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Challenging abdominal incisional hernia repaired with platelet-rich plasma and bone marrow-derived mesenchymal stromal cells. A case report

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ABSTRACT

INTRODUCTION: The necessity to develop new treatment options for challenging procedures in hernia surgery is becoming even more evident and tissue engineering and biological technologies offer even newer strategies to improve fascial healing. The present case reports a patient-tailored surgical technique performed to repair a grade IV abdominal incisional hernia, with a combined use of platelet-rich plasma and bone marrow-derived mesenchymal stromal cells, implanted on a biological mesh.

PRESENTATION OF THE CASE: A 71 year-old female patient complained of an abdominal incisional hernia, complicated by enterocutaneous fistula, four-months following laparostomy. Contrast enhanced computed tomography showed an incisional hernia defect of 15.5 × 20 cm, with a subcutaneous abscess and an intestinal loop adherent to the anterior abdominal wall, with a concomitant enterocutaneous fistula. Surgery involved abdominal wall standardized technique closure, with in addition platelet-rich plasma and bone marrow-derived mesenchymal stromal cells implanted on a biological mesh. Two years follow up showed no recurrences of incisional hernia.

DISCUSSION: Coating surgical meshes with patient's own cells may improve biocompatibility, by reducing inflammation and adhesion formation. Moreover, platelet-rich plasma is a good source of growth factors for wound healing, as well as a good medium for bone marrow multinucleate cells introduction into fascial repair.

CONCLUSION: This approach is likely to improve abdominal wall repair in high grade (IV) incisional hernia, with the real possibility of improving prosthetic compatibility and reducing future recurrences. The authors agree with the necessity of further studies and trials to assure the safety profile and superiority of this procedure.

1. Introduction

What is the best mesh for abdominal incisional hernia (AIH) repair? What is the best surgical technique? For years, answers to these and more questions have been asked, and at the present time, more than 100 surgical meshes are available on the market. However, the ideal mesh does not yet exist, and still needs to be developed [1]. Moreover, there is the necessity to develop new treatment options for challenging procedures in hernia surgery (closure of open abdomen, wound infections, obesity-related issues), and at the same time, tissue engineering and biological technologies offer even newer strategies to improve fascial healing [2]. AIH is one of the most common post-operative complications after abdominal surgery, with a reported incidence around 20% [3], and a 10-year cumulative rate of recurrence between 32% and 63% [4]; in some cases, recurrent AIH can be complicated by enterocutaneous fistula (EF), bowel obstruction, surgical site infection, anatomical loss and lateralization of the abdominal wall muscles[4]. Repairing high grade ventral hernias (more precisely, grade III and IV, according to Ventral Hernia Working Group classification [5]), are challenging for surgeons, and post-operative complications (i.e. adhesions, EF) still occur, despite advances in prosthetic technologies [6,7]. Given this, recent scientific studies have concentrated on improving prosthetic biocompatibility, such as coating mesh with the patient's own cells, thus reducing for-

Abbreviations: AIH, abdominal incisional hernia; EF, enterocutaneous fistula; PRP, platelet-rich plasma; BM-MSCs, bone marrow-derived mesenchymal stromal cells; CECT, contrast enhanced computed tomography; ICU, Intensive Care Unit; VEGF, vascular endothelial growth factor; PDGF, platelet-derived growth factor; TGF, transforming growth factors; FGF, fibroblast growth factors; EGF, epidermal growth factor.

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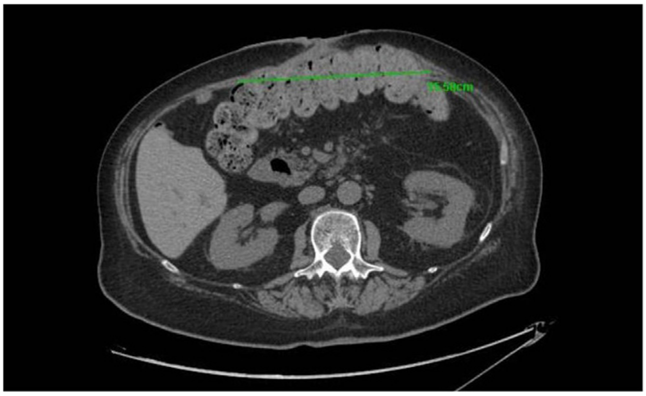


