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

Анализа епидемиолошких карактеристика и хируршког приступа код
болесника са декубиталним улцерацијама

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

Анализа епидемиолошких карактеристика и хируршког приступа код болесника са декубиталним улцерацијама

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 combination of pressure and shear. Pressure ulcers can be identified within a wide variety of patient subpopulations and a major role in their treatment plays epidemiological and etiological aspects.

Methods A retrospective study of data analysis included 72 patients with pressure ulcers that were hospitalized and surgically treated during a five-year period at the Clinic for Burns, Plastic and Reconstructive Surgery of the University Clinical Center of Serbia in Belgrade. Main data features used in the analysis were: gender, 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 into this study with 54.7 ± 16.1 mean age. Three times more patients injured in traffic accidents were male (75% vs. 25%), while the most of the patients with multiple sclerosis were female (85.7%). More than 95% of patients who had pressure ulcers of III or IV stage were treated surgically with a reconstructive method of transposition or rotation myocutaneous flap. The patient with pressure ulcer of stage IV was usually treated with partial osteotomy.

Conclusion A surgical reconstructive treatment with fasciocutaneous and myocutaneous flaps represents a 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

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. Декубитална улцерација представља најчешћу компликацију код лежећих пацијената која настаје изумирањем ткива под дејством притиска. Декубиталне улцерације представљају компликације током лечења различитих субпопулација пацијента, а етиолошке и епидемиолошке карактеристике играју значајну улогу у одабиру адекватног третмана лечења.

Метод Ретроспективна анализа података 72 пацијента са декубиталним улцерацијама који су хируршки лечени на Клиници за опекотине, пластичну и реконструктивну хирургију Универзитетског клиничког центра Србије у Београду 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 је било укључено 72 пацијента са декубиталним улцерацијама, просечна старост пацијената је била 54.7 ± 16.1 . Три пута више пацијената 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% пацијента је било са улцерацијама III и IV степена и лечено је хируршки, реконструкциом транспозиционим или ротационим миокутаном режњем, а остеотомија је најчешће примењена код пацијената са декубиталном улцерацијом IV степена.

Закључак Хируршка реконструкција применом фасциокутаных и миокутаных режњева представља златни стандард за лечење пацијената 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 антдекубиталних мера.

Кључне речи: декубиталне улцерације; хируршко лечење; остеотомија

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 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 to \$11.6 billion per year. The cost of individual patient care for 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 the intensive care unit patients. According to the existing data, 5.6% to 15.5% of hospitalized patients develop pressure ulcers [1, 3], while according to certain studies that number ranges from 5% to 36.4% [1, 4]. This incidence rate is significantly higher with certain subpopulations and it reaches 60% of quadriplegic subpopulation; 56% of elderly patients with thigh bone fractures and even 33% with polytraumatized patients with prolonged medical treatment at the 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 drugs 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].

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

applied during a two-hour period leads to the same degree of tissue injury as 100 mmHg pressure applied during 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: 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 usage 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 pressure ulcer healing. Pressure ulcer guideline gives summary of nutritional intervention to enhance wound healing such as the following rules: provide sufficient calories, provide adequate protein intake for positive nitrogen balance, provide and encourage adequate daily fluid intake for sake 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 on the Clinic for Burns, Plastic and Reconstructive Surgery of the Clinical Center of Serbia. This research included 72 patients with pressure ulcers who were treated within the period from January, 2015 to January, 2020.

Study criteria included the patients with pressure ulcers, older than 18 who had been adequately prepared for surgical treatment. Study criteria excluded patients with pressure ulcers younger than 18 years and patient with pressure ulcer and ASA score ≥ 3 (American Society of Anesthesiologist) and patients with pressure ulcer stage I. Preoperatively, the patients were examined by the team that consisted of a plastic surgeon, a radiologist, a cardiologist and sometimes a neurologist when necessary. 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 cell and hemoglobin, which are normally expected to be like that in patients with pressure ulcers).

