



## Case Report

# Successful conservative treatment of a poly-4-hydroxybutyrate mesh infection: A case report

Maarten Lambrecht, MD<sup>a,\*</sup>, Tim Tollens, MD<sup>b</sup>

<sup>a</sup> Department of General Surgery, UZ Leuven, Herestraat 49, 3000, Leuven, Belgium

<sup>b</sup> Head of Department of Abdominal Surgery, Imelda VZW, Imeldalaan 9, 2820, Bonheiden, Belgium



## ARTICLE INFO

## Keywords:

Case report

Hernia

Poly-4-hydroxybutyrate mesh

Infection

Conservative treatment

## ABSTRACT

**Introduction and importance:** An infection of an abdominal wall prosthesis can be a real disaster for the patient. A conservative treatment might be an option if biological or slowly resorbable synthetic meshes were used. However, adequate research of their use in contaminated and dirty wounds lacks.

**Case presentation:** Herein we report the case of a 69-year-old patient with a heavily infected poly-4-hydroxybutyrate mesh that was successfully treated conservatively.

**Clinical discussion:** Despite promising results of poly-4-hydroxybutyrate meshes, their use remains controversial and studies in contaminated wounds are scarce.

**Conclusion:** Our case report shows the potential benefits of a poly-4-hydroxybutyrate mesh in a very high-risk patient with active infection.

## 1. Introduction

Aside of repair technique, mesh material is an important factor in the outcome of hernia repair. Non resorbable synthetic meshes have been widely accepted as the standard for incisional hernia repair. In contaminated wounds, however, their use can cause severe complications. Mesh infection, mesh erosion, non-healing wounds and chronic fistula may even require subsequent surgery [1]. Conservative treatment of a mesh infection might be an option if biological or slowly resorbable synthetic meshes were used. A fully slowly resorbable synthetic mesh made of poly-4-hydroxybutyrate (P4HB) seems to outperform earlier resorbable synthetic and biological meshes [2]. Nevertheless, their use remains controversial and studies in contaminated wounds are scarce. Herein we report the case of a 69-year-old patient with a heavily infected P4HB mesh that was successfully treated conservatively. This case report has been reported in line with the SCARE Criteria [3].

## 2. Case report

A 69-year-old female was referred to our clinic with a large recurrent incisional hernia. She has a history of chronic kidney disease and got a preemptive renal transplantation 4 years earlier. She is under

immunosuppression. Other comorbidities include uncontrolled diabetes mellitus type 2. Only three months after the transplantation she developed a first incisional hernia. Despite two surgical repairs with mesh, the hernia recurred and is incapacitating her in daily life. Clinical examination revealed a large incisional hernia over a hockey stick incision in the right fossa. CT scan confirmed the large hernia with a defect of 9 cm and showed multiple meshes in different planes.

Thorough preoperative work-up was initiated before proceeding to complex surgery. A stable renal function with good metabolic regulation was obtained under triple therapy with corticosteroids, mycophenolic acid and everolimus. Diabetic workup was done to control the impaired glycemic control.

After preoperative workup, an elective redo incisional hernia repair with open approach was performed by an experienced surgeon. Prophylactic amoxicillin/clavulanic acid 2000mg/200mg and gentamicin 120mg were administered preoperatively. Due to severe adhesions between the intestine and the previous meshes, dissection and removal of the previous meshes was complicated with several enterotomies and soiling. A partial enterectomy was inevitable. Reanastomosis was done using two staples via Barcelona technique. An abdominal wall reconstruction with Ramirez component separation was continued. Despite the controlled contaminated wound, we opted to reinforce the

*Abbreviations:* P4HB, poly-4-hydroxybutyrate; POD, postoperative day; CT, Computed tomography scan.

\* Corresponding author.

*E-mail address:* [maarten.1.lambrecht@uzleuven.be](mailto:maarten.1.lambrecht@uzleuven.be) (M. Lambrecht).

<https://doi.org/10.1016/j.amsu.2021.02.008>

Received 23 January 2021; Received in revised form 1 February 2021; Accepted 2 February 2021

Available online 17 February 2021

2049-0801/© 2021 The Authors. Published by Elsevier Ltd on behalf of IJS Publishing Group Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

abdominal wall with a Phasix™ (Becton, Dickinson and Company, New Jersey) mesh in the retromuscular space. The patient was transferred to the intensive care unit for early postoperative observations. Initial postoperative course was uncomplicated. Amoxicillin/clavulanic acid 1000mg/200mg 4×/d was continued for 5 days after surgery because of a pulmonary infiltrate and in order to protect the hernia repair.

