AORTO-GRAFT ANASTOMOSIS WIHOUT AORTIC CLAMPING

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Background: ***Abdominal aortic surgery requires a period of aortic cross clamping for aort--graft anastomosis. Abdominal aortic clamping and unclamping are associated with several hemostatic and metabolic changes that represent a great danger to the patients. Aortic clamping has been avoided in cardiac surgery by many devices during off pump coronary bypass surgery.***
Aim of the study: ***Anew device was used to do abdominal aortograft anastomosis without aortic clamping. The aim was to study the feasibility of the technique and avoiding all the changes that occur due to aortic cross clamping and unclamping.***
Methods and materials: ***Aorto-graft anastomosis was done in dogs as an experimental study in the animal laboratory. Graft was anastomosed to the intact aorta without interruption of the flow, then by the use of this new device a rounded stoma was made and a functioning graft was establshed. .Aorta -aortic jump bypass, aortofemoral, aortobifemoral, aortorenal bypasses, and aortocaval shunt were done.***
Results: ***The procedure was done easily and all grafts were functioning. There were some bleeding problems due to needle puncture during suturing the graft to the intact aortic wall. Simple compression and additional sutures helped in hemostasis. Graft thrombosis occurred in an aortorenal bypass, a single limp of aorto-bifemoral graft and aorto-caval shunt.***
Conclusion: ***Abdominal aortic graft anastomosis could be done without clamping using this new device.It will help in eliminating changes occurring due to clamping and unclamping.It will be a dual benefit to both the patients and the anesthesia team in surgery of the abdominal aorta.***

Keywords: Aortic surgery – Non Clamping Technique – Complication of Aortic Clamping

INTRODUCTION

Abdominal aortic surgery may be required for atherosclerotic occlusive disease or aneurysmal dilation. Atherosclerotic disease is rarely limited to one part of the arterial tree[1]. The prevalence of coexisting disease particularly angina 20%, congestive hear failure 15%, previous myocardial infarction 18%, silent myocardial ischemia 60%, hypertension 60%, chronic obstructive pulmonary disease 50%, diabetes mellitus 12% is well documented [2] and can be used to effectively guide preoperative evaluation.

The perioperative mortality for aortic surgery (2-4%) remains higher than that reported for all patients undergoing a variety of surgical procedures (.2.4%)[3-4-5]. Myocardial infarction alone is responsible for up to 70% 0f mortality associated with aortic surgery [6].

Abdominal aortic surgery requires a period of aortic cross-clamping either infrarenal or more proximal site for abdominal lesions extending above the renal arteries. Abdominal aortic cross clamping and unclamping are associated with severe hemostatic disturbances in almost all organ systems [7-9]. Major physiological problems that result include left ventricular failure [10], ischemia or hypoperfusion of the kidneys, spinal cord [11], abdominal viscera [12], and accumulation of the metabolites in ischemic tissues below the clamp. In addition, release of mediators from ischemic and reperfused tissues below the clamp may reduce or aggravate the harmful effects of cross clamping on the kidney, lung, spinal cord and abdominal viscera[1316].

Metabolic changes occur during aortic cross clamping also influence the hemodynamic alterations[17]. These include metabolic acidosis, increase renin activity, increase adrenaline and noradrenaline concentration, secretion of prostaglandin E[18], increase thromboxane A2 and its stable metabolite Thromboxane B2 that contribute to with the released myocardial depressant factor from ischemic pancreas to myocardial depression [19-21]. There is also release of endotoxin and tumor necrosis factor from ischemic bowel that may contribute to lung injury [22].

Reactive hyperemia is an important component of aortic unclamping. This contributes to hypotension , myocardial dysfunction and renal vasoconstriction[23-25]. Ischemia reperfusion insult to the kidney plays a central role in the pathogenesis of renal failure associated with aortic surgery. Aortic cross clamping affect both renal perfusion and blood flow distribution. Acute tubular necrosis, a 30% decrease in cortical blood flow, and increased vascular resistance[26] have all been experimentally demonstrated.

Anesthesia management plan should consider all these changes and take the proper techniques and precautions to face and prevent the adverse effects of these changes during abdominal aortic surgery [27-28].