Main data features used in the analysis were: gender, 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 \pm standard deviation, while the values of discontinuous variables are presented as frequency (N, %). The differences in average value of continuous variables between groups were tested using Analysis of Variance (ANOVA) and Student's t-test. X²-test was performed for the purpose of

comparing discontinuous variables. The value $p < 0.05$ is 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. Availability of data and materials - The data used during the study is available upon reasonable request to the author.

RESULTS

72 patients with pressure ulcers were included into this study. 41 patients were male and 31 female. The patients mean age was 54.7 ± 16.1 . The mean age of the males was higher than female. 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 and 50-59 (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 on the Figure 4. It is clear that 50% of the cases refer to spinal cord injuries (SCI). The most common causes of spinal cord injuries are traffic trauma (58.3%), followed by war trauma (27.8%) and falls from height (13.9%). (Figure 5). It showed 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 lower limbs equally affected both genders. All other diseases were slightly more common in males.

Regarding male patients, 48.1% had spinal cord injury caused by a traffic 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 car accidents were the youngest and those injured in falling accidents were 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 trauma is a predominant cause of injuries in all age groups, except for the fact that all patients younger than 30 were injured in traffic accidents. Falling from height was recorded as an injury cause in patients aged 40-70. There were no patients older than 70 among the ones with spinal cord injuries.

The numbers of pressure ulcers that were localized in sacral area was the highest (40.3%) ($\chi^2 = 37.33$; $p = 0.001$) (Figure 7). The most of patients had only one pressure ulcer (72.2%) following the patients with two different 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 identified in none of the patients.

Almost half of our patients (47, 2%) were identified with hypoproteinemia and hypoalbuminemia, 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 II diabetes mellitus and thyroid gland diseases are the most common. Incidence rate of psychiatric disorders and gastro-intestinal diseases is 10%, while the incidence rate of all other diseases was 27.9% in total.

More than 95% of pressure ulcer patients had surgical treatment. We used myocutaneous flap in 47.2% operating patients and fasciocutaneous flap in 47.2%. 1.4% of the patients had a

reconstruction with two different flaps, while 4, 2% 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 determinate by localization and stage of pressure ulcer, with the number of them, 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 frequency of partial osteotomy in two groups of patients: the patients with stage III and IV pressure ulcer. We did not have any patients with stage I pressure ulcers, while those with stage II pressure ulcers had a conservative treatment. Partial osteotomy was performed more frequently in group of patients with pressure ulcers stage IV (53.3%) as compared to the group of patients with pressure ulcer stage III (25%), $\chi^2 = 5.11$; $p = 0.024$ (Figure 10).

The patients involved in this study who are of higher age, with lower levels of serum proteins and albumins, and who are 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 for 80%, and also showing that their leading cause was traffic trauma, following a war trauma in our region. According to National Pressure Ulcer Advisory Panel and European Pressure Ulcer Advisory Panel increasing tendency in the number of younger patients with pressure ulcers can also be noted along with the higher heterogeneity of primary disease, specifically spinal cord injuries as the leading ones. [3, 6, 7]. Many factors have an impact on the development of pressure ulcers, such as primary disease, comorbidities, gender, age, nutritional status and hospital care [1, 2, 3].

The research shows higher incidence rate of pressure ulcers in male patients [2, 6, 8], as well as our study. However, that difference was not statistically significant. Majority of the

