

# Perioperative mortality secondary to a pulmonary embolism during a surgical implantation of the Endo-Exo-Prosthesis: a case report

Marcus Örgel<sup>1\*</sup>, Horst-Heinrich Aschoff<sup>1</sup>, Christian Krettek<sup>1</sup>, Tilman Graulich<sup>1</sup>, Mohamed Omar<sup>1</sup>, Afif Harb<sup>1</sup> and Sulaiman Alazzawi<sup>2</sup>

<sup>1</sup>Trauma Department, Hannover Medical School, Carl-Neuberg-Straße 1, 30625, Hannover, Germany; <sup>2</sup>Orthopaedic Department, UBC Hospital, 2211 Wesbrook Mall, Vancouver, BC V6T 2B5, Canada

## Abstract

We report on a 53-year-old female patient who suffered a perioperative death secondary to a pulmonary embolism (PE) during an implantation of Endo-Exo-Prosthesis. This is a retrospective review of medical case for a patient who had a previous above-the-knee amputation secondary to a failed previous arthroplasty surgery. Our planned surgery was a stage 1 implantation of an Endo-Exo-Prosthesis, and it was performed under general anaesthesia. After 25 min from starting the surgical procedure, the patient sustained a cardiac arrest, and despite an active cardiopulmonary resuscitation for 50 min, the patient did not recover, the ventilator machine was stopped later on, and the patient was declared deceased at that stage. Fatal intraoperative PE is a rare but significant complication during orthopaedic procedures. There are few reports of similar events but include mainly trauma patients with fractured neck of femur. Endo-Exo-Prosthesis is a relatively newly evolved procedure in a unique group of patients. To our knowledge, this is the first case report of such complication during Endo-Exo-Prosthesis implantation. Patient and surgeon should be aware of it, and additional preventive measures like preoperative scoring systems and in special cases using inferior vena cava filter should be considered in patients with high risk of developing venous thromboembolism.

**Keywords** Osseointegration; Transcutaneous Osseointegrated prosthetic systems (TOPSs); Pulmonary embolism; Amputation

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\*Correspondence to: Örgel, Marcus, Trauma Department, Hannover Medical School, Carl-Neuberg-Straße 1, 30625 Hannover, Germany.

Tel: 0049/5115322099; Fax: 0049/5115325877. Email: Oergel.Marcus@mh-hannover.de

## Introduction

Transcutaneous osseointegrated prosthetic systems (TOPSs) have been used as an alternative strategy to the external artificial limbs for patients with limb amputation.<sup>1</sup> This technique is commonly performed as a two-stage surgical procedure in which the implant is surgically impacted in the medullary canal of the femur and extended outwards through the skin.<sup>1,2</sup> The exo-prosthetic component can be connected to the intramedullary shaft, which passes through-out the skin.<sup>2</sup> The technique provides a superior functional outcome and patients satisfaction than does the traditional use of external artificial limb<sup>3,4</sup> (Figure 1). Most of the reported complications associated with this technique were

related to soft tissue irritation and implant loosening. Hereby, we are reporting a case of perioperative death secondary to a pulmonary embolism (PE) during an implantation of Endo-Exo-Prosthesis.

## Case report

This 53-year-old female patient was referred to our tertiary referral centre for consideration of using TOPS implant for her. She has an above-the-knee amputation, which was performed as a result of failed multiple arthroplasty operations. She was initially rehabilitated using an external artificial limb

**Figure 1** Post-operative x-ray image of the left femur following an implantation of Endo-Fix-Stem.



endotracheal intubation. After approximately 25 minutes from starting the surgical procedure and during the last reaming step, a sudden end-tidal CO<sub>2</sub> drop occurred, accompanied by a cardiac arrest; the operation was immediately aborted, and cardiopulmonary resuscitation started. The parameters are shown in *Figure 2*. The resuscitation was performed for 50 min with ventricular fibrillation and amiodarone as per our local resuscitation guidelines. The relevant laboratory values are shown in *Table 1*. The cardiac echocardiography still showed no cardiac activity. After a multidisciplinary discussion, an arteriovenous extracorporeal membrane oxygenation device was implanted and followed by an urgent computed tomography scan of the head and chest (*Figure 3*). The diagnosis of PE was confirmed to be associated with hypoxic brain damage. The patient was declared dead after stopping the ventilator machine at the intensive care unit.