Fig. 1. Preoperative contrast enhanced CT-scan. Incisional hernia defect of about 15 × 20 cm, with a portion of small bowel inside and an important diastasis of rectus muscles.

eign body induced inflammation, formation of adhesions, together with bowel obstruction and fistula formation [8,9]. Platelet-rich plasma (PRP) and bone marrow-derived mesenchymal stromal cells (BM-MSCs), implanted on a collagen scaffold, are one of the possible tissue engineering techniques used to improve fascial healing, as they seem to optimize the second and the third phase of wound healing process (proliferation and maturation). Besides, they strongly improve tensile strength and total energy absorption after a primary fascial repair [10,11]. The present case describes a patient-tailored surgical technique performed at the public Hospital "Infermi" of Rimini, Italy, in order to repair a grade IV AIH, with a combined use of PRP and BM-MSCs, implanted on a biological mesh (cross-linked acellular porcine dermal collagen). The paper has been reported in line with the SCARE criteria [12].

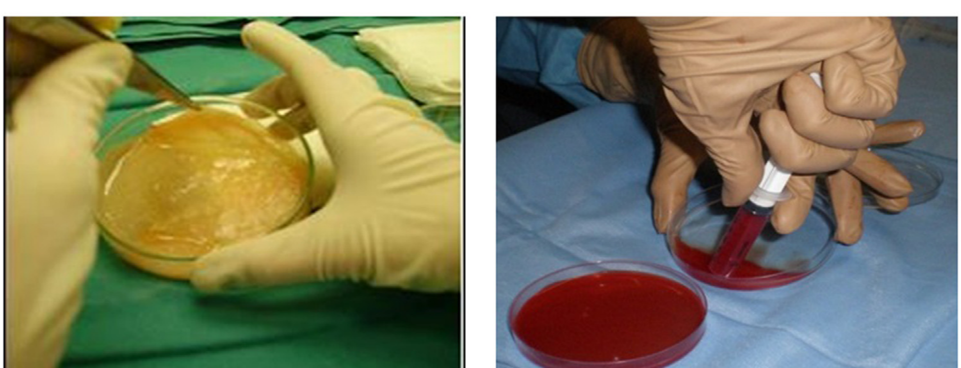
2. Presentation of case

2.1. Patient information

A 71 year-old Caucasian female arrived at the Department of General and Emergency Surgery in the Rimini public Hospital, referred by her family physician. She complained of an AIH complicated by EF (grade IV [5]). Four months earlier, she had laparoscopic surgery for gastroesophageal reflux disease, which was complicated by an intraoperative splenic bleeding with consequent splenectomy, postoperative pancreatic fistula, and pulmonary embolism. Since the patient needed a redo operation, a laparostomy with vacuum negative pressure therapy was performed. The abdomen was closed 7 days later and the patient was finally discharged. Clinical Finding. At admission, the patient was in a weakened state, with a body mass index of 18 kg/cm2, and a large AIH, with the stomach and a small bowel loop under the subcutaneous layer, and an EF. Diagnostic Assessment. The contrast enhanced computed tomography (CECT) showed an (incisional hernia defects of 15.5 × 20 cm) with a subcutaneous collection in epigastric/umbilical regions, and an intestinal loop adherent to the anterior abdominal wall, with a concomitant EF (Fig. 1). Therapeutic Intervention. A multidisciplinary group (surgeon, nutritionist, lung specialist, radiologist, intensivist and interventional radiologist) was set up to discuss the therapeutic strategy and to enhance patient's preoperative optimisation. For 3 weeks, high calorie intravenous nutrition and respiratory physiotherapy was performed, until patient's performance status was good enough for facing an elective surgical procedure. An epidural catheter for postoperative

a b c

Fig. 2. a-b-c Abdominal intraoperative situation. Macroscopic evidence of an enterocutaneous fistula, with important adhesion between small bowel loops. Fig. 2c also represents the skin patch of 8 × 7 cm, with cutaneous fistulas ostia.



a b

Fig. 3. a-b Making of PRP and BM-MSCs. a: Platelet gel. b: bone marrow stem cells.