Postoperative day 20 the patient developed fever and laboratory follow-up showed increased levels of C-reactive protein which peaked at a level of 500mg/L. A CT scan of the abdomen showed non-organized fluid collections around the implanted mesh as well as an abscess around the bowel anastomosis. Empirical treatment of a deep abdominal wound infection was started. According to our hospital and national guidelines Piperacillin-Tazobactam 4g/500mg 4×/d was started. Despite an immediate resolution of fever, inflammatory lab results persisted high. New CT-scan (Fig. 1) on POD 31 showed a more organized encapsulated collection, which was punctured through the mesh under ultrasound guidance. A drain was left behind. Culture of the fluid showed growth of *Escherichia coli*. Based on the obtained puncture cultures and antibiogram, antibiotics were switched to Levofloxacin 750mg 1/d. Follow-up imaging (Fig. 2) after one week (POD 38) showed a new collection which was again drained with an ultrasound guided puncture. A second drain was placed.

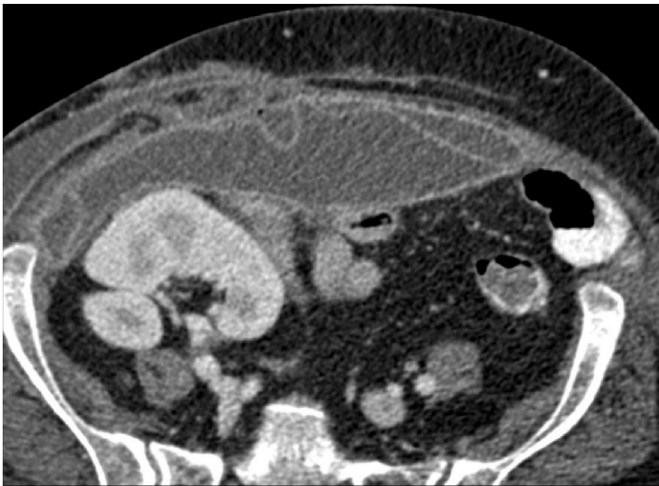


Fig. 1. Cross sectional image of the CT scan on POD 31 shows a big organized encapsulated collection near the implanted P4HB mesh.

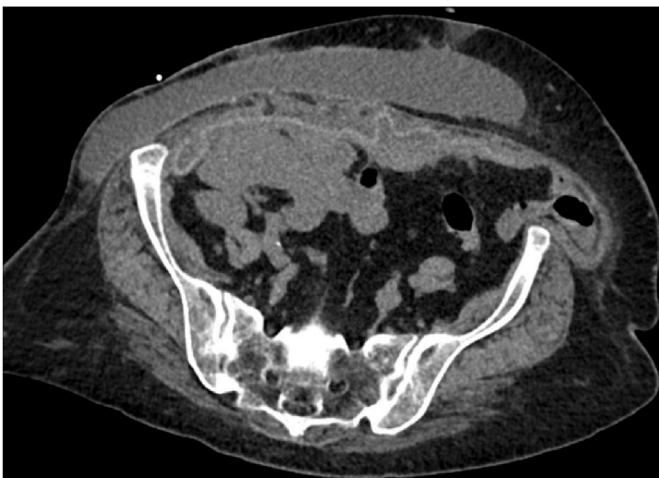


Fig. 2. An additional subcutaneous collection is seen on the CT scan on POD 38.

Ultrasound (Fig. 3) on POD 41 did not reveal any new collections and demonstrated that the old collections had resolved. After normalization of C-reactive protein and leukocytosis, drains were progressively removed the following days.

The patient was discharged from hospital on POD 49. Antibiotic therapy was continued for five more days. Follow-up consultation after two weeks showed a stable abdomen with no evidence for recurrence of the hernia. The patient is doing well, and blood analysis shows normal inflammatory markers. Repeat CT-scan shows diminution and decrease of the known seroma. Postoperative follow-up at one year revealed no recurrent hernia.

### 3. Discussion

Strong non resorbable synthetic meshes have been widely accepted as the standard for incisional hernia repair. Associated complications of infection, migration, erosion and adhesions question their use in particular cases prone to complications. Special care to mesh selection for patients at highest risk of infection, can prevent complications and high costs associated with mesh infections [1]. A hypothetical ultimate mesh is strong, triggers tissue regeneration and remodeling, causes low local inflammation and fibrosis, and is cheap [4]. A new generation of fully but slowly absorbable synthetic meshes may come close to these favorable characteristics.

Phasix™ is a fully resorbable (biologically derived) monofilament mesh. It is made of P4HB, produced by the microorganism *Escherichia coli* via a transgenic fermentation process [2]. It predictably degrades through a process of hydrolysis and a hydrolytic enzymatic digestive process to the monomer form 4HB, which is a naturally occurring human metabolite. This is metabolized quickly via the Krebs cycle and ultimately converted into biocompatible byproducts carbon dioxide and water [5].

