposition or rotation myocutaneous flap. Patients with stage IV pressure ulcer were usually treated with partial osteotomy.

Conclusion Surgical reconstructive treatment with fasciocutaneous and myocutaneous flaps represents the gold standard for treating patients with pressure ulcers. These procedures provide reconstruction with adequate flap coverage and obliteration of dead space with well-vascularized tissue but with necessity of further implementation of antidecubitus measures.

Keywords: pressure ulcer; surgical treatment; osteotomy

INTRODUCTION

A pressure ulcer is a localized injury to the skin and/or underlying tissue, usually over a bony prominence. It appears as a result of pressure or the combination of pressure and shear. The increased pressure prevents the blood from circulating properly causing cell death, tissue necrosis, and consequently development of pressure ulcers [1]. According to some recent literature, hospitalizations related to pressure ulcers cost between $9.1 and $11.6 billion per year. The cost of individual patient care for a pressure ulcer may range from $20,900 to $151,700 [2, 3].

Understanding the challenges that pressure ulcers present both to the patient and health system, the education regarding their prevention and treatment is increasingly important.

Pressure ulcers are the most commonly developed complication in bedridden patients. They most frequently occur in intensive care unit patients. According to the existing data, 5.6–15.5% of hospitalized patients develop pressure ulcers [1, 3], while according to certain studies that number ranges 5–36.4% [1, 4]. This incidence rate is significantly higher with certain subpopulations and reaches 60% of quadriplegic subpopulation; 56% of elderly patients with thigh bone fractures, and as much as 33% in polytraumatized patients with prolonged medical treatment in intensive care units [2, 3, 5, 6]. A major cause of pressure ulcers in younger patients are spinal cord injuries (SCI). Pressure ulcer is an injury caused by body pressure at points of support. It is a tissue injury occurring after a longer period of lying or sitting, or caused by pressure of alloplastic materials such as cannula, oxygenation mask, nasogastric tube, endotracheal cannula, stoma, or other medical equipment during hospital treatment or physical rehabilitation [2, 4, 7]. Along with prolonged pressure and local ischemia, or some system factors, such as malnutrition, hypoproteinemia, hypoalbuminemia, anemia, vitamin deficiency, smoking, alcohol and drug abuse, other cardio-vascular and endocrine comorbidities represent etiological factors in the development of pressure ulceration [1, 5, 7, 8]. Socioeconomic factors and life quality also affect the development of pressure ulcers. The Braden scale as a clinically validated tool allows nurses and doctors to reliably score one's level of risk for developing pressure ulcers by assessing six subscales [3, 5, 9, 10].

Studies performed on animals showed that application of 70 mmHg pressure over a two-hour period can cause pathological changes. A similar study showed that 500 mmHg pressure

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applied during a two-hour period leads to the same degree of tissue injury as 100 mmHg pressure applied during a 10-hour period. Both of these situations result in laboratory animals' tissue necrosis. Both of these studies prove that muscular tissue is more susceptible to ischemia and necrosis than skin and hypodermis. Ischemic changes of muscular tissue and hypodermis were also recorded without any skin changes [1, 7, 11, 12].

Skin areas that cover protruding bony areas are prone to pressure ulcers. These areas are the following: occipital prominence, shoulder blades, vertebrae, elbows, sacrum, hips, and heels. However, pressure ulcers can occur on any body part if they are points of support or pressure for a longer period of time. Pressure ulcers can occur less frequently on: nasal ala due to the pressure caused by a nasogastric tube, nose dorsum due to the oxygenation mask pressure, trachea inner side due to endotracheal cannula pressure, disc pressure near stoma, as well as due to pressure applied by an inadequate part of prosthesis. There are also certain publications discussing unusual instances of pressure ulcers such as toes and shanks occurring due to prolonged use of compression stockings, but also vulva, perineum, and scrotum [2, 8, 12, 13].