studies show the same results, that 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 female was 84.6%. In all other age groups, the number of men was higher. This difference in the patient gender and age distribution is statistically significant ($\chi^2 = 13.44$; $p = 0.02$). Other studies dealing with epidemiological characteristics of the pressure ulcers 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 is in conformity with the results of other studies, that 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) were older than the female patients (mean age: 49.9 ± 13.5) which is a statistically significant fact. Principal cause of pressure ulcers in our patients was a spinal cord injury occurring usually due to traffic trauma (58.3%), immediately followed by war trauma (27.8%) and fall from height (13.9%). Other studies indicate that spinal cord injuries are a principal disease of the patients with pressure ulcers in 80% of the cases. Most often these injuries were caused by traffic trauma, while war trauma appears as a cause in a negligible number of cases. However, previous studies stated that after World War II, increase 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 increase female population with neurological disease. Cerebrovascular insult and vascular diseases of lower limbs equally affected both genders. All other diseases were slightly more common in men. Studies conducted in other countries also show that the principal disease with the highest incidence rate in men is spinal cord injury due to traffic 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 sacral area (40.3%), then in trochanteric and ischial areas. Pressure ulcers in patients involved in other research most often occurred in ischial area, then trochanteric and finally sacral areas [2, 12]. That 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 the 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]. 52.8% of the patients involved in this study had normal nutritional status, while 47.2% of them were with hypoproteinemia and hypoalbuminemia. Other studies show a slightly higher percentage of patients with poor nutritional status, hypoproteinemia and hypoalbuminemia, which also represents a risk factor for the development of pressure ulcers. During preoperative preparation we had toleration of 10–15% lower than normal levels of proteins, albumin, white blood cell 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 only method for pressure ulcer stage IV and sometimes for stage III. Stage 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 advices. Almost half of pressure ulcer patients were treated surgically by using myocutaneous: transposition (41%) and rotation flaps (38%) the most frequently, following with advancement flaps (7%) and insular (5%) or combination of two flaps. This differences in using specific myocutaneous flap type were statistically highly significant and it is strongly connecting with localization and stage of pressure ulcer. Proper flap selection is directly in correlation with localization of pressure ulcer, its stage and number of them. 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 fascia lata myocutaneous flaps [17, 18]. Other authors in the review article and guidelines summarize flap selection in following: 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 group of patients with pressure ulcers stage IV (53.3%) in comparison with group of patients with pressure ulcer stage III (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 following extended reconstruction with myocutaneous flap instead fasciocutaneous flap. The patients in this study were operated by few different surgeons and decision about osteotomy was not made only according to 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 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. No enough studies analyze frequencies of partial osteotomy in surgical reconstructive treatment of pressure ulcer [9, 10, 11, 14]. However, all authors suggest partial osteotomy for patients with pressure ulcers stage IV and when osteomyelitis is suspected [18–21]. Partial osteotomy has important role in 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 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 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 recording. 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. Spinal cord injury represents the most common principal disease in the patients with pressure ulcers. These spinal cord injuries are most often caused by traffic trauma. Pressure ulcers are most often localized in sacral area, following trochanteric area and 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 group of patients with pressure ulcers stage III or IV. Preoperative findings help in preparation and making decision about partial osteotomy but definitive decision is always made during the surgical operation.

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

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

Conflict of interest: None declared.

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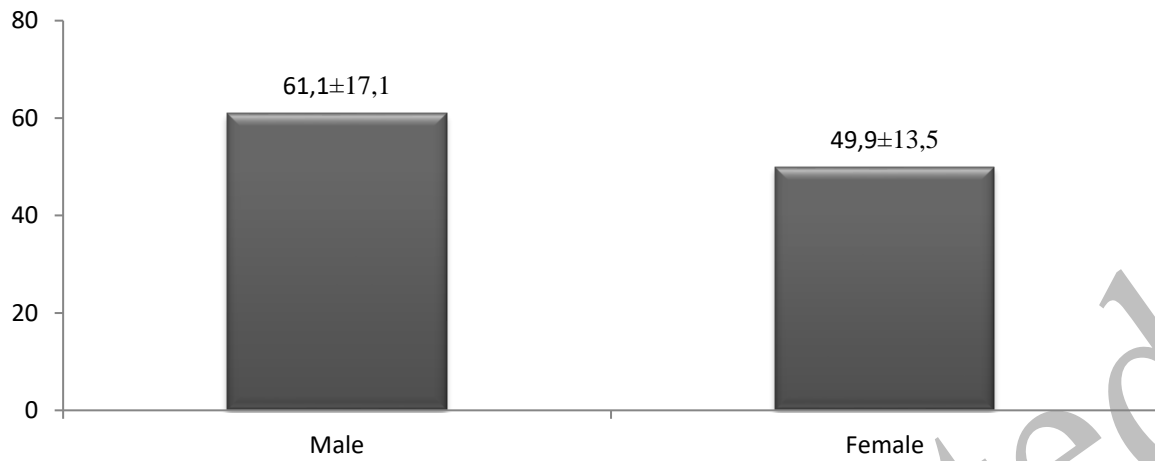