Since the development in the coronary artery bypass surgery during off pump or beating heart, designs are renewed to eliminate the need for partial or complete clamping of the aorta. Hereby it is time to rethink the way bypass surgery is performed. Technological evolution focused on accommodating sutures with the advent of aortic connector device. It is a mechanical device that allows the cardiac surgeon to attach the saphenous vein graft to the aorta without sutures [29-31]. Later cardiothoracic surgeons of Cleveland clinic performed the first beating heart bypass procedure using the Enclose device [32]. This system is a very simple innovative device that allows the surgeon to perform a complete off pump CABG without aortic cross clamping of the ascending aorta. The device creates a small bloodless field, enabling the surgeon to perform a proximal anastomosis with the standard surgical technique.

In this era of non-clamping techniques [33-36], This study was conducted to apply such principal in abdominal aortic graft anastomosis. A special device was made to do aorto-graft anastomosis without aortic cross clamping. The aim is to eliminate all the changes occurred due to clamping and unclamping of the abdominal aorta. It is an experimental study in dogs using an animal model of this new device to create aorto-graft anastomosis without aortic clamping. The procedure was tried first in the vascular laboratory on simulators and modification of the device was done after many trails till the final design was done and applied on animals.

MATERIAL AND METHODS

A new device was used in this study to do aortograft anastomosis in dogs without aortic clamping. Ten dogs were included in this study with their body weight ranges from 27 to 35 kg. Each was operated upon with a first step of aorto-graft anastomosis. Different bypasses were done including aorto-aortic jump bypass, aortofemoral bypass, aorto-renal bypass, aorto-bifemoral bypass and aorto-caval shunt with dacron 8mm graft. Technical results were evaluated by clinical examination, presence of distal pulses, intraoperative doppler examination, and angiography in some cases. Post mortem examination of the aortic graft segment was studied to evaluate the technique.

The new device (nonclamping aortic anastomosis device (NAAD device):

It is a stainless steel device (designed by the author) which consists of two main pieces. An outer part is the sheath, which is put inside the graft to protect the suture line. An inner part is the aortic knife that is introduced inside the first piece to make a suitable stoma in the aorta to create a functioning graft. There is a shoulder in the first piece to prevent progression of the aortic knife in the aorta that might injure the posterior aortic wall during the procedure. There are two more small rings to control the length of the aortic knife according to the size of the aorta. The first two pieces fit inside each other leaving no space between them. The diameter of the sheath is .5mm less than the diameter of the graft used for anastomosis (Fig.1-2).

Surgical technique:

Under general anesthesia, intravenous thiopental one gm diluted in 20-ml saline was used as shots during the procedure. A midline incision is made and aorta is exposed just below the renal arteries. Clearing of the anterior and lateral wall of the aortic segment that will be used for graft anastomosis. The graft 8mm gelatin coated dacron is sutured to the aorta with 5/o proline and needle hole bleeding is secured by simple compression. The outer piece (sheath) is introduced inside the graft and then the aortic knife inside the sheath. By a steady rotatory movement, the knife is made to hug the shoulder of the sheath thus a rounded stoma is made and the graft becomes functioning. The device is removed and the graft flow is controlled by hand. Flushing is done and heprin saline is injected before application of a vascular clamp on the graft. The details of the operative procedure are illustrated in (Fig 3-4-5-6-7).

To test graft patency, different bypasses were done, aorto-aortic jump bypass (Fig 8), aorto-femoral bypass (Fig .9), Aortorenal bypass (Fig. 10), aorto-bifemoral bypass (Fig. 11) and aorto-caval shunt with dacron graft (Fig. 12).

RESULTS

The technique was successful in all cases with very good pulse in the aortic grafts. Distal pulse were well felt after aorto-aotic jump bypasses, aorto-femoral and Aorto-bifemoral bypasses. A palpale thrill was felt after aorto-caval shunt but later it disappeared due shunt thrombosis. Intraoperative Doppler examination revealed patent aorto-renal by pass. Postoperative trans-femoral angiography for a case with aortofemoral graft showed patent graft as seen in (Fig. 13).

Two main complications were met in this study. The first was bleeding during suturing the graft to the intact aorta. This problem was overcome by simple compression additional sutures or performing the anastomosis with interrupted sutures. Graft thrombosis was the second complication that occurred in three cases. Aorto-renal bypass graft due to small size of the renal artery, a single limb of aorto-bifemoral graft due to development of thrombosed suture line aneurysm and lastly the aorto-caval shunt due to incomplete cavel stoma.

DISCUSSION

The introduction of less invasive surgery techniques has clearly been the most significant innovation in the field of cardiac surgery in the last decade[37]. There is evidence that by avoiding the use of extracorporeal circulation, clinically relevant morbidity can be significantly reduced.