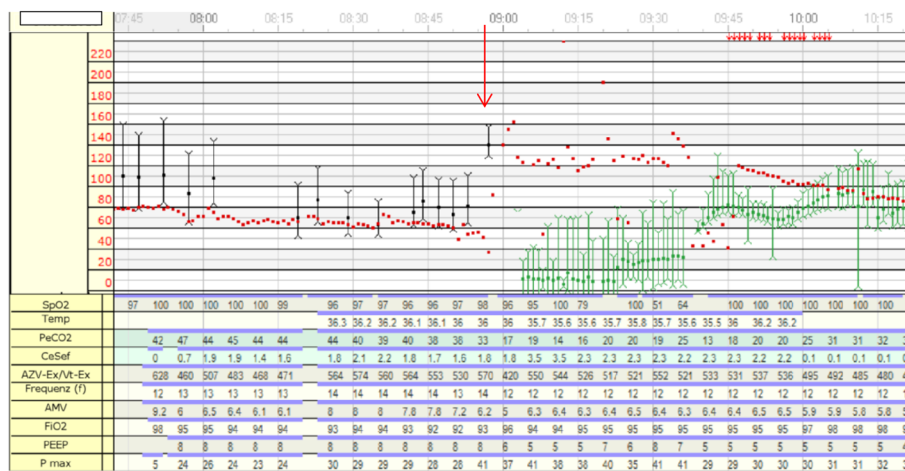
### Discussion

but failed to register any progress with it. Her past medical history also includes Obesity Grade III according to the World Health Organization (body mass index 43.6)<sup>6</sup> and a deep venous thrombosis (DVT) of her left arm a few years ago with unknown underlying cause.

The surgical procedure was performed according to the usual two-stage protocol.<sup>1,2</sup> The first step procedure was performed in a supine position under general anaesthesia with

Various predisposing factors play a role in the development of venous thromboembolism (VTE; *Tables 2 and 3*).<sup>5-7</sup> One possibility in our case is that the PE could have occurred as a result of undiagnosed existing DVT of the deep pelvic veins, as the patient had been immobilized in a wheelchair for a few years. However, we do not have preoperative Doppler ultrasound or magnetic resonance (MR) imaging of the pelvis prior to surgery, and the patient did not undergo post-mortem study. Therefore, it is difficult to confirm this hypothesis. The other potential cause is that the patient may have had an undiagnosed coagulopathy disorder, as she had previous

**Figure 2** Representation of the relevant monitoring parameters from the start of the operation with intraoperative cardiovascular failure (red arrow) with subsequent resuscitation until the extracorporeal membrane oxygenation was set up.



**Table 1** Predisposing factors for the emergence of venous thromboembolism<sup>5,6</sup>

Strong risk factors (odds ratio > 10)
<ul style="list-style-type: none"> <li>• Fracture of the lower extremities</li> <li>• Hospitalization for heart failure or atrial fibrillation/flutter (in the past 3 months)</li> <li>• Hip or knee joint replacement</li> <li>• Severe trauma</li> <li>• Myocardial infarction (in the past 3 months), previous venous thromboembolism, spinal cord injury</li> </ul>
Moderate risk factors (odds ratio = 2–9)
<ul style="list-style-type: none"> <li>• Arthroscopic knee surgery, autoimmune disease, blood transfusion</li> <li>• Central vein catheter, chemotherapy</li> <li>• Heart or lung failure</li> <li>• Erythropoiesis-stimulating substances</li> <li>• Hormone replacement therapy (depending on composition)</li> <li>• In vitro fertilization</li> <li>• Infection (especially pneumonia, urinary tract infection, HIV infection)</li> <li>• Chronic inflammatory bowel disease</li> <li>• Cancer (highest risk for metastasis)</li> <li>• Oral contraceptives</li> <li>• Stroke with paralysis</li> <li>• Puerperium</li> <li>• Superficial venous thrombosis</li> <li>• Thrombophilia</li> </ul>
Low risk factors (odds ratio < 2)
<ul style="list-style-type: none"> <li>• Bed rest &gt; 3 days</li> <li>• Diabetes mellitus</li> <li>• High blood pressure</li> <li>• Immobility due to long periods of sitting (e.g. long car or air travel)</li> <li>• Higher age</li> <li>• Laparoscopic surgery (e.g. cholecystectomy), obesity</li> <li>• Pregnancy</li> <li>• Varicose veins</li> </ul>