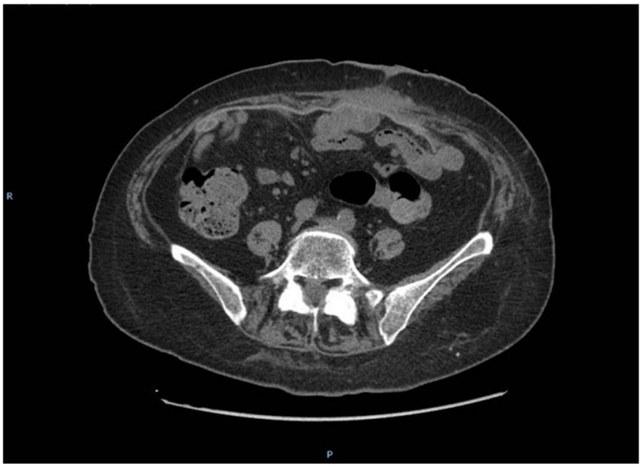


Fig. 4. Postoperative day contrast enhanced CT-scan on the eight day. A fluid collection (10 × 3,5 cm) appeared over the prosthesis.

analgesia was put in, then the patient underwent general anaesthesia and she was placed in supine position. Antibiotic prophylaxis was administrated, according to internal hospital guidelines. After laparotomy and a long adhesiolysis, about 30 cm of the ileum, the EF, and a piece of adherent skin of 8 × 7 cm, were resected, and after this, a manual ileal-ileal lateral-lateral anastomosis was done (Fig. 2a-b-c). The abdominal wall reconstruction involved combined Rives-Stoppa technique [13] with Ramirez component separation technique [14], using a biological porcine mesh (cross-linked acellular porcine dermal collagen, 20 × 30 cm) with a wide overlap. Then, 120 ml of bone marrow (Total nucleated cells/ml 56×10^6/ml) was extracted from the iliac crest bone, and, after processing and centrifugation of the cells (BMAC, Harvest®, Terumo), it was gathered in 20 ml of volume (Total nucleated cells/ml 72×10^6/ml). On a Petri-dish, the platelet gel was combined by autologous PRP (5 ml; cells/ml 1.2×10^9/ml), Plasma (5 ml), Thrombin (2 ml) and Gluconate Calcium (2 ml). Finally, the 20 ml bone marrow total nucleated cells were put on 60 ml of platelet gel, and spread over the biological mesh (Fig. 3a-b). The total operative time was 540 min, because of the extensive adhesion syndrome which involved the entire small bowel, the necessity to free all the intestinal loops from the scar tissue and to remove the loops involved in the EF. Blood loss was compatible with the performed surgery, and blood transfusions were not necessary. Three surgical drains were placed: one in the peritoneal cavity and the other two above the prosthesis, under the skin. These last two drains remained closed until the third postoperative day to avoid the leakage of platelet-gel mixed with stem cells through the tubes. After surgery, the patient stayed in ICU for two days, where the lung ventilation was strictly monitored, because of the risk of intra-abdominal pressure increasing, which could reflect itself on the intra-thoracic pressure and respiratory mechanics. The peritoneal drain was removed at the third postoperative day, while the subcutaneous ones remained inside until the seventh postoperative day. Follow-up and Outcomes. After eight days, a control CECT was performed in order to monitor the PRP and stem cells behaviour around the mesh. It demonstrated a fluid collection (10 × 3.5 cm) over the prosthesis, which was treated non-operatively and followed up with ultrasounds, because the patient had no signs of active infection (Fig. 4). The patient received postoperative physiotherapy for 30 days and she was discharged on 48th postoperative day, with the advice of going on with abdominal muscles rehabilitation [15]. Histological response confirmed the EF with fibrous-adhesive and fibrinous-granulocytic peritonitis. Moreover, there were signs of extensive inflammation steatonecrosis and foreign body multinucleate giant cells. Two years follow-up showed no recurrence of AIH and complete resolution of the fluid collection.

