Comparative analysis of autodermal graft and polypropylene mesh use in large incisional hernia defects reconstruction

Uporedna analiza upotrebe autodermalnog grafta i polipropilenske mreže u rekonstrukciji velikih incizionih hernija

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Abstract

Background. Large defects of the abdominal wall caused by incisional hernia still represent a challenging problem in plastic, reconstructive, and abdominal surgery. For their successful tension-free repair a proper selection of reconstructive material is essential. In the last decades, the use of synthetic meshes was dominant while biological autodermal grafts were rarely used. The aim of the study was to comparatively analyse efficacy and safety of autodermal grafts or by synthetic polypropylene mesh. The surgical techniques of reconstruction, duration of surgery, the occurrence of early, minor and major (severe) and delayed complications and hospital stay were analysed. The average follow-up took 2 years. Results. Statistically significant differences in demographic characteristics of patients and in size of defects were not found. The surgical technique of reconstruction with an autodermal graft was more complicated. The duration of surgery in patients treated with autodermal grafts was significantly longer. There was no statistically significant difference regarding occurrence of early, minor postoperative complications and hospital stay in our study. Two severe complications were registered in the synthetic mesh group: intestinal obstruction and enterocutaneous fistula. The recurrence rate was 10% in the autodermal graft group and 15% in the group with a synthetic mesh. Conclusion. Tension-free repair of large incisional hernia with autodermal grafts was unjustly neglected despite the fact that it is safe and effective. It can be applied in all cases where synthetic mesh are not indicated (presence of infection, immunodeficient patients, after radiotherapy). They are especially important in war surgery and in lack of funds when commercial grafts cannot be purchased.

Key words: hernia, abdominal; reconstructive surgical procedures; transplantsants; polypropylene; treatment outcome.

Apstrakt

Uvod. Veliki defekti trbušnog zida kod incizionih kila još uvek su veliki izazov u plastično rekonstruktivnoj i abdominálnoj hirurškoj. Za njihove uspješne bestenzionе rekonstrukcije, kojim se postižu najbolji rezultati, pored adekvatnih indikacija i hiruršка tehnike presudan je i pravilan izbor rekonstruktivnog materijala. U poslednjim decenijama dominirala je primerna sintetskih graftova, dok su biološki autodermalni grafitovi retko koristišeni. Cilj rada bio je da se uporedi efikasnost i bezbednost sintetskih i autodermalnih grafTO

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Ključne reči: hernija, ventralna; hirurgija, rekonstruktivne procedure; graftovi; plastične materije; lečenje, ishod.

Introduction

Abdominal wall defects of different origin, size and location are defined as partial or complete loss of its anatomical structures. They lead to functional disabilities and compromise health, quality of life, work ability and aesthetic appearance of the patient. In addition, complications occurred in clinical course of large incisional hernia could be life threatening. For these reasons, their repair takes an important place in contemporary reconstructive and abdominal surgery.

The most challenging problem in surgical treatment are defects larger than 10 cm in diameter. They are most frequently found in incisional, postoperative hernia in 90% of cases and less common in posttraumatic and defects of infectious etiology or after neoplasma resection. The most common abdominal wall defects are full-thickness skin graft. Autologous skin grafts are used in abdominal wall reconstruction in the Clinic of Plastic and Reconstructive Surgery and Department of Abdominal Surgery of the Surgical Clinic, Clinical Center of Niš during a 10-year period (2000–2009). All the treated patients gave their written consent and were prospectively observed in the study period. The patients were divided into two equal study groups. The group D included 20 patients with autodermal graft. The group M included 20 patients with synthetic graft. The choice of appropriate implant for individual patient is the crucial point in surgery planning, but there are a lot of controversial opinions and dilemmas. One of the current dilemma is whether biological auto-grafts are still unjustly neglected in comparison to commonly applied synthetic mesh.

The aim of this study was to compare the results achieved with tension free reconstruction of large abdominal wall defects either by autodermal graft (most commonly used biological autograft) or polypropylene mesh (the most frequently applied synthetic mesh), as well as to analyse their advantages and disadvantages, thus to contribute to solving this dilemma.

Methods

This prospective, comparative clinical study enrolled 40 patients hospitalized and surgically treated for large abdominal wall defects at site of incisional hernia with tension-free reconstruction in the Clinic of Plastic and Reconstructive Surgery and Department of Abdominal Surgery of Surgical Clinic, Clinical Center of Niš during a 10-year period (2000–2009). All the treated patients gave their written consent and were prospectively observed in the study period. The patients were divided into two equal study groups. The group D included 20 patients with autodermal graft. The group M included 20 patients with synthetic polypropylene mesh used for reconstruction. Both groups of patients had similar characteristics of abdominal wall defect and general condition for an objective assessment and comparison of results.

