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Research Article

Knotless Closure of the Cardiac Venous Cannulation Site Using Barbed Suture: A First Step in Including Barbed Sutures in our Cardiac Surgery Practice

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ABSTRACT

Background: Barbed sutures have rarely been used in cardiac surgery. The reason is the absence of safety and feasibility data. This study was set up to assess the safety and efficacy using barbed sutures for right atrium cannulation-site closure both in short and longer-term follow up.

Methods: Ten patients undergoing routine CABG through sternotomy with the use of ECC were included after giving written informed consent. After performing CABG, closure of the venous cannulation site at the right atrium is performed, using Stratafix® 2/0 non-resorbable, spiral polypropylene (SXPL1B400), without knotting.

Results: No postoperative bleeding complications or revisions for bleeding or tamponade were noted. No complications or major adverse cardio-cerebrovascular incidents were registered during follow-up. The relevance of this lies in the difficulty in tying timely knots, even in experienced hands, during scopic or minimally invasive procedures. Being able to avoid this cumbersome procedure would largely reduce time spent on tying knots (the single most efficient time reducing step in minimally invasive cardiac surgery).

Conclusion: Using knotless barbed sutures with an additional self-locking manoeuvre is feasible for the closure of the right atrium cannulation site in cardiac surgery, with no short-term or long-term complications. This opens up possibilities using knotless barbed sutures safer in minimally invasive cardiac surgery. This study confirms barbed knotless sutures perform adequately when closing a low-pressure cardiac structure, and in such, potentially saving time in minimally invasive surgery. Further investigation in closure of other cardiovascular structures is advisable and are planned by the authors.

Visual Abstract

Are knotless barbed sutures feasible for closing right atrium cannulation-site, both in short and longer-term follow up? No infectious complications or major adverse cardio-cerebrovascular incidents were registered during follow up. Knotless barbed sutures are feasible for the closure of the right atrium cannulation site, with no short-term or long-term complications.

Introduction

A barbed suture is a monofilament suture with barbs cut out on its surface (Figure 1), designed to be used without knotting, initially mostly used in Aesthetic surgery [1]. Barbs are cut out on one or more sides of the thread or in a spiral motion around the thread, in a bi- or monodirectional fashion, depending on the manufacturer. The tension on the suture is distributed through every barb, which gives its fixation in tissues without knotting. Barbed sutures are becoming omnipresent in many surgical specialties [1-4]. Their ease-of-use, flexibility and their ability to be used without knots make them ideal for minimally invasive surgery.

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Indeed, performing knots in narrow spaces is cumbersome and time-consuming. For this reason, this type of suture became one of the main options for laparoscopic anastomosis in general surgery [1-4]. In spite of these advantages, barbed sutures have never been used in cardiac surgery, let alone in minimally invasive cardiac surgery. The reason for this is the absence of safety data. This pilot study was set up to assess the safety and efficacy of the use of barbed sutures for right atrium cannulation-site closure both in short and longer-term follow up.

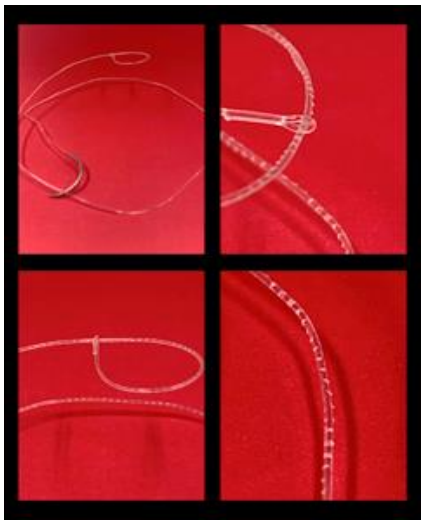

Figure 1: Close-up of Stratafix® 2/0 non-resorbable, spiral polypropylene (SXPL1B400) which clearly shows spiral barbs and its intended knotless use through its design.

Objective

The primary goal of this study was to determine the safety and efficacy properties of knotless barbed sutures when closing the venous cannulation site in cardiac surgery through sternotomy. The study suture is a Stratafix® 2/0 non-resorbable, spiral polypropylene (SXPL1B400) (Ethicon, Johnson and Johnson, Somerville, New Jersey, USA).

Primary endpoint was safety, as measured by the need for reoperation for bleeding or tamponade. Secondary endpoints were major adverse cardiovascular events (MACE). MACE was defined as the composite of total death, myocardial infarction, coronary revascularization, stroke, and hospitalization because of heart failure [5].

Methods

I Inclusion

All patients over 18-year-old and able to provide written informed consent who were presenting for elective Coronary Artery Bypass Grafting (CABG) through sternotomy were eligible for this study. The sole exclusion criterion was concomitant valvular surgery.

II Procedure

Preoperative assessment and trajectory did not divert from our routine practice, including transthoracic echocardiography, blood analysis, coronary angiogram, chest x-ray and clinical examination. Our routine CABG procedure is commenced by harvesting all graft material, be it full arterial or combined venous-arterial grafting.