Figure 1. Average age of patients in comparison to their sex

Paper accepted

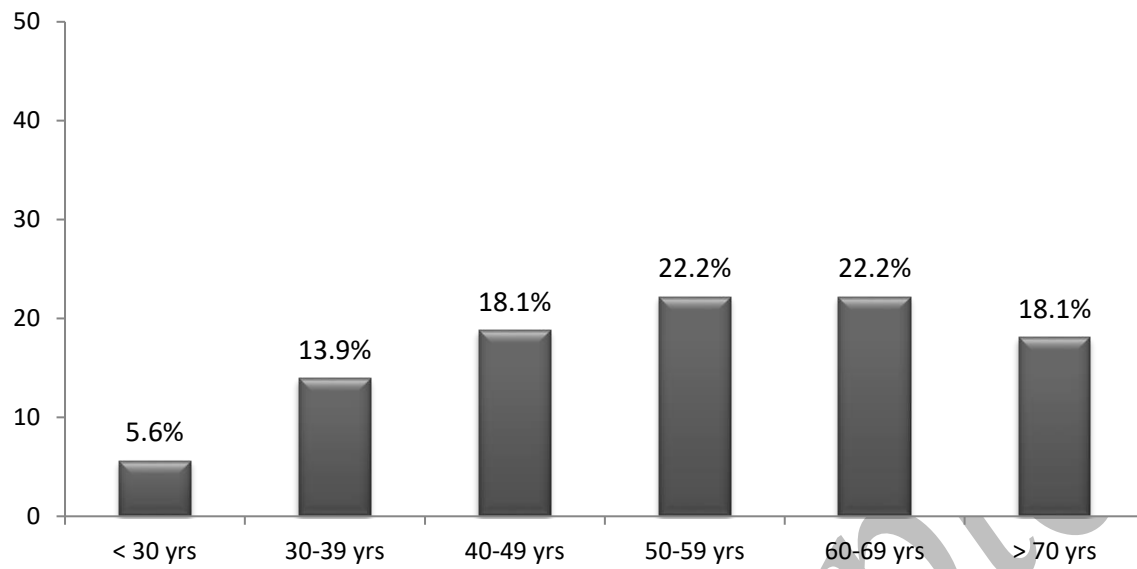


Figure 2. Patient distribution according to the age group

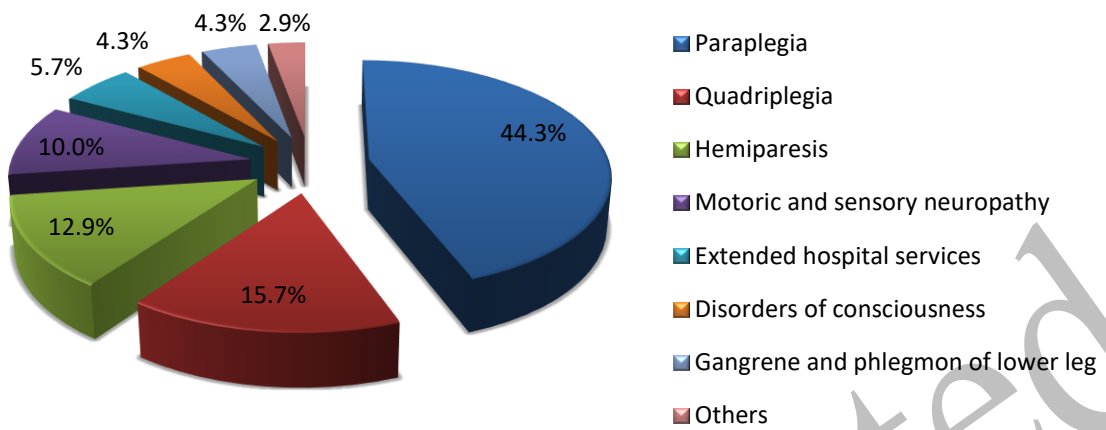


Figure 3. Causes of pressure ulcer development

