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PERITONEAL TABULARIZATION FOR INFERIOR VENA CAVA (IVC) REPLACEMENT IN ANIMAL MODEL STUDY (DOG)

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ABSTRACT

The aim of the present study was to evaluate the flap of parietal peritoneum for replacement of the inferior vena cava as interposition graft in dogs during an observation period of two months.

Background: The development of reconstructive venous surgery has been hampered by the lack of suitable graft. Patency rates with grafts in the venous system are commonly less satisfactory than in the arterial system, mainly due to non-pulsatile flow velocity and the low pressure in veins. Grafting in the inferior vena cava may be necessary in the cases of trauma and major tumour surgery involving the vena cava. Several types of grafts have been evaluated. Reconstruction of vena cava with autologous vein is so time consuming and requires extra incisions. Prosthetic material is associated with an increased risk of infection and thrombosis. We, therefore, created an animal model of the Inferior Vena Cava reconstruction using the flap of parietal peritoneum.

Methods: A tube was constructed from parietal peritoneum of the antero-lateral part of abdominal wall of 10 dogs with a length of 5cm and 1 cm in diameter. It was anastomosed end-to-end as an interposition graft in the inferior vena cava. The observation period was 2 months.

Results: Seven out of ten grafts were macroscopically and venographically patent, but three of ten were occluded. Eight out of ten yielded suitable specimens for pathologic examination; and five of them revealed patent lumens, which were completely deendothelialized. No infection or other problems were noted.

Conclusions: The Peritoneum is an accessible and safe substitute for reconstruction of Inferior Vena Cava at least in animal model.

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INTRODUCTION

Replacement of veins is a challenging issue in vascular surgery, different kinds of materials which have been used successfully for arterial replacement have been tried in the venous system (Collins *et al*., 1960; Moore, 1963; Moore, 1964; Jones , 1958) the results were not encouraging.

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MATERIALS AND METHODS

After ethical approval and permission from *ethic committee* of shiraz university, ten randomly selected, healthy dogs of both sexes and various ages weighing 15 to 20 kg were used to develop the model. Anesthesia was induced with intravenous thiopental sodium (Penttotal, Abbot, Sweden). Endotracheal intubation was done and the anesthesia maintained with oxygen and halothane, using a mechanical ventilator. 800,000 units of Penicillin G plus Procaine (Penicillin G Mixture,

Haian, Iran), were given intramuscularly and continued for 2 doses post operatively. The Dogs were put on the operation table in supine position. Surgical Procedures Surgery was performed under sterile conditions. Through a midline laparotomy, the intestines were reflected to the left (and kept moist with gauze swab), to expose the vena cava from the renal veins to the caval bifurcation the Inferior Vena Cava distal to the renal veins was dissected free .A tube was constructed with Parietal Peritoneum from the antero-lateral part of abdominal wall with the length of 5cm and 1cm in diameter. This was made by using a thoracic catheter (chest tube) as a stent, and continuous everting 5-0 polypropylene (Prolene, Ethicon, U.K) sutures. Then it was carefully dissected from the abdominal wall (and also cleaned from fat), till it was easily put close to the Inferior Vena Cava .After intravenous injection of Heparin (Heparin, IPDIC, Iran) with a dose of 50 units /kg , Inferior Vena Cava was cross clamped, using vascular clamps, below the renal veins and above the confluence of the iliac veins and 4-5cm of the vena cava was excised.The peritoneal tube graft was anastomosed as an interposition graft to the vena cava with end-to-end anastomosis. The anastomosis was performed with continuous everting 5-0 Prolene sutures.Patency was awaited for 10 minutes after which the laparotomy wound was closed. The duration of the operation was 2.5-3 hours and clamping time was about 50 minutes.

Dressing was not done over the surgical wound, but tetracycline spray was used for 1-week post operatively. The animals were brought to recovery room after extubating and kept there for 24 hours to be stable. In the first day after operation the diet started for animals and advanced. Heparin continued for 2 doses post-operative, but intramuscularly. Each dog was kept in a separate cage and was given unlimited access to food and water. After at least 2 months the dogs were re-anaesthetized as previously described, and phlebography was done for them; patency was evaluated by inspection after which the graft area was excised and sent for pathology; and the dogs were sacrificed painlessly. Phlebography was done by introducing a catheter into the right femoral veins. Dogs were in the anterior posterior position using 20 ml of contrast medium (Meglumine Compound 76%, Darous Pakhs Pharmaceutical Mfg, Iran). The grafted peritoneum and its surrounding soft tissue were examined in situ macroscopically. Any possible lumen was marked by an appropriate cannula. Then the whole grafted region was excised en-bolc and put n 10% buffered formalin. After proper fixation serial cross sections were made at the level of cannula and any other possible lumen. A mean of 2 paraffin blocks were prepared from each case. A 3 µm thick slide was made from each block and stained by Haematoxylin and Eosin and finally examined under ling microscope.