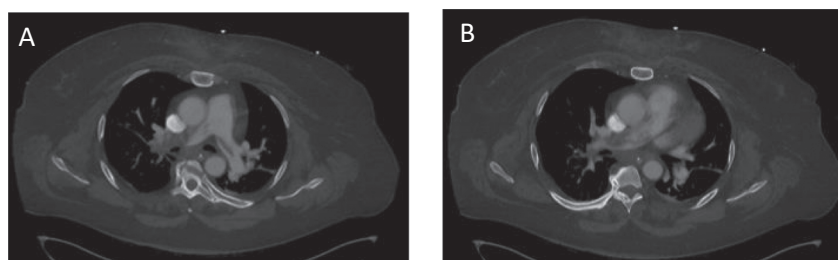
**Table 3** Wells score to assess an existing pulmonary embolism<sup>5,8,9</sup>

Wells score	Points
Clinical signs and symptoms of DVT	1.5
Heart rate greater than 100/min	1.5
Surgery or immobilization in the previous 4 weeks	1.5
Haemoptysis	1
Malignancy (on treatment, treated in the last 6 months, or palliative)	1
Previous DVT/PE	3
Alternative diagnosis is less likely than PE	3
Clinical likelihood for PE	
Three-level score	
Low	0–1
Middle	2–6
High	≥7
Two-level score	
PE unlikely	0–4
PE likely	>5

upper limb DVT, which is a relatively uncommon incident in a healthy individual.

It is also important to notice that the occurrence of minor PE during surgery is not always obvious. The entire process is influenced by anaesthesia and surgery. Possible clinical symptoms such as dyspnoea, haemoptysis, or chest pain are not visible.<sup>5</sup> Therefore, we do not know the percentage of perioperative non-fatal PE, but its occurrence may be more common than we are aware of.

To minimize the risk of PE during surgery, Donaldson *et al.* described five critical surgical steps for the implantation during a total arthroplasty. These include cementation

**Figure 3** (A, B) Computed tomography of the thorax with contrast medium imaging of the central thrombus in the axial layer, from cranial to caudal.**Table 2** Representation of the intraoperative relevant laboratory parameters

	Time/date	Time/date	Time/date	Time/date/ECMO	Time/date
Laboratory parameters	09:05 05/04/2018	09:16 05/04/2018	09:37 05/04/2018	09:47 05/04/2018	10:09 05/04/2018
pH	7.46	7.37	7.18	7.05	7.24
pO <sub>2</sub> , mmHg	132	157	82	397	467
pCO <sub>2</sub> , mmHg	26	31	49	65	39
Lactate, mmol/L	3.2	6.3	11.6	12.3	10.8
Base excess, mmol/L	-4.2	-6.3	-10.0	-12.3	-10.2

ECMO, extracorporeal membrane oxygenation.

of the cavity or shaft, insertion of the prosthesis into the bone, and reduction of the joint and reaming the bone tube, like in our case.<sup>10,11</sup>

Venous thromboembolism events are a serious and potentially fatal complication that should be avoided by sufficient preoperative, perioperative, and post-operative prophylaxis. Therefore, we recommend that all patients undergoing the Endo-Exo-Prosthesis surgery should be assessed using a preoperative questionnaire to categorize the risk of VTE (Table 2).<sup>5–8</sup> Moreover, if their risk profile is increased, assessment should be followed by a preoperative Doppler ultra-

sound of the lower limbs, MR imaging of the pelvis, and perioperative antithrombotic prophylaxis according to the guidelines of the German Association of the Scientific Medical Societies of Thromboembolism. Owing to its associated potential complications, the inferior vena cava filter may only be considered in special circumstances.<sup>12–15</sup>

## Conflict of interest

The authors declare no conflict of interest.

