Case Report

A promising contribution to negative pressure wound therapy in treatment of prosthetic joint infection. Discussion based on case report

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\textbf{A B S T R A C T}

\textit{Introduction and importance:} Although a significant number of periprosthetic joint infection cases and well-proven algorithms of its cure are available, there still is a potential to make a more justified decision and thus improve treatment result.

\textit{Case presentation:} This paper presents a case report of late simultaneous Prosthetic Joint Infection of both knees. Clinical discussion dedicates to the possible contribution of Negative Pressure Wound Therapy in treatment of Prosthetic Joint Infection.

\textit{Conclusion:} We conceive the role of NPWT in the treatment of PJII to be underestimated to date and should be assessed in controlled trial.

\section{1. Introduction}

Notwithstanding the relatively low incidence of infection of joint prostheses, the huge volume of operations ensures that significant number of patients get periprosthetic joint infection (PJI). Due to accumulated experience and hard work by specialists, efficient care algorithms have been established and generally accepted. Two different approaches have been developed for the PJI treatment, depending on (1) timing of manifestation, (2) severity of inflammation, (3) stability of endoprosthesis, (4) viability of surrounding tissues, and (5) drug sensitivity of wound microflora [1].

A single- or multi-stage replacement of prosthesis is usually recommended in case of chronic, complicated and recurrent infection.

Treatment of infection without removal of prosthesis, a so-called D\textit{A}IR tactic (Debridement, Antibiotics, Irrigation, Retention) may be suggested in early or acute infection. Good prosthesis stability and high sensitivity of pathogens to antibiotics are prerequisites for success of D\textit{A}IR [1,2]. Comprehensive revision of the wound, thorough necrectomy with complete removal of necrotized and nonviable tissues are essential conditions. It is also recommended (a good practice) to remove and replace all replaceable endoprosthesis components, such as polyethylene liners or removable head. The extensive wound irrigation with antiseptics, drainage and sutures are essential [1,2].

However, there is still no consensus on the effectiveness of D\textit{A}IR [3], which may vary from 26\% to 92\% [4]. This variability is clearly associated with the absence of strict criteria for decision-making whether to retain a prosthesis, namely, subjectivity in evaluation of the required amount of debridement, and lack of data on the pathogen sensitivity at the start of antibacterial therapy.

The risk of secondary nosocomial infection of endoprosthesis during the open wound treatment resulted in a consistent recommendation for primary wound closure with drainage [1]. However, the closed treatment of an infected wound in the presence of a foreign body involves high risks of postoperative complications to which, most probably, the failures of the D\textit{A}IR tactics may be attributed.

Moreover, in some cases it is difficult to assess viability of soft tissues and bones immediately after opening of the periprosthetic abscess, and thus to predict the prospects for endoprosthesis retention.

The need of primary wound closure makes the surgeon administer empirical wide-spectrum antibacterial therapy prior to obtaining the results of a bacteriological study. This early decision-making may also affect the treatment efficacy and the disease outcome.

A reasonable solution to these problems could be the use of Negative pressure wound therapy (NPWT) that have long been established as an effective method to cure infected and complicated wounds in various areas of surgery [5].
Even so, despite the extensive history and exhaustive practices in treatment of complicated forms of surgical infection, to date there is a scarce available literature on the use of NPWT for PJI treatment. Several observations note successive effects of this tool in the treatment of both early and late periprosthetic infection [6,7].

Specifically, a number of papers are available assessing the outcome of the irrigational NPWT application in small groups of patients with acute PJI, showing encouraging results with persistent infection containment and retention of endoprostheses [8,9]. All researchers point the need to extend the study of using NPWT [10,11].

In contrast, the Pro-Implant Foundation guide [1], as well as some current reviews [12] claim that the use of vacuum bands on open wounds should be avoided in the presence of an endoprosthesis.

This recommendation is based on the work by E. Yusuf et al. (2013), who found additional strains of microorganisms in the sponge in three out of 17 patients with various chronic wounds [13].

A similar and more detailed study was carried out by Anagnostakos K. et al. The authors have also observed the inconsistency in microflora composition from the wound and that from the draining sponge, but could not establish if it was due to an infection or an imperfection of sample collection [14].

During the last years, this medical facility has been treating from 40 to 70 patients with PJI annually. Patients with acute periprosthetic infection require urgent surgery on the day of admission.

The intervention protocol consists of wide opening of the periprosthetic cavity, total debridement and necrectomy, extraction of removable elements of the prosthesis (polyethylene liners).

During the operation we thoroughly evaluate the stability of the components of the endoprosthesis and collect bacteriological samples from the implant surface. The main difference in the surgical treatment of PJI in our institution is the routine use of NPWT for treatment of a certain category of patients.

The main indication to resort to NPWT is the potential of retention of the prosthesis. The conditions are:

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Fig. 1. Opening of periprosthetic abscess of right knee.

Fig. 2. After the extraction of polyethylene envelops, complete debridement was performed. Next, external fixation and distraction with ilizarov devices was performed and vacuum-assisted dressings applied.
• acute infection, regardless of timing of the outburst;
• absence of septic instability of endoprosthesis and osteomyelitis;
• absence of massive common soft tissue necrosis and possibility of radical debridement.

The first change of the dressing is normally performed in 3 days after the surgery, upon obtaining the bacteriological results. If the prosthesis remains stable, microbial strains are antibiotic-sensitive and there is no signs of prolonged inflammation and tissue necrosis, the wound can be drained and closed. If at least one of these conditions fails to hold, the NPWT course can be prolonged.

The proposed treatment scheme can be illustrated by the following clinical case.