Before hospital admission all the patients underwent routine laboratory testing, electrocardiography and radiography and were also clinically examined by internist and anesthesiologist. Routinely, all the patients were suggested to stop smoking, reduce body weight, and use medications for chronic heart and lung diseases as well as to regulate hypertension and diabetes mellitus and other comorbidities in order to reduce postoperative complication rate. Prophylactic doses of cephalosporins and low-molecular weight heparin were administered appropriately. All the elective open surgeries were performed under general anesthesia.

The key points of the surgical technique in the group D were as follows: autodermal graft was harvested from the distended skin of incisional hernia formation by sharp dissection. The deepitisation was made by a surgical blade. Following trimming grafts were perforated with small incision 2–3 mm in length and 1 cm for one from another. The prepared grafts were placed in saline with an antibiotic (gentamicin). Then, the hernia sac and musculoaponeurotic layer were prepared 2 to 3 cm from the edge of hernia defect. A tailored graft, with deepitilized surface directed towards the peritoneum, was laid over the defect, by definition 2 cm overlapping the defect (in the lay position). A crucial point is to fix the graft under maximal tension like “skin on the drum” to the abdominal wall by 4 non-absorbable polypropylene 0 or 1 sutures at its four corners, followed by a continuous polypropylene suture between the corners (Figure 1). Two aspiration drains were used and subcutaneous tissue was closed directly with continuous absorbable sutures and skin with interrupted non-absorbable sutures. All the patients used to wear abdominal belts for three months.

In the group M, after hernia sac preparation, the musculoaponeurotic layer was prepared 2–3 cm from the defect edge. A polypropylene mesh was tailored and fixed peripherally to the musculoaponeurotical layer in the in-lay position, too, but without tension in the same way as in the group D (Figure 2). Drainage and closure of the skin and subcutaneous tissue were performed in the same way as in the group D with a set of abdominal belts.

The postoperative early minor complications (seroma, hematoma, wound infection) and major complications (graft infection, intestinal obstruction, enterocutaneous fistula), the duration of surgery, the duration of hospital stay and quality of life following surgery were noted. All the patients were provided with printed instructions upon discharge to avoid risk factors for recurrence. Follow-up was carried out in an outpatient clinic or telephone contact, 4 weeks after surgery, every 6 months for the first year, yearly thereafter. A thorough history and physical examination, with particular attention to the operative site, were undertaken on every visit.

The results were analyzed and presented in tables and figures (Excel 2000, Word 2000), and analyzed using descriptive statistics and quantitative analysis (SPSS v15 for Windows v5 Statcalc Epi Info).

**Results**

All the patients enrolled in study had been admitted for elective large incisional hernia repair. All hernias were uncomplicated (without incarceration or skin necrosis). Defects size ranged from 10.5 cm to 18.6 cm. The mean size of hernia defects was lower in the group D (14.54 ± 2.34 cm) than in the group M (14.78 ± 1.63 cm), but there were no statistically significant differences between the groups (Table 1).

Demographic characteristics of patients are shown in Table 2. There were more male patients in both groups and the average age was 57.6 ± 10.91 years and slightly higher in the group M. There were no statistically significant differences in gender and age among the patients.

The mean operating time for the group D was 1 h and 20 min (range 50 min to 3 h and 45 min) and that for the
The surgery in 2 patients in the group D and in 10 patients in the group M took less than 120 min, while in the other patients the operation was longer as shown in Figure 3.

There was a statistically significant difference in surgery time between the two groups, and surgery was significantly longer in patients with biological auto-grafts ($\chi^2$ test, $p < 0.05$).

The type and the number of early minor complications are shown in Table 3. Seroma occurred in 20% and 18% of the patients with autodermal graft, and with polypropylene mesh, respectively. Hematoma formation was not found in any of the patients. Only one patient with a synthetic mesh graft had a light wound infection. No statistically significant difference in the number of complications was found between the two groups ($\chi^2$ test, $p > 0.05$). These complications occurred in the first 6 months after the surgery.

Serious complications were registered only in the group M. In this group, one patient was reoperated because of adhesional intestinal obstruction 6 months after the reconstruction and the formation of an enterocutaneous fistula with graft infection was registered in another after 18 months. In both patients the reconstruction of the abdominal wall in the repeated surgery was done using autodermal graft. There was no hospital mortality in both groups.

The length of hospital stay in the groups is shown in Table 4. The average hospital stay was 6.8 ± 2.8 days in the group D and 6.4 ± 2.5 days in the group M. There was no statistically significant difference in the length of hospital stay between the two groups ($\chi^2$ test, $p > 0.05$).
Prospective follow-up of 40 patients regarding the recurrence revealed recidivant hernias in 10% of the patients in the group D and 15% in the group M. There was no significant difference in the recurrence rate between the two groups (log rank test, $p > 0.05$). All recurrences occurred in the first two years of monitoring.