P4HB characteristics include ultra-long-term absorbability, elasticity and great biocompatibility. These interesting biological and physico-chemical properties advocate their use in biomedical applications. The first medical device made of P4HB and cleared by the Food and Drug Administration was a surgical suture which hit the market in 2007. Since then this new generation of products is expanding with application in sutures, artery augmentation patches, skin grafts, stents, and more [5].

In contrast to quickly resorbable synthetic meshes which showed increased recurrence of incisional hernia because of the short-term strength retention, P4HB meshes have a predictable and long-term resorption profile of 1,5 years. This slow degradation rate facilitates a more gradual transfer of load from the mesh back to the native tissue [6]. Ball burst force tests prove that the mesh offers additional strength

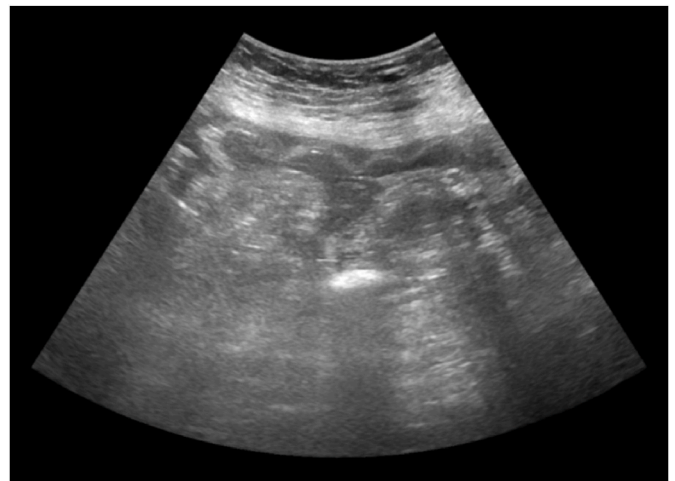


Fig. 3. Ultrasound on POD 41 suggests resolution of the collections.

to the surgical site of repair in the first four months. The stiffness of the repair during this phase indicates a natural fibrotic response that occurs during remodeling and wound repair. The remodeling with native host tissue continues, even when the fibers begin to degrade and resorb starting from eight months. After one and a half year the fiber remnants that remain are completely nonfunctional [2]. Another advantage of the predictable long-term resorption may be a protection from rapid degradation by collagenases if exposed to bacteria during or after implantation [6].

P4HB monofilament meshes are expected to be more biocompatible and less susceptible to infections than polyfilament meshes [2]. Macropores present the host with less surface area and are thought to cause a less pronounced inflammatory response [7]. Butyrate has shown to have additional antimicrobial benefits including anti-inflammatory properties [8]. Research in a rat model showed a significant higher ratio of M2 over M1 macrophages when using P4HB compared to polypropylene mesh [9]. This increase in M2 (anti-inflammatory) response is associated with driving the natural wound-healing process for a strong and lasting repair [10]. This possibly explains why a P4HB mesh provides remaining significant mechanical strength after one year, despite material resorption over time [11]. Research in a rabbit model where the mesh was inoculated with methicillin-resistant *Staphylococcus aureus* (MRSA) confirms the positive antimicrobial effect of P4HB meshes as opposed to multifilament microporous meshes. There was less bacterial colonization and less abscess formation found in the group with P4HB mesh [7].

Despite previous described great characteristics of the P4HB mesh for use in contaminated or dirty wounds, previous human research has excluded these contaminated cases. An open-label prospective multicenter study by Roth J., et al. described positive outcomes when testing a P4HB mesh for hernia repair in 121 subjects with CDC Class I (clean) wounds at high risk for complications. Although encouraging results during 18 months follow-up, it is important to note that all patients had CDC class I clean wounds [1]. Another smaller prospective study by Margaret A. Plymale et al. describing 31 patients, showed favorable outcomes of P4HB meshes with a low incidence of complications during 24 months postoperatively, though the study only included 1 patient with CDC wound class II [8]. A retrospective multivariate analysis of 73 cases by Buel J.F., et al. showed superior clinical performance of a P4HB scaffold compared to porcine cadaveric mesh. Unfortunately there was no distinction made between wound classes [12]. Studies comparing synthetic and biologic mesh in contaminated fields are lacking. Although these studies did not include subjects with clean-contaminated, contaminated nor dirty wounds, our case report demonstrates it is possible to conservatively treat an incisional hernia in a dirty wound using a P4HB mesh. Our findings in this case report are interesting but provide little basis for a more generalized application of P4HB meshes. Further investigation of their use in contaminated wounds remains necessary.