All clinical decisions were made ex consilium, all surgical procedures were performed by a single team of surgeons and orthopaedists.

The work has been composed in accordance with the SCARE 2020 criteria [15].

2. Case report

Female patient, 63 y.o. underwent total knee joint endoprosthesis due to bilateral gonartrosis: in September 2014 on the right knee, and in April 2016 on the left knee.

No evidence of family genetic disorders, any other complicated background such as diabetes mellitus, and use of corticosteroids or cytostatic treatment, smoking or drug abuse was detected.

The patient was admitted to the facility due to sepsis on October 5, 2016. Both knees were painful and oedematous, body temperature was up to 38.5°C for 3 days before admission.

The WBC level was 14.9x10^9/l, erythrocyte sedimentation rate 70 mmph.

The diagnosis of acute late hematogenous periprosthetic simultaneous infection was established.

At the same day periprosthetic abscesses were opened (100 ml of purulent exudate on the right, 130 ml on the left) (Fig. 1). No evidence of septic instability of endoprostheses was found during the first surgery.

We removed polyethylene liners and performed total debridement of septic loci. Next, external fixing devices were applied for distraction and

Fig. 3. The view of the right knee wound after reimplantation of liners just before the wound closure.

Fig. 4. Implantation of the vancomycin-impregnated spacer after the removal of left knee prosthesis.
immobilization, and vacuum-assisted dressings on both sides were applied (Fig. 2).

Bacteriological study showed MRSA growth on both sides. We used vancomycin 1,0 twice a day i.v. until the sample from the right knee became sterile.

On October 31, 2016, reinstallation of the polyethylene insert on the right knee, removal of the external fixation device, and wound closure with drain tube were performed (Fig. 3).

The post-surgery period was uncomplicated and the wound healed by primary adhesion.

On the left, purulent exudation continued despite treatment, and then evidence of septic instability of the prosthesis was found. On November 23, removal of the endoprosthesis was performed and vancomycin-impregnated spacer implanted (Fig. 4).

The wound healed by primary intention, however on December 09, 2016 signs of inflammation resumed, and recurrence of the infection was diagnosed. The infected spacer was removed, and upon the patient’s request, we abstained from further attempts of reimplantation. An arthrodesis was performed using an external fixation device (Fig. 5).

Remote result on May 22, 2018:
On the right: no signs of inflammation, endoprosthesis function completely restored.
On the left: arthrodesis completed; weight-bearing and walk function achieved (Fig. 6).

The follow-up control performed on May 22, 2021 revealed no evidence of infection recurrence.

At the time of follow-up the patient estimates her condition as satisfactory. No additional surgical procedures or medical rehabilitation required.

3. Discussion

This clinical observation demonstrates the relevance of vacuum therapy in the process of selecting optimal surgical tactics and identifying the possibility of retaining an infected prosthesis.

The proposed approach features both use of a vacuum-assisted dressing and application of an external fixing apparatus for immobilizing and distracting endoprosthesis components upon the extraction of polyethylene inserts.

This procedure helps both monitor the entire periprosthetic cavity and obtain prompt and complete suppression of inflammation.

The use of DAIR shows promise to suppress PJI without resorting to repeated traumatic and expensive surgeries not ensuring, at that, a successful outcome.

The main argument of the opponents is a high risk of secondary infection of endoprosthesis by resistant strains of hospital microflora in the course of the open-wound period of treatment.

From our perspective, the use of vacuum-assisted dressing helps reduce the risk of nosocomial wound infection and increase, therefore, the possibility of prosthetic retention.
4. Conclusion

Treatment of periprosthetic infection is a challenging problem. The future of the implant depends on its sustainability (i.e. well-functioning), condition of surrounding tissues, risk of secondary complications and germ sensitivity to antibacterial treatment.

Retention of infected implant is governed by several necessary conditions, such as radical debridement, recovery of surrounding soft tissues and effectiveness of prolonged antibacterial therapy.

In our opinion, vacuum therapy of periprosthetic wound (NPWT) makes it feasible:

- to prevent secondary nosocomial contamination of the prosthesis;
- to evaluate the implant condition, as well as surrounding bone and soft tissue viability and make a deliberate informed decision on whether endoprostheses can be preserved;
- to promptly reduce the inflammation and, thus, shorten the time before secure wound closure;
- to determine bacterial sensitivity to obtain the target antibacterial therapy before wound closure.

Our experience enables us to assert that the use of NPWT will definitely result in better outcome of infection treatment while preserving the infected prosthesis. Further follow-up in conducting a controlled trial in accordance with the requirements of Good Clinical Practice would make it possible to clearly define the place of NPWT in the scope of treatment of Prosthetic Joint Infections.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Ethical approval

Approved for publication by Local Ethical Committee of V.V.Vinogradov Moscow Municipal Hospital.

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Author contribution

All authors contributed to the study conception and design. Vitaly O. Tsvetkov: Conceptualization as a Surgeon; Project administration; trial in accordance with the requirements of Good Clinical Practice Ethical approval.

Author contribution

- Tsvetkov: Conceptualization as a Surgeon; Project administration; trial in accordance with the requirements of Good Clinical Practice Ethical approval.
- Ivanov: Patient curator, Surgical assistance; Writing - review
- Vladov: Patient curator, Surgical assistance; Writing - review
- Paedist; Writing - review
- Radoslav Moscow Municipal Hospital.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2022.103339.

Declarations of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Guarantor

Vitaly O.Tsvetkov.

Consent

The patient’s signed consent for publication of case report and concerned images has been obtained.

Research registration

(for case reports detailing a new surgical technique or new equipment/technology) Not applicable.