In the group M 3 patients referred constantly foreign body sensation and rigidity of the abdominal wall, and two patients were dissatisfied with the aesthetic appearance of the abdominal wall.

Discussion

Large abdominal wall defects in incisional hernia present significant and actual problem in plastic and reconstructive and abdominal surgery, due to its frequency and complex surgical strategy that require multidisciplinary approach.

The best results are achieved by tension-free group of techniques using free (biological or synthetic) implants or flaps. Due to a simple surgical technique, implant reconstruction is widely used while flaps are reserved for the most complex defects. There is no “ideal implant” and the types of implants available for use in complex ventral hernias repair are numerous.

Successful outcome of abdominal wall reconstruction primarily depends on choosing an adequate implant for each individual patient. However, adequate choice is only possible with extensive knowledge of the properties (advantages and disadvantages) of the available implants. The most commonly used biological autograft in clinical practice is autodermal graft, while nonbiological synthetic one is unresorbable polypropylene mesh (Marlex Mesh). Therefore, these implants are selected and used for our research.

Data from the literature refer to the use of autodermal grafts before synthetic mesh. First description of autodermal graft in clinical practis was given by Otto Loewe and Edward Rehn in 1913–14 year, and in America in 1939 by Uihlein. However, after the explosive development of industrial polymers and production of synthetic implants, skin grafts went into the margins for almost 40 years. Their reaffirmation began in the 80's primarily due to experimental and clinical work of German surgeons.

Numerous investigations have defined the excellent properties of those grafts. From immunology and biology viewpoint, they are referred as skin autotransplants which do not cause rejection. Because of the outstanding characteristics of human skin, these grafts have good physical properties - sufficient strength, elasticity, flexibility and proper resistance to traction and tension.

Abdominal wall repair using these grafts goes through specific biological processes and reactions through synchronized degradation and transformation of grafts. After the implantation, autodermal graft was remodeled into formation of dense fibrous sheet which provided proper integrity of the abdominal wall. Skin autografts can be used in two forms: like full-thickness skin graft without removing epidermal layer and as a dermal graft without epidermis.

The disadvantage of autodermal graft harvesting is longer operative time due to the removal of epidermal layer. In case of full-thickness skin graft use, experimental studies reveal epidermal cyst formations and a prolonged time of remodeling.

Considering good revascularization and smooth surface, autodermal grafts without epidermal layer are less prone to the development of infection and adhesions.

The main advantage of autodermal grafts compared to synthetic mesh is the fact that they are available at any time from the patient’s body, an “always open bank”. This is significant, especially in emergency situations such as wars or natural disasters when the production, market availability and use of all other implants are impossible.

Utilisation of nonbiological synthetic mesh made of polypropylene fibers began in 1962, in America by Usher. During the last four decades, these synthetic meshes were implanted worldwide to millions of patients. They are biocompatible and do not cause severe inflammation, anaphylactic and allergic reactions and host reaction. Furthermore, not carcinogenic, they are chemically inert and are not disassembled in the body. Also, they are resistant to traction and tension and are thermostable.

Synthetic mesh incorporation is caused by inflammatory response and fibrous tissue proliferation through the pores of meshes. Thus, incorporation of mesh in the abdominal wall structures and its complete isolation as a foreign body occur. A lifetime reconstruction of abdominal wall defects is achieved by the presence of synthetic mesh reinforced by surrounding fibrous tissue.

However, mesh structure has its disadvantages. It decreases the resistance to bacterial infection because bacterial inoculation in pores provide them with better survival and reproduction. Mesh infection can be solved only by implant removal. Use of synthetic mesh is related to higher incidence of intraabdominal adhesions.

Analysis of our clinical material showed that large defects in the abdominal wall incisional hernia are common and important problem in our society. According to the available data, the overall incidence of incisional hernia following laparotomy remains reported to be up to 11%–15%. Incisional hernias typically occur two to four years after laparotomy. The incidence of recurrent incisional hernia is 24%–58% and the rate remained unchanged in the last 50 years, which accentuates the importance of finding the optimal method of reconstruction of muscleaponeurotic layer defects of the abdominal wall.

Our clinical study on applying autodermal grafts and polypropylene mesh was conducted only on patients with large abdominal wall defects (greater than 10 cm). The average size of the defect in the two groups of patients was not significantly different, so the size of the defect could not be considered as an independent factor for complications ($p = 0.716$).

The average age of the patients in our study was of 57.6 $\pm$ 10.91 years correlating with the reported data on the average patient’s age of 45.5 to 62 years. The patients were predominantly male. In several studies females are pre-

dominant, whereas in studies of Mc Greevy et al. and La Mura et al. dominate males.

