Early Experience with a New Aortic Clamping System Designed for Port Access Cardiac Surgery: The PortaClamp

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ABSTRACT

Background: We report a clinical study to demonstrate the feasibility and safety of a new aortic crossclamping concept for use in port access cardiac surgery. The limited access to the aorta in minimally invasive cardiac surgery mandates specific clamping modalities, which entail specific limitations, drawbacks, and costs. Therefore a new autoguided, extravascular, and atraumatic clamping system (PortaClamp) was developed to facilitate port access surgery while potentially avoiding the complications and costs inherent to endoluminal clamping or “blind” crossclamping.

Methods: Twenty patients underwent various cardiac operations under cardiopulmonary bypass and aortic crossclamping with the PortaClamp between February and September 2003. The method of aortic clamping is described and the operative course and clinical outcome of the patients are reported as surrogates of feasibility and safety.

Results: The average time to position the clamp was 196 ± 75 seconds. Crossclamping through a 10-mm port or incision was achieved successfully, enabling cardiac arrest throughout the procedure in every patient. No patient presented with cardiovascular accident or transient ischemic attack, aortic dissection, or hematoma. Intensive care unit times were 12 ± 3 hours; length of stay was 7.2 ± 1.1 days.

Conclusion: From this early experience we conclude that the PortaClamp system is safe and can effectively be used to crossclamp the aorta inexpensively to facilitate port access cardiac surgery. Further comparative studies with the existing systems are warranted to confirm that the atraumatic design provides further benefit.

INTRODUCTION

Despite increasing evidence that port access surgery is a beneficial option in numerous indications [Casselman 2003], its rate of adoption remains low in the surgical community. This situation has multiple causes.

First, most of the operations can be performed with satisfactory results through sternotomies. It is difficult to demonstrate much incremental added value to the existing mature and efficient procedures, such that the benefits of port access are regarded by some surgeons as marginal or insufficient to change their practice in the absence of large-scale randomized studies.

Second, cardiopulmonary bypass and cardiac arrest themselves require experience and carry inherent risks and costs [Wimmer-Greinecker 1999] in the port access environment. Thus the additional investment in time and energy in the development of the skills required by the port access technique itself for a given intervention (eg, mitral repair, atrial septal defect closure) is regarded by many as a step back. If femoral cannulation can easily be performed, aortic crossclamping and cardioplegia delivery are made awkward by the limited access to the ascending aorta.

These disadvantages have led to the design of purpose-built devices. Aortic clamping is performed either with an endovascular balloon (Endoclamp Cardiovations; Ethicon, Cornelia, GA, USA or Remote Access Perfusion cannula; Estech, Danville, CA, USA) or with the Chitwood clamp (Scanlan International, St. Paul, MN, USA) [Aybeck 2000]. The endovascular balloons necessitate continuous monitoring, may generate specific life-threatening complications, and are associated with a significant increase in operative cost [Wimmer-Greinecker 1999]. The Chitwood clamp represents a cost-effective and readily available alternative but requires a remote and partially blind maneuver to crossclamp the aorta, a procedure that carries the risk of injuring a cardiac structure without direct access to bail out. Because of these drawbacks, an alternative clamping system has been designed to enable safer, easy, and steady extraluminal crossclamping of the aorta with the objective of avoiding the specific difficulties and risks of the existing systems. Here we describe the PortaClamp and report our early clinical experience with this device.
METHODS

Between February and September 2003, 20 patients underwent various cardiac procedures on cardiopulmonary bypass with aortic crossclamping and cardioplegia (Table). We report the surgical procedure, operative times, and patient outcomes. All patients provided written informed consent in concordance with a protocol approved by the ethics committee of Erasme Hospital at Brussels University.