Pressure ulcer care is a complex, long, and slow process. First of all, pressure must be relieved or removed by appropriate measures to prevent further injury. Also, an early and adequate rehabilitation should be applied. Nutrition is important in pressure ulcer healing. Pressure ulcer guidelines give a summary of nutritional intervention to enhance wound healing, such as the following: provide sufficient calories, provide adequate protein intake for positive nitrogen balance, provide and encourage adequate daily fluid intake in the interest of hydration, provide adequate vitamins and minerals. Pressure ulcer treatments can include partial necrectomy and debridement of devitalized tissue, frequent change of bandages, infection control and appropriate plastic and reconstructive surgical treatments, in order to compensate for the skin and muscular structure defects and bone prominence [1, 2, 12, 14, 15]. Pressure ulcers that are critically colonized or infected may show subtle signs of infection, such as delayed healing, change in odor, seriously increased exudate, absent or friable tissue granulation, new or increased pain. Necrotic or devitalized tissue in a wound signals the growth of bacteria and prevents it from healing. Debridement is the removal of nonviable tissue from a wound and is a natural part of the wound repair process.

The paper aims to give a thorough summary of both epidemiological characteristics of patients affected by pressure ulcers and morphological characteristics of pressure ulcers. Specific insight was given to the principal disease, comorbidity, evaluation of reconstructive method in surgical treatment, as well as partial osteotomy incidence.

METHODS

This retrospective study was performed in our institution. This research included 72 patients with pressure ulcers treated within the period from January, 2015 to January, 2020.

Study criteria included patients older than 18 years with pressure ulcers, who had been adequately prepared for surgical treatment. Study criteria excluded pressure ulcer patients younger than 18 years and patients with pressure ulcers and the American Society of Anesthesiologist score ≥ 3 and patients with stage I pressure ulcers. Preoperatively, the patients were examined by the team that consisted of a plastic surgeon, a radiologist, a cardiologist, and, when necessary, a neurologist. They were adequately prepared for surgery in general endotracheal, spinal, or local anesthesia depending on their neurological status and laboratory analyses that were within normal limits (toleration of 10–15% under normal limits for levels of proteins, albumin, white blood cells, and hemoglobin, which are normally expected in patients with pressure ulcers).

Main data features used in the analysis were sex, age, principal diseases, comorbidities, and biochemical indicators of malnutrition. The patients' data was obtained from the existing patients' records. Additionally, the study analyzed the method of treating pressure ulcers, types of reconstructive methods in surgical treatment, as well as the incidence rate of partial osteotomy.

Descriptive and analytical statistics methods were used for data processing and result presentation. The values of continuous variables are presented as an average value ± standard deviation, while the values of discontinuous variables are presented as frequency (n, %). The differences in the average value of continuous variables between the groups were tested using the analysis of variance (ANOVA) and Student's t-test. The χ^2 test was performed for the purpose of comparing discontinuous variables. The value of $p < 0.05$ was considered to have statistical significance.

This paper was planned in compliance with the Patient Rights Directive and ethical rules defined by the principles of the Declaration of Helsinki. The data used during the study is available upon reasonable request to the author.

RESULTS

Seventy-two patients with pressure ulcers were included in this study. Forty-one patients were male and 31 were female. The patients' mean age was 54.7 ± 16.1 years. The mean age of the male patients was higher than that of female patients. This difference had high statistical importance ($p = 0.003$) (Figure 1). Patients belonging to other age groups had similar incidence, but slightly higher incidence was noticed in age groups 40–49 years and 50–59 years (Figure 2).

In almost half of the cases, paraplegia was the main reason for long-lasting lying (immobility), and the cause of pressure ulcers (44.3%). Quadriplegia was the second most common cause of pressure ulcers (15.7%), immediately followed by hemiparesis and other causes (Figure 3).

Principal diseases, i.e., injuries resulting in immobility or impaired mobility of patients, are presented in Figure 4. It is clear that 50% of the cases refer to SCI. The most