Paper accepted

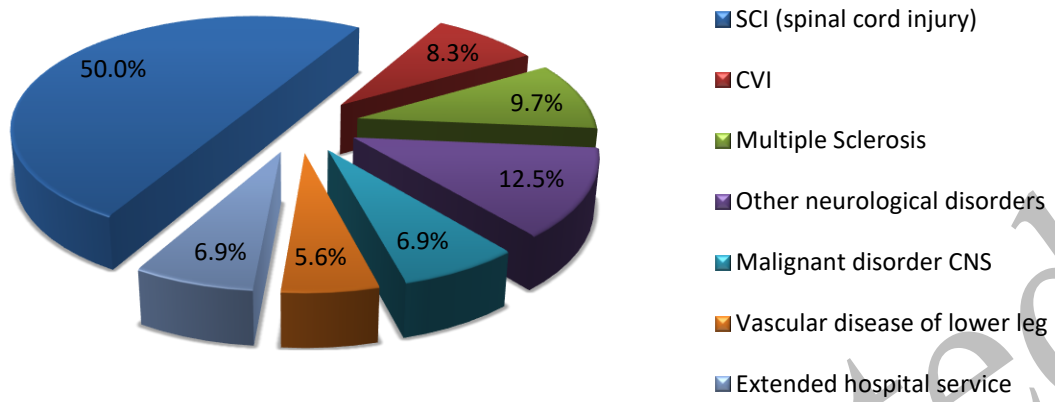


Figure 4. Principal diseases and injuries causing pressure ulcer development

Paper accepted

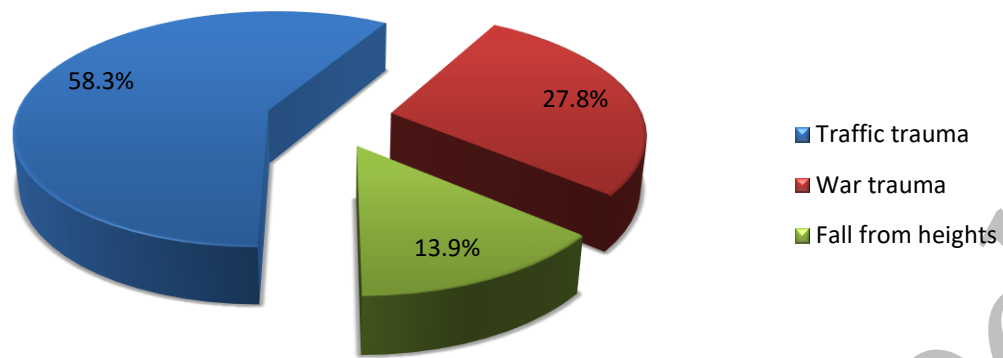


Figure 5. Main causes of spinal cord injuries

Paper accepted