Coronary bypass surgery on the beating heart continued to become less technically demanding for the surgeon due to development in vascular devices. These devices allow the surgeon to do sutureless anastomosis or conventional anastomosis without aortic clamping [38].

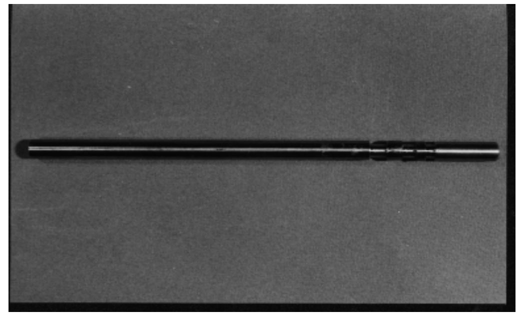
Since this technique has not yet been applied in abdominal aortic graft anastomosis, it is a time to rethink about the way of abdominal aorto-graft anastomosis. So if abdominal aortic graft anastomosis could be done without aortic clamping, it will help avoiding all the hemodynamic and metabolic changes occurred due to aortic clamping and unclamping.

A new device was designed by the author to allow completion of this step in vascular procedures including the abdominal aorta. This device will have many advantages. It will be useful in making aortic anastomosis without aortic clamping. Extensive aortic dissection for proximal and distal clamp control will be unnecessary and there will be no need for lumber artery back bleeding control. Moreover, in cases of redo aortic surgery or high aortic bock, the length of the aortic segment for graft anastomosis is usually short. Using this technique would be beneficial to avoid putting a clamp in a very restricted area.

Our observations during this trial showed that the graft must depart from the aorta at right angle and this might result in graft kink. This problem could be corrected by refashioning the graft before making the distal anastomosis. Another observation is that the pressure in the aorta is necessary to resist the knife during creation of the stoma. Sustained aortic pressure against movement of the knife will produce a well, rounded, clean edge stoma in the aorta. That conclusion was relatively confirmed by caval graft thrombosis and inspection of the inner surface of the cava- graft specimen that showed incomplete cut of the stoma.

One more interesting observation was that bleeding occurred during anastomosis was due to needle puncture bleeding. This problem could be easily solved by just compression, continuous suturing and additional interrupted sutures. There was no problem with bleeding from the aorta after graft functioning as the device will seal the graft and all have been controlled with the left hand of the surgeon. Finally we feel that visualization of the stoma by intra-operative angiography will add more confidence in the device and the technique.

In conclusion, the device can be helpful in making aorto-graft anastomosis without the need for aortic clamping. It will be easy to do aortic anastomosis in difficult cases. It will also help prevention of all adverse effects and changes occurred due to aortic clamping and unclamping specially in highrisk patients. Further modification of the device is in the way using the new technology and will avoid the problems associated with use of this device. Another study is in the way to test the results of this technique in clinical practice with new modifications in the device



(Fig.1) : The new device consists of two pieces; An outer piece is the sheath, an inner piece is the aortic knife and two rings to adjust the length of the knife according to the size of the aorta.

(Fig.2): The new device as it is used during the procedure.

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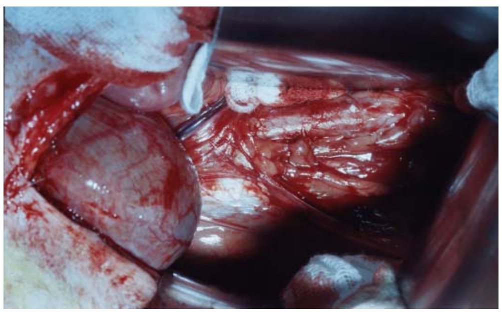

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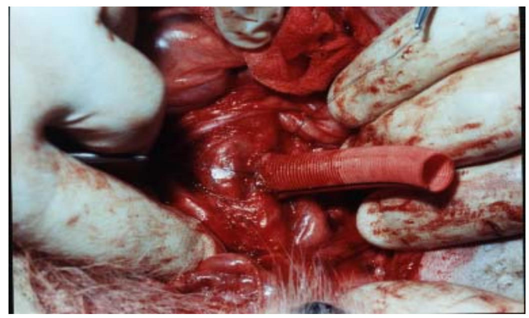