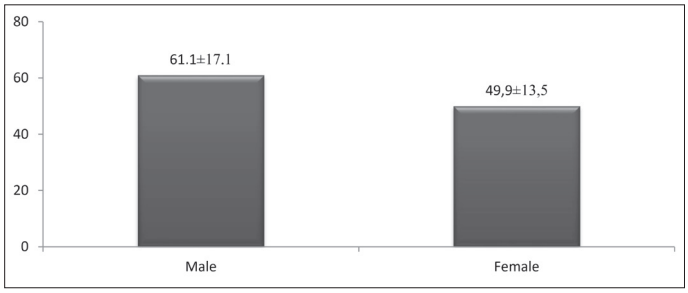

Figure 1. Average age of patients in comparison to their sex

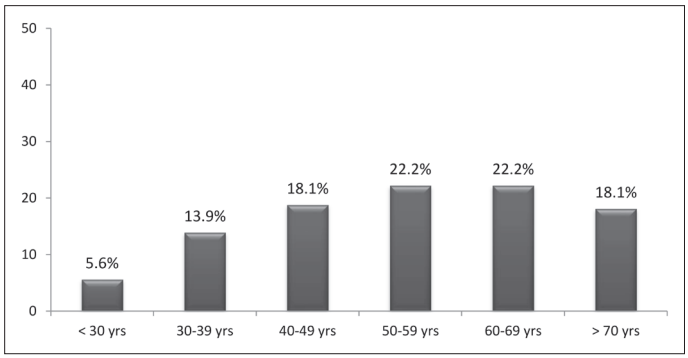

Figure 2. Patient distrubution according to the age group

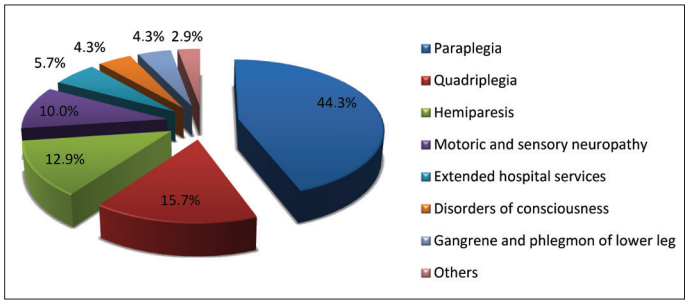

Figure 3. Causes of pressure ulcer development

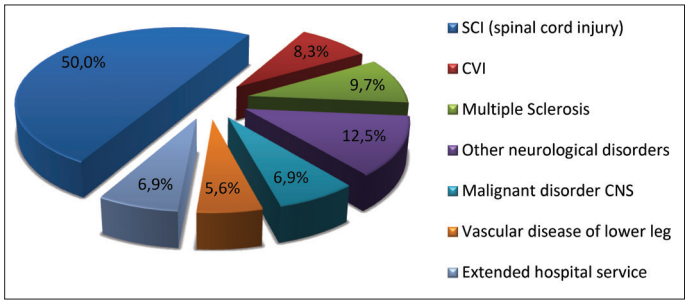

Figure 4. Principal diseases and injuries causing pressure ulcer development

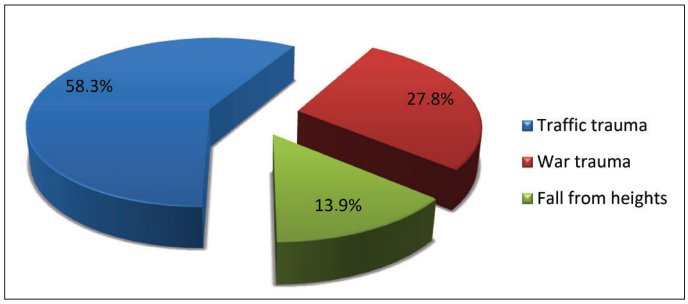

Figure 5. Main causes of spinal cord injuries

common causes of SCI are traffic accident trauma (58.3%), followed by war trauma (27.8%), and falls from height (13.9%) (Figure 5). It showed that there are three times more male patients injured in traffic accidents (75% *vs*. 25%), while 85.7% of the multiple sclerosis patients were female. Cerebrovascular insult and vascular diseases of the lower limbs equally affected both sexes. All other diseases were slightly more common in males.

Regarding male patients, 48.1% had SCI caused by a traffic accident trauma. As for the female patients, the result was significantly higher (88.9%). Only one female patient suffered from SCI due to war trauma (11.1%). There was no record of fall from heights. This difference in the incidence of injuries with different causes for male and female patients was statistically significant ($p = 0.02$).

Even though it was shown that the patients injured in traffic accidents were the youngest and those injured in falling accidents were the oldest, there is no statistically significant difference in the mean age of patients in relation to the cause of injury ($p = 0.379$) (Figure 6).

Traffic accident trauma is the predominant cause of injuries in all age groups, except for the fact that all patients younger than 30 years were injured in traffic accidents. Falling from height was recorded as an injury cause in patients aged 40–70 years. There were no patients older than 70 years among the ones with SCI.

The number of pressure ulcers localized in the sacral area was the highest (40.3%) ($\chi^2 = 37.33$; $p = 0.001$) (Figure 7). Most of the patients had only one pressure ulcer (72.2%), followed by patients with two pressure ulcers (26.4%), and only one patient with three pressure ulcers.