3. Discussion

High grade IAH requires complex and tailored reconstructive surgical techniques. Optimization of the wound healing process is a valuable element for the prevention of recurrent IAH [10]. A biological mesh, such as a cross-linked acellular porcine dermal collagen one, has a good dimensional stability but, after some time, the mechanical strength decreases as a result of enzymatic degradation. In the meanwhile, tissue engineering helps tissue self-regeneration and self- repair, with reported successes in IAH repair, thanks to decellularized scaffold seeded with cells [16,17]. Recently, some authors have declared that the damage of angiogenic and vasculogenic pathways can lead to IAH recurrence and they have underlined the importance of the VEGF in this process [18]. Mesenchymal stem cells secrete this kind of vasculogenic cytokines and so, they create vascular networks that might improve wound healing [19]. Coating surgical meshes with the patient's own cells helps the implanted meshes to hide themselves from the host immune system, to reduce their adverse effects, and to improve biocompatibility [8,9]. In literature, few authors emphasize the importance of combined use of PRP, BM-MSCs and collagen to improve fascial healing [10,11]; in particular, Heffner et al. showed how the tensile strength, the total energy absorption vascularization and the collagen abundance increase in mice treated with collagen overlay, PRP and BM-MSCs versus others groups [10]. PRP is a good source of growth factors for wound healing, because platelets release PDGF, VEGF, TGF-beta, FGF, and EGF, and in this way, they provide a suitable environment for cellular repair and proliferation. For these reasons, it is essential to include PRP as part of a medium for bone marrow multinucleate cells introduction into the fascial repair [10]. Finally, another recent study supports the methodology of coating various types of surgical meshes with different cell lines, with good expectations for further development and improvement of IAH repair techniques [20]. Otherwise, Petter-Puchner et al. stated that even though BM-MSCs are among the best investigated options in stem cell therapy, the invasiveness of obtaining the cells (with regard to pain and possible complications) could be a limitation of this procedure, and the superiority of a treatment with BM-MSCs for AIH repair-related indication still need to be proven [2].

4. Conclusion

In this specific complex patient, PRP and BM-MSCs implanted on a biological mesh, seemed to be a feasible technique for the repairing high grade IAH, with the real possibility of improving prosthetic compatibility and reducing future recurrences. However, the authors agree with the necessity of further studies and trials to assure the safety profile and superiority of this procedure.

Conflict of interest

The authors declare no conflicts of interest.

Source of funding

The Authors declare no funding.

Ethical approval

The study did not need ethical approval.

Consent

Written informed consent was obtained from the patient for publication of this Case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Authors' contribution

GMP and LM concepted and designed the study.
FP and MN acquired data and drafted the article.
FC and GC revised it critically for important intellectual content.
GMP and LV final approved the version to be submitted.

Guarantor

Gian Marco Palini and Luigi Veneroni are the guarantor of this paper.