In our study, the operative time was significantly longer in the group with autodermal graft ($p = 0.03$), which is consistent with the literature data with the mean operative time with synthetic grafts of 1.7 h. In the study of Chan and Chan conducted on 135 patients, the duration of surgery using mesh technique was up to 40 min in 15 cases, up to 60 min in 77 cases, up to 90 minutes in 41 cases and up to 120 min in 2 cases. The time required for graft harvesting was significantly longer if the graft was taken by a surgical blade and less when taken by dermatome. In our Clinic there is no dermatome, so it may be for the longer duration of surgery. Also, surgical techniques using dermatomes provide an ideally smooth surface of the graft, which reduces the possibility of tearing the graft, forming keratine cysts and other complications, particularly adhesion. Operation of large abdominal wall defects should be performed as a team work, with the participation of the abdominal and plastic and reconstructive surgeon in order to shorten operative time.

Application of autodermal graft reduces the frequency of pain and intensity of inflammatory response, but correlate with higher complications rate, even up to 25%. The overall incidence of early complications in our study in both groups was 20%. The available literature data reported the incidence of infection and bleeding of 10%. Some authors stated that seroma after applying synthetic mesh may occur even one year after surgery, but such a complication was not observed in our study. Kingsnorth et al. in their study reported the early complications rate of 34%. Our study results correlate well with other studies, where the percentage of early minor complications (seroma, hematoma, infection) ranged from 16% to 18%, and severe complications from 6% to 27% (intestinal obstruction, intraperitoneal infection and enterocutaneous fistula), accordingly.

A literature review shows the most common use of synthetic mesh for incisional hernia repair. Artificial materials such as synthetic grafts, represent a strong stimulus for the development of intestinal adhesions, which can lead to serious complications, such as intestinal obstruction and enterocutaneous fistula. In our research we recorded one patient with intestinal obstruction and one with enterocutaneous fistula.

Enterocutaneous fistula is rarely formed with synthetic mesh placed extraperitoneally, although some authors reported increased incidence of complications with intraperitoneally placed mesh. In this study, enterocutaneous fistula was observed in one patient with synthetic mesh. During surgery, the most important point is to avoid contact of mesh and skin. When infection occurs mesh must be removed and definitive abdominal wall reconstruction have to be done after 6 months. Although some literature data indicate a higher complication rate in patients treated with autografts, in our study there were no significant differences in the early minor complication rate between the groups.

Hospital stay analysis for the patients who required autodermal grafts showed 6.8 ± 2.8 days, and by the use of synthetic mesh 6.4 ± 2.5 days, but statistical significance was not found. These data correlate with the literature, where the average duration of hospital stay was 5–13 days. In the group of patients with synthetic mesh, two of all the patients had repeated hospitalization increasing the overall cost of treatment.

In contemporary clinical practice, there are numerous studies that analyse indications, complications, length of hospitalization and economical aspects of the treatment. A total cost of frequent severe complications treatment after the use of synthetic mesh, was lower when biological materials (allo- or xenograft) were applied regardless the fact that they are more expensive. Application of autografts in this study, despite the longer operative time led to lower overall costs of treatment because autodermal graft is free of charge.

In our research, the recurrence rate observed in autografts was 10% in the first 20 months, and with synthetic mesh the observed rate was 15% in the first 42 months following the surgery. According to the literature data, recurrence rate after the use of synthetic mesh varies from 15% to 36%, where 45% of recurrences occur within the first year, 19% in the second year, 14% in the third and the rest later.

The reestablishment of the anatomical and functional integrity of the abdominal wall using synthetic mesh is safe and secure in general but is accompanied by a number of adverse effects, most notably reduced flexibility of the abdominal wall, due to the presence of the permanently rigid structure, which consists of the mesh and the fibrous capsule, unsatisfactory aesthetic appearance, particularly with lean patients, feeling the presence of foreign body, as well as granuloma formation. Therefore, the use of synthetic mesh should be avoided in young patients.

Applying autodermal graft could be an ideal choice for patients with infection or exposure to synthetic implant, and in patients with intraabdominal infections, immunocompromised patients and after radiotherapy, where a synthetic mesh is contraindicated.

Conclusion

We believe that tension-free reconstruction with an autodermal graft is a safe operation with minimal morbidity and mortality. Autodermal graft reconstruction is technically more difficult and prolongs the duration of operation but it is more cost effective. The incidence of early minor and major postoperative complications is lower with autodermal graft, and they can be efficiently treated. We believe that the dominance of synthetic mesh in reconstruction of large defects of the abdominal wall is unduly favored and biological autografts should be more often applied in everyday surgical practice. They can be applied when synthetic implants are contraindicated (the presence of infection, immunodeficient patients, or after radiotherapy) and in unusual conditions such as natural disasters or war surgery with no industrials manufactur of grafts.
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