The highest percentage of patients had stage IV pressure ulcers (62.5%). The percentage of patients with stage III pressure ulcers was half as high (33.3%), and only 4.2% of patients had stage II pressure ulcers. Stage I pressure ulcers were not identified in any of the patients.

Hypoproteinemia and hypoalbuminemia were identified in almost half of our patients (47.2%), with levels of protein value less than 60 g/L, and albumin less than 40 g/L.

Apart from principal diseases and injuries causing pressure ulcers, our patients had numerous other comorbidities. According to their incidence rate (37.2%), cardiovascular diseases, such as hypertension, stenocardia, and myocardial infarction, are the first ones in ranking. Endocrine diseases come second in ranking, with 14% incidence rate, including type 2 diabetes mellitus and thyroid gland diseases as the most common. Incidence rate of psychiatric disorders and gastro-intestinal diseases is 10%, while the incidence rate of all other diseases is 27.9% in total.

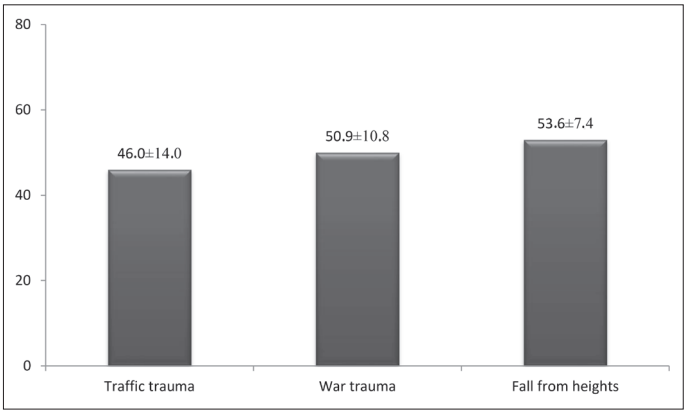

Figure 6. Mean age of patients with spinal cord injury

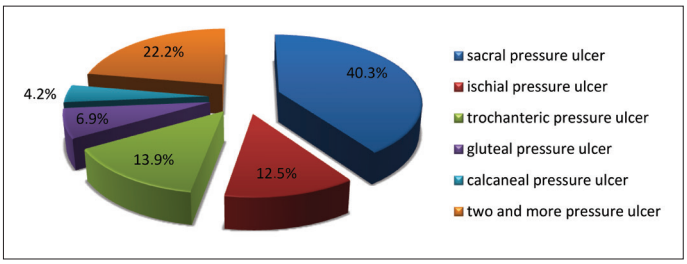

Figure 7. Pressure ulcer localization distribution

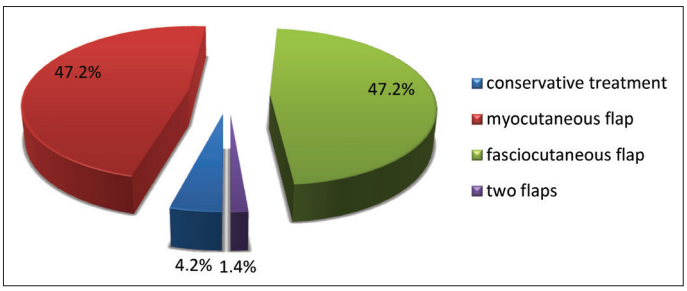

Figure 8. Reconstructive operative method

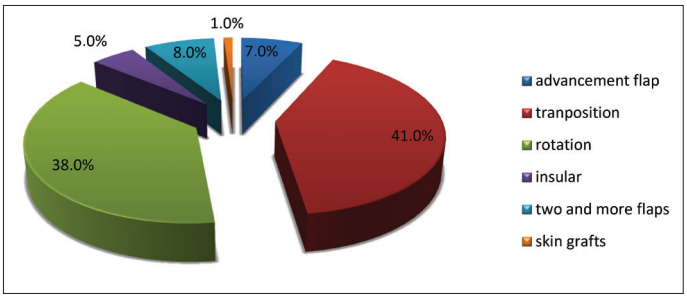

Figure 9. Distribution of different myocutaneous flap types

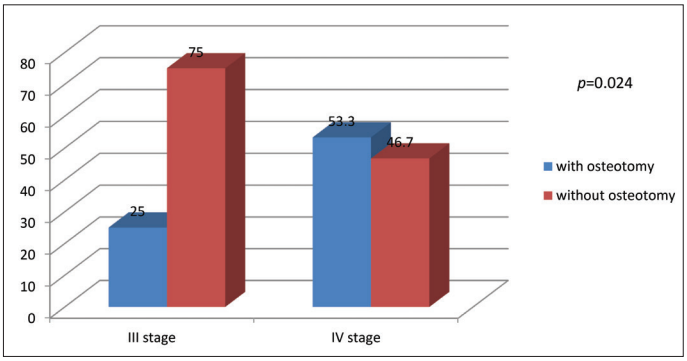

Figure 10. Distribution of partial osteotomy in comparison with pressure ulcer stage

