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HOW TO DO IT

Off-pump hemostasis for left ventricular rupture after myocardial infarction with Hydrofit® and Surgicel®

Hikaru Ishii[1] · Hidehito Endo[1] · Hiroshi Tsuchiya[1] · Yusuke Inaba[1] · Katsunari Terakawa[1] · Hiroshi Kubota[1]

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Abstract

Left ventricular free wall rupture (LVFWR) is a catastrophic complication of myocardial infarction. In these cases, cardiopulmonary bypass (CPB) should be performed for left ventricular repair, but can impact hemodynamic stability. An 87-year-old man presented with acute shock. He was diagnosed with LVFWR after myocardial infarction. We describe a simple, effective, and reproducible technique to achieve hemostasis at the LVFWR site during emergency operation using Hydrofit® and Surgicel® surgical hemostatic agents. We simply placed and manually pressed the Hydrofit® and Surgicel® composite on the bleeding site. This technique provides complete hemostasis without CPB establishment.

Keywords Acute myocardial infarction · Left ventricle rupture · Off-pump hemostasis

Introduction

Myocardial infarction complicated by left ventricular free wall rupture (LVFWR) remains a catastrophic condition associated with high mortality rates. Despite the introduction of newer and improved surgical strategies, complete hemostasis remains challenging. Moreover, cardiopulmonary bypass (CPB) is mandatory during emergency left ventricular repair. Normally, sufficient time is required to establish CPB. During this manipulation, hemodynamic stability may be lost. We successfully repaired LVFWR in a patient using a simple, effective, and reproducible technique without CPB.

Case and technique

An 87-year-old man with acute shock was referred to our hospital because of severe chest pain. Blood and serum testing showed the following results: creatinine kinase isoenzyme MB level 1.8 ng/mL, troponin T level 3416.5 ng/mL, and B-type natriuretic peptide level 145.7 pg/mL. His electrocardiogram demonstrated normal sinus rhythm with ST elevation in V2–V4 leads. The echocardiogram showed a massive fluid around heart. The computed tomography (CT) scan also demonstrated a massive fluid in the whole pericardial circumference (15 mm) (Fig. 1a). An emergency coronary angiogram showed 100% stenosis of the left circumflex coronary artery (Fig. 1b). The patient was in cardiogenic shock with a blood pressure of 80/52 mmHg; hence, he was intubated without cardiopulmonary support. We decided to perform emergency surgical intervention.

Surgical technique

The pericardium was opened after median sternotomy. Bleeding and the infarcted area were found in the left ventricular wall next to the posterolateral branch of the circumflex artery after removing the massive hematoma from the pericardium. Excessive "pulsatile" spurting bleeding was detected from the infarcted, ruptured site of the left ventricular free wall. Although controlling the bleeding was difficult,

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✉ Hikaru Ishii
hikaru3@dg8.so-net.ne.jp

[1] Department of Cardiovascular Surgery, Kyorin University, 6-20-2 Shinkawa, Mitaka, Tokyo 181-8611, Japan

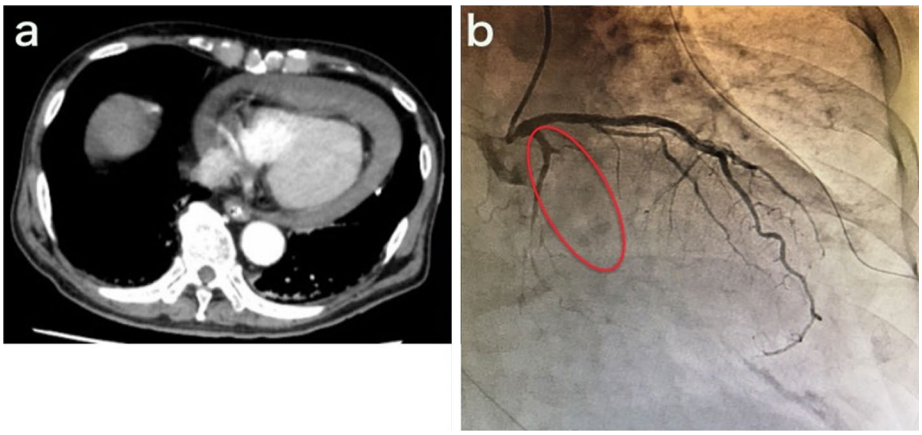

Fig. 1 **a** Chest computed tomography scan demonstrating massive cardiac tamponade. **b** The coronary angiogram revealing 100% left circumflex coronary artery stenosis

we decided to use the Hydrofit® (Sanyo Chemical Industries, Kyoto, Japan) and Surgicel® (Ethicon, Inc., Somerville, NJ, USA) surgical hemostatic agents, as described below.

First, a flat, square working area next to the heart was designated. Second, a surgical towel, sealant, accessory rectangular transparent silicone seat, and Surgicel® were arranged (Fig. 2a). Third, a piece of Surgicel® measuring approximately 2 cm^2 in size was prepared. Fourth, on the flat surgical field, the accessory transparent silicon seat was placed on the surgical towel. Fifth, the square of Surgicel® was stacked on the transparent silicon seat. Sixth, a moderate amount of Hydrofit® sealant was applied to the Surgicel® (Fig. 2b). Seventh, this composite was placed and manually pressed on the bleeding site. Eighth, rough hemostasis was achieved after waiting for 3 min (video 1). Finally, horizontal mattress sutures were placed repeatedly on the left ventricle wall with polypropylene felt strips measuring approximately 1.5 × 5 cm to clamp the bleeding site in order to achieve complete hemostasis and to prevent pseudoaneurysm formation (Fig. 2c, d). We sufficiently clamped the bleeding site. Additionally, no pseudoaneurysm was observed on postoperative CT on the 21st postoperative day (video 2).