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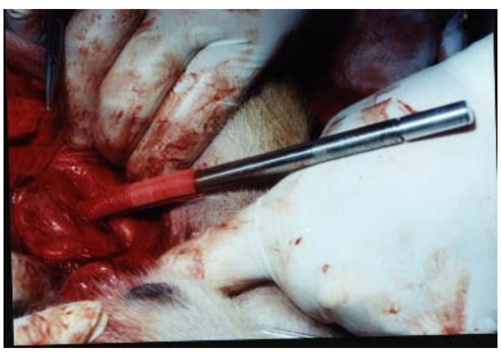

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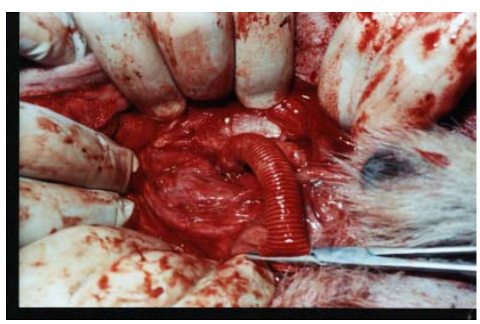
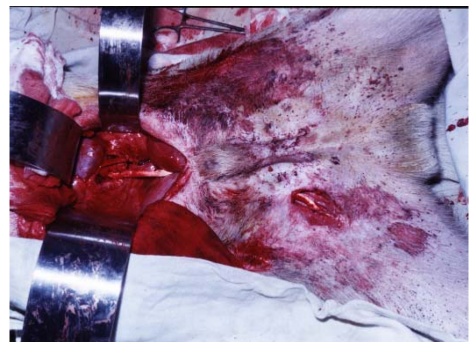
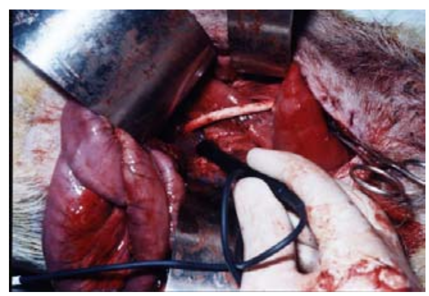


Fig.(3,4,5,6,7): Operative technique: Exposure of asegment of the abdominal aorta-Graft anastomosis to the pulsating aorta - Introduction of the sheath inside the graft-Introduction of the aortic knife inside the sheath,after making the rounded hole in the aorte thus creating a functioning graft -Heparin saline injection after flushing and then putting a clamp on the functioning graft. (Notice no clamping of the aorta at any step of the procedure).

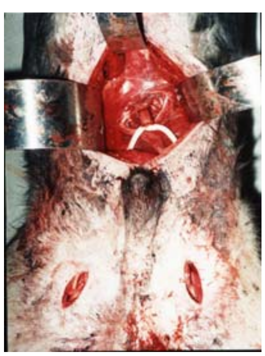
(Fig.8): Aorto-aortic jump graft.



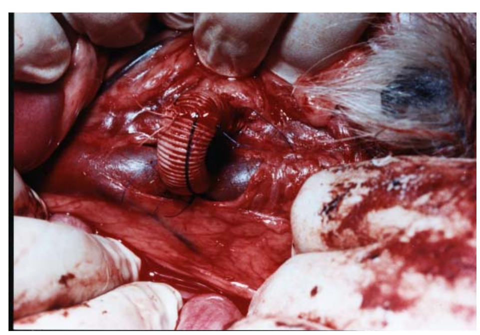
(Fig.9): Aorto-femoral bypass graft.



(Fig.10): Aorto-renal bypass graft

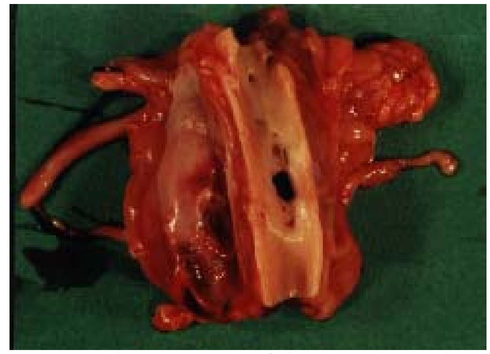


(Fig.11): Aorto-bifemoral bypass gra



(Fig.12): Aorto-caval shunt with dacron graft

(Fig.13): Postoperative angiography shows the aorto-femoral bypass graft.



(Fig.14): Postmortal examination of the aorta shows the opening of the graft from inside the aorta. Notice the caval opening is ncomplete that is why the shunt was thrombosed in the vaval side.

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