More than 95% of pressure ulcer patients had surgical treatment. We used a myocutaneous flap in 47.2% and a fasciocutaneous flap in 47.2% of patients who were operated on; 1.4% of the patients had a reconstruction with two different flaps, while 4.2% of the patients were treated with skin grafts or conservative treatments. Myocutaneous flaps were used in almost half of the patients: transposition (41%) and rotation flaps (38%) the most frequently, following with advancement flaps (7%) and insular flaps (5%) or combination of two flaps. This differences in using specific myocutaneous flap type were statistically highly significant ($\chi^2 = 35.46$; $p = 0.001$). Proper flap selection was determined by the localization and the stage of the pressure ulcer, their number following the rules of not violating adjacent flap territories for possible future flap coverage and obligation to obliterate dead space with well-vascularized tissue. We analyzed the frequency of partial osteotomy in two groups of patients: the patients with stage III and those with stage IV pressure ulcer. We did not have any patients with stage I pressure ulcers, while those with stage II pressure ulcers underwent conservative treatment. Partial osteotomy was performed more frequently in the group of patients with stage IV pressure ulcers (53.3%) compared to the group of patients with stage III pressure ulcer (25%), $\chi^2 = 5.11$; $p = 0.024$ (Figure 10).

Patients involved in this study who were of higher age, with lower levels of serum proteins and albumins, and who were underweight, had only minor complications in postoperative period, such as small dehiscence, partial flap necrosis and hematomas (Clavien–Dindo grade I or II).

DISCUSSION

Research conducted in the past two decades has shown that the number of patients with pressure ulcers has increased by 80%, and that their leading cause was traffic accident trauma, followed by war trauma in our region. According to the National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel, an increasing tendency in the number of younger patients with pressure ulcers can also be noted, along with the higher heterogeneity of the primary disease, specifically SCI as the leading ones [3, 6, 7]. Many factors have an impact on the development of pressure ulcers, such as primary disease, comorbidities, sex, age, nutritional status, and hospital care [1, 2, 3].

Previous research, as well as our study, shows higher incidence rate of pressure ulcers in male patients [2, 6, 8]. However, that difference was not statistically significant. Majority of the studies show the same results –male patients with pressure ulcer are the dominant subpopulation group [6–9]. There

were no female patients in the patient group younger than 30. In the patient group over the age of 70 the percentage of females was 84.6%. In all other age groups, the number of males was higher. This difference in the patient sex and age distribution is statistically significant ($\chi^2 = 13.44$; $p = 0.02$). Other studies dealing with epidemiological characteristics of the pressure ulcer patients show the same or similar results [4, 6, 7].

The principal cause of pressure ulcers is immobility, most often due to paraplegia or quadriplegia. This coincides with the results of some other studies, which also indicated paraplegia as the principal cause of pressure ulcers [1, 2, 6, 12].

The male patients involved in this study (mean age: 61.1 ± 17.1 years) were older than the female patients (mean age: 49.9 ± 13.5 years) which is a statistically significant fact. Principal cause of pressure ulcers in our patients was a SCI occurring usually due to traffic accident trauma (58.3%), immediately followed by war trauma (27.8%), and fall from height (13.9%). Other studies indicate that SCI are a principal disease of patients with pressure ulcers, accounting for 80% of the cases. These injuries were most often caused by traffic accident trauma, while war trauma appears as a cause in a negligible number of cases. However, previous studies stated that after World War II, an increase in the number of pressure ulcers of 85% was recorded among war veterans [1, 12, 13]. There were three times more male patients injured in traffic accidents than female ones (75% *vs*. 25%). Also, 85.7% of multiple sclerosis patients were females. Other researches show an increase in the female population with neurological diseases. Cerebrovascular insult and vascular diseases of the lower limbs equally affect both sexes. All other diseases were slightly are common in men. Studies conducted in other countries also show that the principal disease, with the highest incidence rate in men, is SCI due to traffic accident trauma, while in women these are neurological diseases [1, 2, 3, 11].