Surgical Procedures

With the patient under general anesthesia with trans-esophageal echocardiography (TEE) monitoring, a sternotomy (n = 4), ministernotomy (n = 3), or right anterolateral minithoracotomy (n = 13) is performed and cardiopulmonary bypass instituted either centrally or peripherally. A 5-mm port (Thoracoport, US Surgical, Norwalk, CT, USA) is positioned in the 2nd or 3rd intercostal space laterally behind the anterior axillary line. The PortaClamp guidewire is inserted through this port in the transverse sinus through a small (2-3 cm) pericardial incision between the aorta and the superior vena cava (SVC) (unless the pericardium had been widely opened in the case of central cannulation). The guidewire is pushed into the sinus (eventually with the help of a forceps in the vicinity of the SVC) perpendicularly to the axis of the aorta, until it pops up along the anterior aspect of the pulmonary artery (PA) and aorta (Figure 1). The proximal end of the guidewire is retrieved and pulled back through the same port with a shafted forceps while the distal end is pushed forward. At this point in time the guidewire encircles the aorta and pulmonary artery and the Thoracoport is eventually withdrawn (Figure 1). After cardiopulmonary bypass is instituted, 2 clamping jaws are inserted sequentially in front of and behind the aorta. Those clamping jaws follow the guidewire as they present with an axial lumen in which the 2 free ends of the guidewire are threaded (Figure 2). The clamping jaws are pushed freely around the aorta, and eventually also around a part of the PA without risk of damaging any cardiovascular structure. A marking shows the surgeon that the clamping position has been reached. A cylindrical squeezing tube (Figure 3) is placed around the 2 clamping jaws and gently slid toward the aorta until it reaches a stop, to crossclamp the vessel (Figures 4 and 5). The guidewire does not play any role in the clamping mechanism and is left loose to avoid a strangulation effect of the PA. The unclamping is performed by gently withdrawing the squeezing tube. The jaws have been designed to ensure a homogenous clamping force and pressure along the clamping area and to avoid the "crab forceps effect," which is encountered with the Chitwood clamp and other external clamps. A broader and smoother clamping surface enables the delivery of a smaller clamping pressure to the aortic wall for any given clamping force.

Antegrade cardioplegia was delivered through a regular cardioplegic needle (DLP standard aortic root cannula;...
Medtronic, Tolochenaz, Switzerland) that was eventually inserted through the working incision: small anterolateral thoracotomy or sternotomy. The needle was secured by a purse string pledgetted suture and a tourniquet. No bleeding occurred at the puncture site.

RESULTS

Four cases were performed with sternotomy in order to verify the adequacy of the clamping function with the ability to convert the procedure in the event of a device malfunction or complication such as aortic hematoma or dissection. The next 16 cases were performed through right minithoracotomies (n = 13) or ministernotomies (n = 3). The time to position the clamp, including the port placement, pericardial incision, guidewire, and jaws insertion and clamping decreased steeply from 370 to 127 seconds with increasing experience (mean 196 ± 75 seconds). Satisfactory crossclamping, as demonstrated by a complete heart arrest throughout the entire clamping period, was achieved in every single case without need for repositioning. In only 1 case a recurrence of some electrical activity during crossclamp occurred and mandated reiteration of antegrade cardioplegia. The completeness of occlusion was further verified by direct vision in cases of proximal aortotomy (4 aortic valve replacement and 3 coronary artery bypass grafts necessitating proximal venous anastomosis performed on the crossclamped aorta). TEE and visual inspection of the aortic clamping site at the end of operation showed no lesion or even marking of the aortic wall at the site of clamping. All the patients recovered uneventfully. No complications occurred in this group, namely no patient experienced transient ischemic attack or stroke. Mean intensive care unit stay was 0.7 ± 0.5 days, mean length of hospital stay was 7.2 ± 2.1 days.

COMMENT

The present pilot study shows that port access aortic crossclamping is feasible, stable, and reproducible with the new dedicated PortaClamp system. This procedure does not generate undue morbidity.

The clamping maneuver is safe, fast, and easy and does not require a long learning process. To the best of our knowledge it has been reported only once in the literature as a technology enabling a new minimally invasive approach to aortic valve replacement [Gersak 2003].

The limited access to the aorta in port access cardiac surgery has mandated the design of new clamping modalities because the insertion of a “classical” clamp was impossible. New technologies developed include endoluminal clamping systems and the Chitwood clamp. Those systems have demonstrated their usefulness and validity as platforms enabling port access cardiac surgery [Casselman 2003], but they carry specific complications and drawbacks.

The endoaortic clamping mode entails specific risks for the benefit of exerting its action without necessitating a direct intrathoracic introduction. Those specific risks are rupture of the dedicated aortic cannula (Heartport), endoclamp balloon rupture, balloon migration toward the left ventricle or toward the brachiocephalic trunk, and aortic dissection. Besides those specific risks, which are due to the catheterization technique, there is a risk of particulate embolism into the systemic circulation as in any clamping modality [Barbut 1994].

Balloon rupture is an event that is reported in almost every Heartport series [Hesselvik 1999]. The consequence of a bal-
Aortic dissection may be the Achilles heel of endovascular clamping; the incidence of this rare but catastrophic complication of endovascular clamping has been part of the driving force to develop an alternative such as the PortaClamp. The endoaortic balloon can migrate and occlude the brachiocephalic trunk [Grocott 1998, Schneider 1998]; the monitoring of this complication, requires specific invasive insertion of an intraarterial catheter which may provoke ischemia to one hemisphere of the brain, or atheromatous plaques and trigger aortic dissection.


REFERENCES