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References

[1] V. Shankaran, D.J. Weber, R.L. Reed, F.A. Luchette, A review of available prosthetics for ventral hernia repair, Ann. Surg. 253 (2011) 16–26.
[2] A.H. Petter-Puchner, R.H. Fortelny, S. Gruber-Blum, H. Redl, U. Dietz, The future of stem cell therapy in hernia and abdominal wall repair, Hernia 19 (1) (2015) 25–31.
[3] J. Höer, G. Lawong, U. Klinge, V. Schumpelick, Factors influencing the development of incisional hernia. A retrospective study of 2,983 laparotomy patients over a period of 10 years, Chirurg 73 (5) (2002) 474–480.
[4] J.W. Burger, R.W. Luijendijk, W.C. Hop, J.A. Halm, E.G. Verdaasdonk, J. Jeekel, Long-term follow-up of a randomized controlled trial of suture versus mesh repair of incisional hernia, Ann. Surg. 240 (4) (2004) 578–583.
[5] K. Breuing, C.E. Butler, S. Ferzoco, M. Franz, C.S. Hultman, J.F. Kilbridge, et al., Ventral Hernia Working Group Incisional ventral hernias: review of the literature and recommendations regarding the grading and technique of repair, Surgery 148 (3) (2010) 544–558.
[6] C.L. Nockolds, J.P. Hodde, P.S. Rooney, Abdominal wall reconstruction with components separation and mesh reinforcement in complex hernia repair, BMC Surg. 30 (14) (2014) 25.
[7] S. Sriussadaporn, S. Sriussadaporn, R. Pak-Art, K. Kritayakirana, S. Prichayudh, P. Samorn, Management of difficult abdominal wall problems by components separation methods: a preliminary study in Thailand, J. Med. Assoc. Thai. 96 (11) (2013) 1449–1462.
[8] M. Kapischke, K. Prinz, J. Tepel, J. Tensfeldt, T. Schulz, Precoating of alloplastic materials with living human fibroblasts – a feasibility study, Surg. Endosc. 19 (6) (2005) 791–797.
[9] C.J. Dolce, D. Stefanidis, J.E. Keller, K.C. Walters, W.L. Newcomb, J.J. Heath, et al., Pushing the envelope in biomaterial research: initial results of prosthetic coating with stem cells in a rat model, Surg. Endosc. 24 (11) (2010) 2687–2693.
[10] J.J. Heffner, J.W. Holmes, J.P. Ferrari, J. Krontiris-Litowitz, H. Marie, D.L. Fagan, et al., Bone marrow-derived mesenchymal stromal cells and platelet-rich plasma on a collagen matrix to improve fascial healing, Hernia 16 (6) (2012) 677–687.
[11] Y. Zhao, Z. Zhang, J. Wang, P. Yin, J. Zhou, M. Zhen, et al., Abdominal hernia repair with a decellularized dermal scaffold seeded with autologous bone marrow-derived mesenchymal stem cells, Artif. Organs 36 (3) (2012) 247–255.
[12] R.A. Agha, A.J. Fowler, A. Saeta, I. Barai, S. Rajmohan, D.P. Orgill, CARE Group, The SCARE statement: consensus-based surgical case report guidelines, Int. J. Surg. 34 (2016) 180–186.
[13] R. Stoppa, J. Petit, X. Henry, Unsutured Dacron prosthesis in groin hernias, Int. Surg. 60 (8) (1975) 411–412.
[14] O.M. Ramirez, E. Ruas, A.L. Dellon, Components separation method for closure of abdominal-wall defects: an anatomic and clinical study, Plast. Reconstr. Surg. 86 (3) (1990) 519–526.
[15] A. Giannini, G. Palini, N. Ferri, L. Veneroni, Enhanced abdominal wall rehabilitation after major surgery: a randomized controlled trial, Chirurgia (Bucur) 29 (4) (2016) 114–120.
[16] J.Y. Lai, P.Y. Chang, J.N. Lin, Body wall repair using small intestinal submucosa seeded with cells, J. Pediatr. Surg. 38 (12) (2003) 1752–1755.
[17] T. Drewa, P. Galazka, A. Prokurat, Z. Wolski, J. Sir, K. Wysocka, et al., Abdominal wall repair using a biodegradable scaffold seeded with cells, J. Pediatr. Surg. 40 (2) (2005) 317–321.
[18] J. Lisiecki, J. Rinkinen, O. Eboda, J. Peterson, S. De La Rosa, S. Agarwal, et al., Adipose-derived mesenchymal stem cells from ventral hernia repair patients demonstrate decreased vasculogenesis, BioMed Res. Int. 2014 (2014), 983715.
[19] C. Szpalski, M. Barbaro, F. Sagebin, S.M. Warren, Bone tissue engineering: current strategies and techniques – part II: cell types, Tissue Eng. Part B Rev. 18 (4) (2012) 258–269.
[20] Y. Gao, L.J. Liu, J.A. Blatnik, D.M. Krpata, J.M. Anderson, C.N. Criss, et al., Methodology of fibroblast and mesenchymal stem cell coating of surgical meshes: a pilot analysis, J. Biomed. Mater. Res. B Appl. Biomater. 102 (4) (2014) 797–805.