Pressure ulcers in patients involved in this study were most often localized in the sacral area (40.3%), followed by the trochanteric and ischial areas. Pressure ulcers in patients involved in other research most often occurred in ischial area, followed by the trochanteric, and finally sacral area [2, 12]. This can be explained by early verticalization of patients, better physiotherapy, and more frequent use of wheelchairs when patients in developed countries are concerned.

The greatest number of our patients had stage III and IV pressure ulcers, which is also in conformity with some studies conducted in tertiary health institutions in European countries [10]. Our patients mainly had cardiovascular (37.2%) and endocrine diseases. All studies referring to pressure ulcers show that comorbidities which affect the patients with pressure ulcers are the following: cardiovascular diseases (41%), neurological diseases (27%), orthopedic injuries (15%), and endocrine diseases (15%) [2, 3, 4]. Normal nutritional status was found in 52.8% of the patients involved in this study, while 47.2% of the patients had hypoproteinemia and hypoalbuminemia. Other studies show a slightly higher percentage of patients with poor nutritional status, hypoproteinemia, and hypoalbuminemia, which also represent a risk factor for the development of pressure ulcers. During preoperative preparation, we had a tolerance of 10–15% lower than normal levels of proteins, albumin, white blood cells, and hemoglobin. All these lower levels are normally expected in patients with pressure ulcers. However, when patients have normal levels of protein and albumin, better surgical treatment outcome can be expected [1, 2, 3, 12].

Almost all patients in this study were treated surgically. Surgical treatment is the only method for stage IV pressure ulcer and sometimes for stage III. Stages II and III pressure ulcers can be treated in a conservative way with negative-pressure wound therapy [11, 16]. Stage I pressure ulcers were not included in this study because patients with pressure ulcer stage I are treated as outpatient patients with conservative treatment and advice. Almost one-half of pressure ulcer patients were treated surgically by using myocutaneous transposition (41%) and rotation flaps (38%) most frequently, following by advancement flaps (7%) and insular flaps (5%) or the combination of the two. The differences in using specific myocutaneous flap types were statistically highly significant and are strongly connected with the localization and the stage of the pressure ulcer. Proper flap selection is directly in correlation with the localization of the pressure ulcers, their stage, and their number. Moreover, one large retrospective study deals with flap selection type. Ischial pressure ulcers were covered with gluteal myocutaneous rotation flaps or posterior thigh/hamstring advancement flaps. Sacral pressure ulcers were covered with gluteal myocutaneous rotation flaps or gluteal fasciocutaneous V–Y advancement flaps. Trochanteric pressure ulcers were covered with tensor fasciae latae myocutaneous flaps [17, 18]. Other authors of the review article and guidelines summarize flap selection as follows: for sacral ulcer – lumbosacral flap; unilateral or bilateral gluteal fasciocutaneous flap versus myocutaneous rotation flap; unilateral or bilateral gluteal myocutaneous V–Y advancement flap; for ischial pressure ulcers – gluteal fasciocutaneous flap versus myocutaneous rotation flap; posterior hamstring myocutaneous V–Y advancement flap; for trochanteric pressure ulcer – tensor fasciae latae; tensor fasciae latae and vastus lateralis; Girdlestone procedure (proximal femurectomy and obliteration of dead space with vastus lateralis) [1, 3, 10, 19, 20]. Partial osteotomy was performed more frequently in the group of patients with stage IV pressure ulcers (53.3%) in comparison with the group of patients with stage III pressure ulcers (25%). Sometimes, during the operation, we touched the 'tip of the iceberg' and it was necessary to change the primary surgical plan with more extended debridement. Often, we had to use osteotomy when it was not primary planned to do so following extended reconstruction with the myocutaneous flap instead of the fasciocutaneous flap. The patients in this study were operated on by several different surgeons and the decision about osteotomy was not made only according to the pressure ulcer stage. Sometimes, that decision was made when osteomyelitis was suspected. Sometimes it is necessary to make decision about partial osteotomy to prevent bone