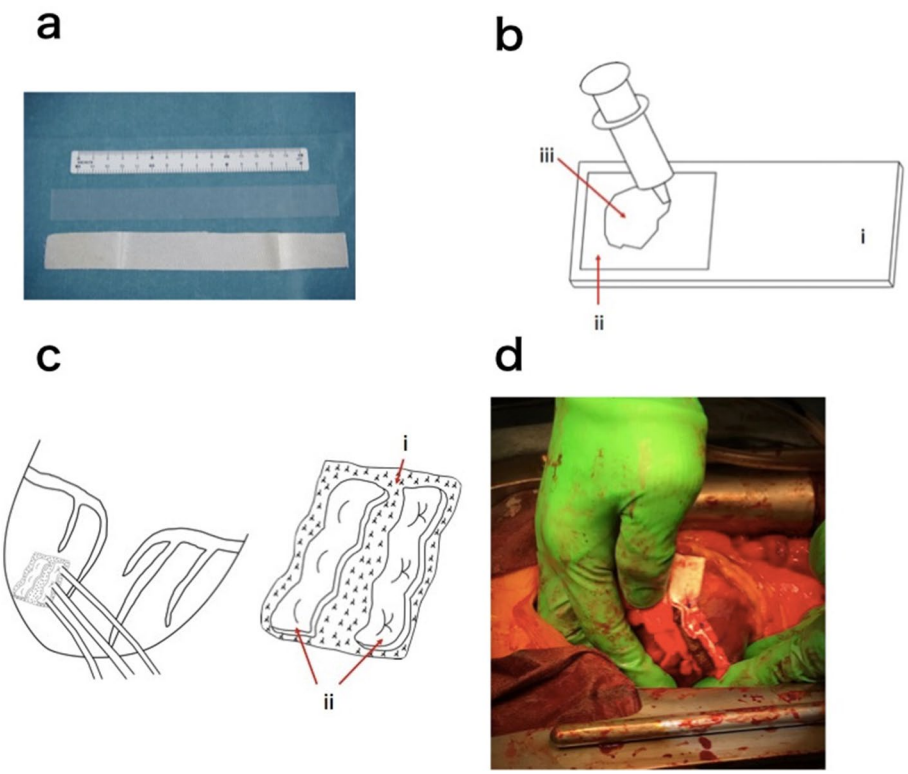

Fig. 2 **a** (from top to bottom): The measurement scale, silicon seat, and a piece of Surgicel® measuring approximately 2 cm^2 in area. **b** (i) The silicon seat, (ii) Surgicel®, (iii) the amount of sealant. **c** (i) Composite seat made from the Hydrofit® and Surgicel® and (ii) polypropylene felt strip. **d** Hemostasis was achieved after approximately 3 min. Subsequently, a horizontal mattress suture was placed repeatedly in the left ventricle with polypropylene felt strips measuring approximately 1.5 × 5 cm to clamp the bleeding site

Discussion

We performed a simple, effective, and reproducible technique for LVFWR after myocardial infarction. The Hydrofit® sealant was reinforced with Surgicel®, since Surgicel® is capable of holding or containing water or blood [1]. Meanwhile, Hydrofit®, a recently developed surgical sealant by Sanyo Chemical Industries (Kyoto, Japan), has an affinity towards water. Hydrofit® sealant is formed by a reaction between a copolymer of poly (ethylene glycol) (PEG) and poly (propylene glycol) (PPG) [weight ratio 80 weight percentage (wt%) of PEG, 20 wt% of PPG, molecular weight: approximately 4×10^3 g/mol] with fluorinated hexamethylene diisocyanate. The synthetic sealant is a viscous liquid with high water uptake. During this process, crosslinks and polymerization reaction with fluorinated hexamethylene diisocyanate occurs with water. Therefore, Hydrofit® enhances hemostasis by water absorption and adheres tightly to the target tissues [2]. Thus, in the presence of water, Hydrofit® is more therapeutic than other clinically used surgical adhesives or glues, such as fibrin glue or Bioglue® (CryoLife Inc., Kennesaw, GA, USA). In contrast, Surgicel® is a bioabsorbable hemostatic sheet, composed of oxidized cellulose polyanhydroglucuronic acid, which is also capable of holding or containing water or blood at the anastomotic site. Therefore, Hydrofit® was reinforced with Surgicel®. In addition, the combined unit was not stiff; hence, additional sutures for hemostasis could be easily placed if needed.

Acute LVFWR is classified into two different types: the "blow-out type" and "oozing type" (i.e., slow rupture type). Conventionally, LVFWR is surgically repaired by infarctectomy and direct mattress suture reinforced with Teflon felt using CPB. In this procedure, the suture line must be placed within non-infarcted area. The suturing on infarcted and necrotic site of left ventricle wall results in re-rupture of left ventricle or incomplete hemostasis. On of the most important process during surgical intervention for LVFWR is getting stabilization of hemodynamics as early as possible. Therefore, our technique can be suitable for both types of LVFWR, "blow-out type" and "oozing type". However, this procedure is not suitable for post-infarction ventricular septal defects.

In conclusion, we performed and described successful repair of cardiac rupture after a myocardial infarction with a simple, effective, reproducible technique without CPB. This technique may be useful for patients in whom CPB cannot be used.

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Compliance with ethical standards

Conflict of interest Hikaru Ishii, MD, Hidehito Endo, MD, Hiroshi Tsuchiya, MD, Yusuke Inaba, MD, Katsunari Terakawa, MD, and Hiroshi Kubota, MD declare that they have no conflict of interest.

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