#### 4. Conclusion

Synthetic meshes are widely used because of their low cost and good results. However, in some cases mesh complications are inevitable. Biosynthetic monofilament P4HB meshes are fully resorbable and have favorable biological and mechanical characteristics. Despite promising results of P4HB meshes, adequate research of the use in contaminated and dirty wounds lacks. Our case report shows the potential benefits of a P4HB mesh in a very high-risk patient with active infection. This suggests that the use of a P4HB mesh in contaminated environments seems superior to other meshes. In contrast to the use of conventional synthetic meshes in clean wounds, we expect high cost-effectiveness of the use of a P4HB mesh in contaminated wounds.

#### Ethical approval

Not applicable for this case report.

#### Source of funding

The authors declared that this study has received no financial support.

#### Author contribution

Maarten Lambrecht drafted the manuscript and provided the original pictures.

Dr. Tim Tollens revised the manuscript critically.

All authors read and approved the final manuscript.

#### Research registration

N/A.

#### Consent

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

#### Provenance and peer review

Not commissioned, externally peer-reviewed.

#### Declaration of competing interest

The authors report no conflict of interest.

#### References

- [1] J.S. Roth, G.J. Anthone, D.J. Selzer, et al., Prospective evaluation of poly-4-hydroxybutyrate mesh in CDC class I/high-risk ventral and incisional hernia repair: 18-month follow-up, *Surg. Endosc.* 32 (2018) 1929–1936, <https://doi.org/10.1007/s00464-017-5886-1>.
- [2] D.P. Martin, A. Badhwar, D.V. Shah, et al., Characterization of poly-4-hydroxybutyrate mesh for hernia repair applications, *J. Surg. Res.* 184 (2013) 766–773, <https://doi.org/10.1016/j.jss.2013.03.044>.
- [3] R.A. Agha, T. Franchi, C. Sohrabi, et al., The SCARE 2020 guideline: updating consensus surgical CAse RReport (SCARE) guidelines, *Int. J. Surg.* 84 (2020) 226–230, <https://doi.org/10.1016/j.ijss.2020.10.034>.
- [4] U. Klinge, J.K. Park, B. Klosterhalfen, The ideal mesh? *Pathobiology* 80 (2013) 169–175, <https://doi.org/10.1159/000348446>.
- [5] S.F. Williams, S. Rizk, D.P. Martin, Poly-4-hydroxybutyrate (P4HB): a new generation of resorbable medical devices for tissue repair and regeneration, *Biomed. Tech* 58 (2013) 439–452, <https://doi.org/10.1515/bmt-2013-0009>.
- [6] J.R. Scott, C.R. Deeken, R.G. Martindale, M.J. Rosen, Evaluation of a fully absorbable poly-4-hydroxybutyrate/absorbable barrier composite mesh in a porcine model of ventral hernia repair, *Surg. Endosc.* 30 (2016) 3691–3701, <https://doi.org/10.1007/s00464-016-5057-9>.
- [7] N.F.N. Stoikes, J.R. Scott, A. Badhwar, C.R. Deeken, G.R. Voeller, Characterization of host response, resorption, and strength properties, and performance in the presence of bacteria for fully absorbable biomaterials for soft tissue repair, *Hernia* 21 (2017) 771–782, <https://doi.org/10.1007/s10029-017-1638-3>.
- [8] M.A. Plymale, D.L. Davenport, A. Dugan, A. Zachem, J.S. Roth, Ventral hernia repair with poly-4-hydroxybutyrate mesh, *Surg. Endosc.* 32 (2018) 1689–1694, <https://doi.org/10.1007/s00464-017-5848-7>.
- [9] B.S. Gandhi Riddhi, Sicari Brian, Pineda Catalina, Poly-4-Hydroxybutyrate (P4HB) surgical mesh for, *Hernia Repair* 1 (1958) 3–4.
- [10] S. Hanakawa, A. Kitoh, Macrophages, *Immunol. Ski. Basic Clin. Sci. Ski. Immune Responses.* (2016) 169–178, [https://doi.org/10.1007/978-4-431-55855-2\\_10](https://doi.org/10.1007/978-4-431-55855-2_10).
- [11] C. Bio, B. Matthews, C.R. Deeken, B.D. Matthews, Characterization of the mechanical strength, resorption properties, and histologic characteristics of a fully absorbable, in: *Characterization of the Mechanical Strength, Resorption Properties, and Histologic Characteristics of a Fully Absorbable Mater*, 2013, p. 2013, <https://doi.org/10.1155/2013/238067>.
- [12] J.F. Buell, D. Sigmon, C. Ducoin, et al., Initial experience with biologic polymer scaffold (Poly-4-hydroxybutyrate) in complex abdominal wall reconstruction, *Ann. Surg.* 266 (2017) 185–188, <https://doi.org/10.1097/SLA.0000000000001916>.