prominences to compromise flap vitality or to prevent new pressure ulcer in the future. Regardless of the bone status, in most of the cases osteomyelitis is not a contraindication to definitive surgery and can be treated definitively with decortication of the bone and appropriate soft-tissue coverage. Few studies analyze frequencies of partial osteotomy in surgical reconstructive treatment of pressure ulcer [9, 10, 11, 14]. However, all authors suggest partial osteotomy for stage IV pressure ulcer patients and when osteomyelitis is suspected [18–21]. Partial osteotomy has an important role in the prevention of osteomyelitis, but according to some authors partial osteotomy is an integral but tricky part of the surgical treatment of pressure ulcers [9, 12, 20, 21]. In the postoperative period, patients in this study had only minor complications, such as small dehiscence, partial flap necrosis, and hematomas (Clavien–Dindo grade I or II), but only in the group of patients who are of higher age, with hypoproteinemia and hypoalbuminemia or underweight. Furthermore, minor (Clavien–Dindo grade I) complications might not always be recorded in the medical records, and some minor complications might have been missed due to incomplete records. Authors in review studies have found that patients at higher age, with low serum albumin level, and who are over or underweight, were associated with an increased risk of complications [22, 23]. There is evidence that abnormal nutritional markers (e.g., anemia, serum protein, inflammatory markers) become normal after surgery. This study has limitations because it is a retrospective study and the follow-up was not long enough.

CONCLUSION

This study showed that the incidence rate of pressure ulcers is higher in male patients. SCI represents the most common principal disease in patients with pressure ulcers. These SCI are most often caused by traffic accident trauma. Pressure ulcers are most often localized in the sacral area, followed by the trochanteric area and the ischial area. The highest percentage of patients involved in this study had stage III and IV pressure ulcers. Surgical treatment represents the gold standard in pressure ulcer treatment especially in the group of patients with stage III or IV pressure ulcers. Preoperative findings help to prepare and make a decision about partial osteotomy, but the definitive decision is always made during surgery.

The most common comorbidities in patients involved in this study were cardiovascular, neurological, and endocrine diseases. Almost one-half of all patients involved were diagnosed with hypoproteinemia and hypoalbuminemia.

Understanding the challenges pressure ulcers present both to the patient and the health system, and the education regarding their prevention and treatment, is increasingly important. In the future, we can expect an increase of less usual localizations of pressure ulcers in the context of the COVID-19 pandemic, because prone position has been frequently used in intensive care units to improve the prognosis in patients with respiratory distress.

Conflict of interest: None declared.

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Анализа епидемиолошких карактеристика и хируршког приступа код болесника са декубиталним улцерацијама

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САЖЕТАК

Увод/Циљ Декубитална улцерација је рана настала изумирањем ткива под дејством прекомерног притиска који ствара само тело својом тежином на тачкама ослонца или у комбинацији са смицањем. Представља најчешћу компликацију код лежећих болесника која настаје изумирањем ткива под дејством притиска. Декубиталне улцерације представљају компликације током лечења различитих субпопулација болесника, а етиолошке и епидемиолошке карактеристике играју значајну улогу у одабиру адекватног третмана лечења.
Методе Урађена је ретроспективна анализа података 72 болесника са декубиталним улцерацијама који су хируршки лечени у нашој установи у петогодишњем периоду. Анализирана обележја посматрања су била пол, годиште, главна дијагноза, коморбидитети, биохемијски параметри малнутриције. Обрађени су одабир метода лечења, реконструктивни метод лечења као и учесталост остеотомије.
Резултати У студију су била укључена 72 болесника са декубиталним улцерацијама. Просечна старост болесника је била 54,7 ± 16,1 година. Три пута више болесника мушког пола је повређено у саобраћајном трауматизму (75% *vs*. 25%), док је већина болесника са мултиплом склерозом била женског пола (85,7%). Више од 95% болесника је било са улцерацијама III и IV степена и лечено је хируршки, реконструктивном методом транспозиције или ротације миокутаног режња, а остеотомија је најчешће примењена код болесника са декубиталном улцерацијом IV степена.
Закључак Хируршка реконструкција применом фасциокутаних и миокутаних режњева представља златни стандард за лечење болесника са декубиталним улцерацијама. Овим процедурама обезбеђује се адекватна надокнада изгубљеног ткивног волумена и коже квалитетним и добро васкуларизованим ткивом уз обавезну облитерацију мртвог простора, али уз неопходност даљег спровођења антидекубиталних мера.

Кључне речи: декубиталне улцерације; хируршко лечење; остеотомија