After heparin is administered and an activated clotting time (ACT) of more than 480 seconds is reached, extracorporeal circulation (ECC) is initiated after cannulation of the ascending aorta and the right atrium. Purse-string sutures (Prolene® 3-0, polypropylene, Ethicon) are used on both sites to protect and stabilize the arterial and venous cannula. After performing CABG, perioperative intervention consisted of weaning from ECC. Followed by removal of the venous cannula, control of the bleeding from the right atrium through tightening, but not knotting, of the purse-string suture, placed prior to inserting the venous cannula. Thereafter closure of the venous cannulation site at the right atrium is performed, using Stratafix® 2/0 non-resorbable, spiral polypropylene (SXPL1B400). As an extra precaution we used an additional self-locking maneuver when closing the cannulation site as described by De Decker *et al*. [4]. Gradually, the purse-string suture was released and then completely removed to depend solely on the closure by the spiral polypropylene. When necessary, additional hemostatic measures were taken, after the correction of the ACT: for example, additional hemostatic stitches or the application of a small size Tachosil® (Baxter). All interventions were performed under direct vision and maximum control of the surgical site (Figure 2).

Figure 2: Venous cannulation site closed with Stratafix® 2/0 non-resorbable, spiral polypropylene (SXPL1B400), using an additional self-locking maneuver as safety.

The postoperative course did not divert from our routine practice: which consists of routine daily clinical examinations, analgesia, blood analysis, removal of surgical chest tubes, removal of temporary pacemaker wires and chest x-rays and at discharge consist of a routine transthoracic echocardiography, clinical assessment, a final chest x-ray and blood analysis. On discharge, all patients were included in our regular follow up after CABG with an additional study related follow up after six months.

Results

Ten patients undergoing routine CABG through sternotomy with the use of ECC were included after giving written informed consent. We determined the inclusion of ten subjects would suffice to prove safety

and efficacy [6-8]. Eight patients were male. Mean age was 67 years with a standard deviation (SD) of 6.50, median age was 68, mean BMI 27.72 (SD +/- 2.57), mean Euroscore II was 1.38 (SD +/- 0.62, median 1.47), mean length of stay was 8.6 (SD +/-2.01, median 8.5) days. Additional perioperative hemostatic interventions were performed in 2 patients (both female) with the application of a small Tachosil® (Baxter) for stitch hole leaks. No postoperative bleeding complications or revisions for bleeding or tamponade were noted. No infectious complications or major adverse cardio-cerebrovascular incidents were registered during follow up.

Discussion

Establishing the safety of barbed sutures in cardiac surgery through sternotomy would enable cardiac surgeons to use knotless barbed sutures confidently in minimally invasive procedures. The relevance of this lies in the difficulty in tying timely knots, even in experienced hands, during scopic procedures (e.g., laparoscopy [9]). Indeed, Jernigan *et al*. describe an *in vitro* model comparing a laparoscopic knot-tying device for minimally invasive cardiac surgery to conventional laparoscopic tools, in which mean knot-tying times were 246 ±116 seconds for conventional knotting [10]. Being able to avoid this cumbersome procedure would largely reduce time spent on tying knots (the single most efficient time reducing step in minimally invasive cardiac surgery), and potentially eliminate the surgeon's frustration score concerning tying minimally invasive knots [11]. This could also potentially result in reducing ECC and cross clamping time, which would benefit the patient.

The use of knotless barbed sutures in cardiovascular surgery is hampered by the unease of the surgeon using this type of suture when closing cardiac chambers or structures. The knotless nature of the suture could be a cause for bleeding when failing under pressure. We countered this issue by using an additional self-locking maneuver when finishing up the atrial closure (Figure 3) [4]. This gave a strong adhesion of tissue and suture in which we confided [12]. Overall results were excellent.

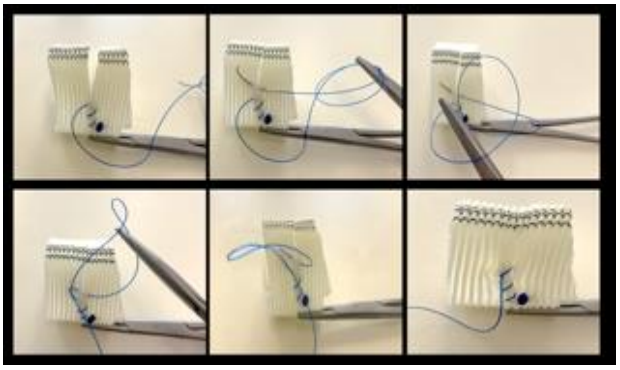

Figure 3: Visualization of the stitch used to 'lock' the barbed suture in place. (Use of novel 3/0 suture for contrast – same principle applies).

In two patients, both female, additional Tachosil® (Baxter, CA, USA), was applied because of bleeding from a few stitch holes. The reason for the additional application is to be found in the use of the 2/0 Stratafix with a broader-than-thread needle in more fragile tissue. This is a technical issue which can be resolved by making other combinations of thread and needle available. In our general practice, a round, as-broad-as-thread, needle is used for this type of tissue to minimize bleeding from stitch holes. The Stratafix® 2/0 non-resorbable, spiral polypropylene (SXPL1B400) was the thinnest non-resorbable suture available to us. We foresee no issues when using appropriate round body needles, even in fragile tissue. In future, a 3/0 non-resorbable, spiral polypropylene will be available to us and will replace the 2/0.

Conclusion

Using knotless barbed sutures with an additional self-locking maneuver is feasible for the closure of the right atrium cannulation site in cardiac surgery, with no short-term or long-term complications in this population. This opens up possibilities of using knotless barbed sutures in minimally invasive cardiac surgery. This is the first study confirming barbed knotless sutures are feasible in closing heart chambers and perform adequately when closing a low-pressure cardiac structure, and in such, potentially saving time in minimally invasive surgery. Further investigation in closure of cardiovascular structures with a higher pressure or longer incision are advisable.

Ethical Approval

This study was approved by the Ethical Comity of the Antwerp University Hospital on 20/07/2020. Registration number B3002020000129.

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