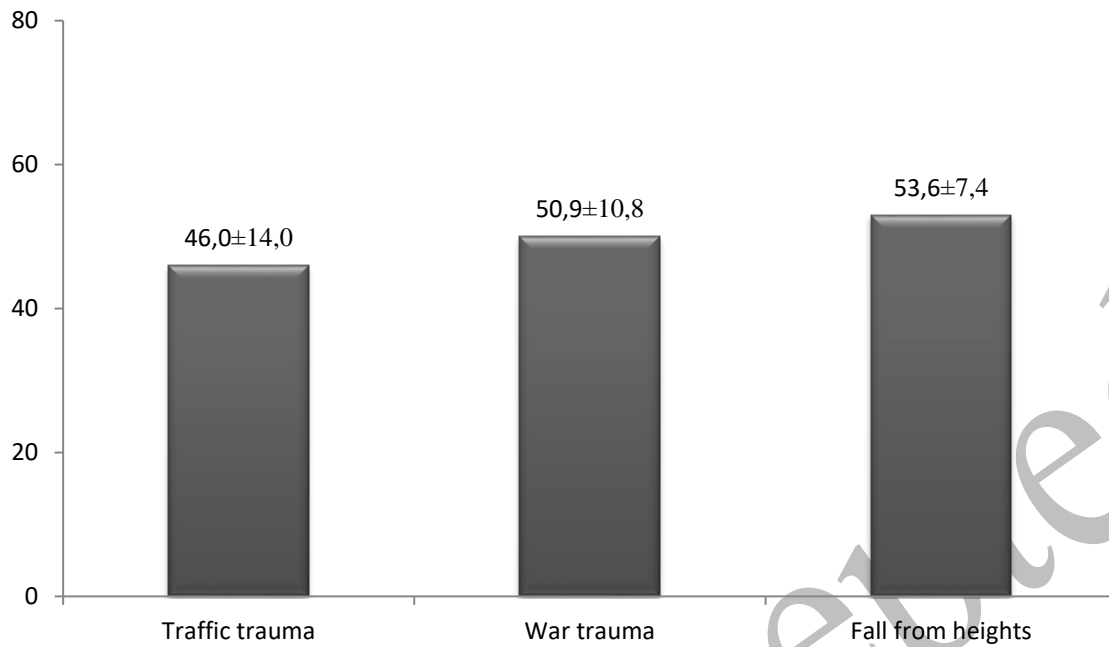


Figure 6. Mean age of patients with spinal cord injury

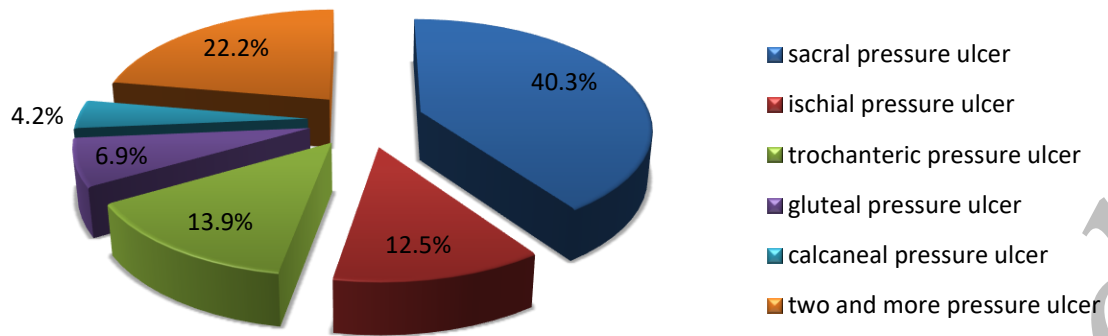


Figure 7. Pressure ulcer localization distribution

Paper accepted

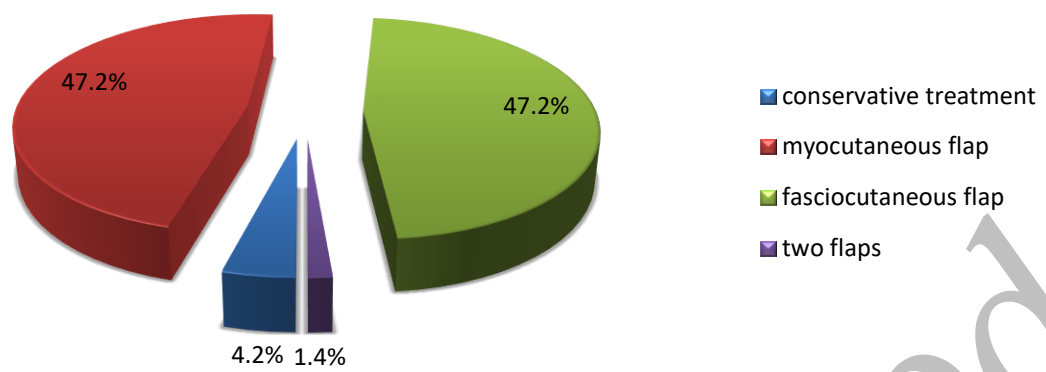


Figure 8. Reconstructive operative method