## References

- Aschoff HH, Clausen A, Hoffmeister T. The endo-exo femur prosthesis—a new concept of bone-guided, prosthetic rehabilitation following above-knee amputation. *Z Orthop Unfall* 2009; **147**: 610–615.
- Aschoff HH, Clausen A, Tsoumpris K, Hoffmeister T. Implantation of the endo-exo femur prosthesis to improve the mobility of amputees. *Oper Orthop Traumatol* 2011; **23**: 462–472.
- Schalk SA, Jonkergouw N, van der Meer F, Swaan WM, Aschoff HH, van der Wurff P. The evaluation of daily life activities after application of an osseointegrated prosthesis fixation in a bilateral transfemoral amputee: a case study. *Medicine (Baltimore)* 2015; **94**: e1416.
- Hagberg K, Branemark R. One hundred patients treated with osseointegrated transfemoral amputation prostheses—rehabilitation perspective. *J Rehabil Res Dev* 2009; **46**: 331–344.
- ESC Pocket Guidelines European Society of Cardiology; 2015.
- Konstantinides SV, Torbicki A, Agnelli G, Danchin N, Fitzmaurice D, Galiè N, Gibbs JS, Huisman MV, Humbert M, Kucher N, Lang I, Lankeit M, Lekakis J, Maack C, Mayer E, Meneveau N, Perrier A, Pruszczyk P, Rasmussen LH, Schindler TH, Svitil P, Vonk Noordegraaf A, Zamorano JL, Zompatori M. Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC). 2014 ESC guidelines on the diagnosis and management of acute pulmonary embolism. *Eur Heart J* 2014; **35**: 3033–3080. <https://doi.org/10.1093/eurheartj/ehu283>
- Shahi A, Bradbury TL, Guild GN 3rd, Saleh UH, Ghanem E, Oliashirazi A. What are the incidence and risk factors of in-hospital mortality after venous thromboembolism events in total hip and knee arthroplasty patients? *Arthroplast Today* 2018; **4**: 343–347.
- Wells PS, Ginsberg JS, Anderson DR, Kearon C, Gent M, Turpie AG, Bormanis J, Weitz J, Chamberlain M, Bowie D, Barnes D, Hirsh J. Use of a clinical model for safe management of patients with suspected pulmonary embolism. *Ann Intern Med* 1998; **129**: 997–1005.
- Wells PS, Anderson DR, Bormanis J, Guy F, Mitchell M, Gray L, Clement C, Robinson KS, Lewandowski B. Value of assessment of pretest probability of deep-vein thrombosis in clinical management. *Lancet* 1997; **350**: 1795–1798.
- Pietak S, Holmes J, Matthews R, Petrusek A, Porter B. Cardiovascular collapse after femoral prosthesis surgery for acute hip fracture. *Can J Anaesth* 1997; **44**: 198–201.
- Donaldson AJ, Thomson HE, Harper NJ, Kenny NW. Bone cement implantation syndrome. *Br J Anaesth* 2009; **102**: 12–22.
- Bass AR, Mattern CJ, Voos JE, Peterson MG, Trost DW. Inferior vena cava filter placement in orthopedic surgery. *Am J Orthop (Belle Mead NJ)* 2010; **39**: 435–439.
- Patel G, Panikkath R, Fenire M, Gadwala S, Nugent K. Indications and appropriateness of inferior vena cava filter placement. *Am J Med Sci* 2015; **349**: 212–216.
- Ha CP, Rectenwald JE. Inferior vena cava filters: current indications, techniques, and recommendations. *Surg Clin North Am* 2018; **98**: 293–319.
- Patel NN, Avlonitis VS, Jones HE, Reeves BC, Sterne JA, Murphy GJ. Indications for red blood cell transfusion in cardiac surgery: a systematic review and meta-analysis. *Lancet Haematol* 2015; **2**: e543–e553.