Paper accepted

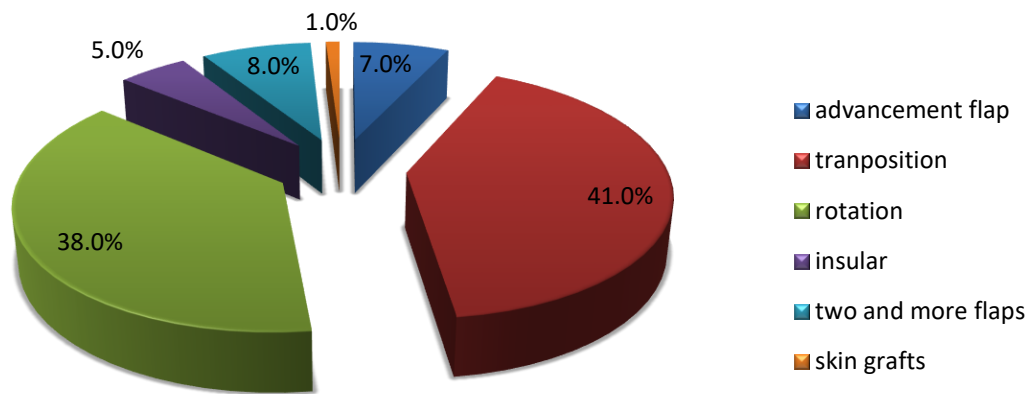


Figure 9. Distribution of different myocutaneous flap types

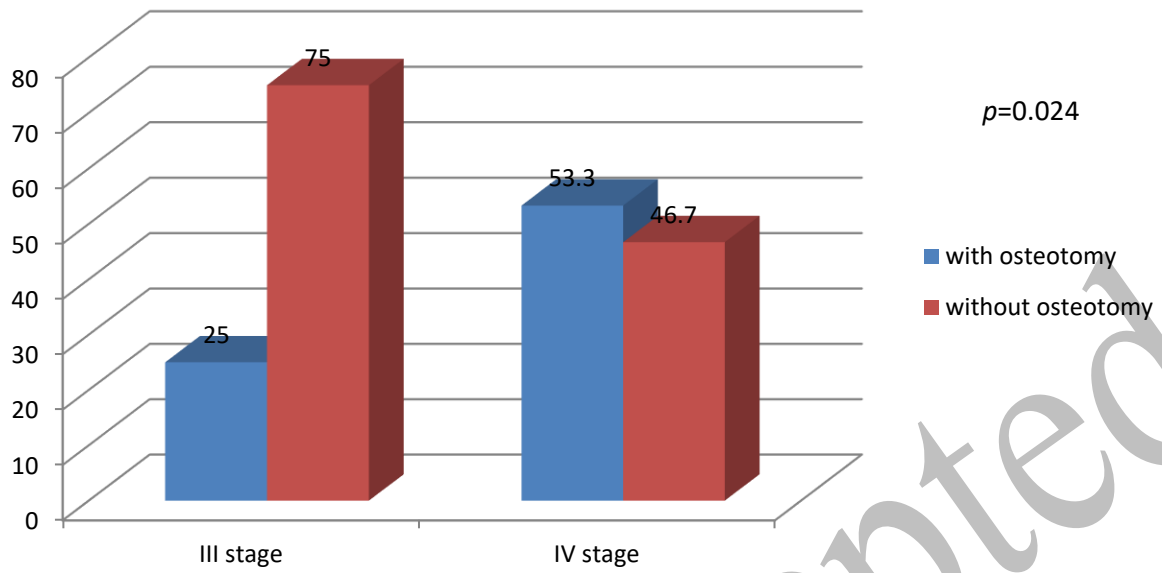


Figure 10. Distribution of partial osteotomy in comparison with pressure ulcer stage