RESULTS

All the animals survived the operation and the subsequent observation period. The early post-operative period was uneventful, and all the wounds healed primarily. None of the animals developed lower extremity edema, but some engorgement of the superficial vein was detected in the abdomen of three animals (Dogs 7, 9,10). We started to scarify the animals after 2 months. At Phlebography 2 months after surgery, 7 grafts were patent. (Dogs 1 to 7). In two of patent grafts (Dogs 6,7), there was some degree of stenosis (esp. at the cranial part of anastomosis).

Three of the grafts were occluded. In those animals with occluded grafts the venous flow was drained with few collaterals None of the animals showed any sign of infection at relaparotomy; but some degree of adhesion formation adjacent to graft area was presented. Macroscopically six grafts (Dogs 1 to 6) were patent at the end of study, while three grafts (Dogs 8,9,10) were occluded. One graft (Dog 7) seemed stenotic. Eight out of ten sacrificed dogs have yielded suitable specimen for pathologic examination. Macroscopically five of them revealed patent lumen which was confirmed microscopically (Dogs 1 to 5). The walls of lumens were composed of fibro fatty tissue with no definite and recognizable three-layer pattern (intima, media, and adventitia) of true vessels). The lumens were deendothelialized completely. No thrombosis identified. Two out of eight cases did not show any grossly recognizable lumen (Dogs 8,11). On histopathologic examination, the lumen of artificially made channels were totally obliterated withfibrosis. No definite endothelialisation identified. Besides, chronic inflammation and foreign body giant cell reaction to suture materials was the only abnormal pathologic findings Histopathologic examination of one of the specimens did not reveal any artificially produced peritoneal channel at all, this could be due to improper sampling during autopsy.

DISCUSSION

Venous grafting procedures imply a challenge in vascular surgery. Grafts in the venous system, do not perform as well as their counterparts in the arterial system because of several unique characteristics of the venous environment: Low intraluminal pressure Slow flow against a hydrostatic pressure gradient, Low oxygen tension, Irregular flow as a result of phasic nature and turbulence around valves, Thin, fragile vessel so Venous grafts are desirable clinically for large veins involved by obstruction, neoplastic invasion, congenital anomalies and extensive laceration. Although in the area of venous reconstruction no graft material has been found superior to autologous vein, but there is lack of suitable veins for large vein repair. Miller (1991) and associates and later Bower and Nagorney (1993) used the superficial femoral vein as a replacement for Inferior Vena Cava. Spiral jugular vein was used by Gloiczki (?) and associates for reconstruction of IVC. Also, there are other reports (Alavaikko, 1988; Herring, 1984) of using small-caliber veins for IVC reconstruction. techniques which create large-caliber autogenous vein grafts are tedious and so time consuming that patients may not be able to withstand the operative time, also require additional incisions.

Polytetrafluoroethylene (PTFE) grafts have been used as a synthetic alternative to autologous vein grafts for reconstruction of IVC. Total replacement of the Inferior Vena Cava with PTFE graft was first reported by *Sarti* (1970) in 1970. To prevent anastomotic stenosis that invariably occurs in the venous system and to prevent grafts narrowing because of extrinsic compression by the overlying abdominal viscera, external ring-supported PTFE, that was first suggested by *Kunlin* (1979) and associates, has become a choice13,14. Reinforced or ringed PTFE grafts resist external compression from adjacent organs and positive intra-abdominal pressure. Despite numerous studies showing improved patency of venous reconstruction with adjunctive AVFs,there has not become universally accepted. *Okada* (1989) and colleagues successfully replaced the IVC using tubular expanded PTFE

vascular grafts after the bloc removal of the tumour thrombus and IVC and followed the patients long term and observed IVC patency. At the end the suggested that total replacement of the Inferior Vena Cava using an expanded PTFE tubular grafts may offer a feasible method with good patency rates in the long term. However, as a result of these investigations and some other reports (Akimaru *et al*., 2000; Huguet *et al*., 1995; Ribbe, 1988), PTFE is the most promising solution for IVC reconstruction, but still there are two major unresolved problem with clinical use of prosthetic grafts: 1) A persistently higher thrombosis rate compared with autologous grafts when they are used in a (low-flow runoff bed 2) An increased risk of graft infection.

Marshall et al. (1985) reported a pericardial patch after surgical extirpation of a renal cell carcinoma with a large tumourthrombus and suggested that a pericardial patch may be considered for preservation of continuity of the vena cava in patients without complete vena cava obstruction. Use of autologous material probably will have a lower thrombosis rate and greater resistance to infection than prosthetic materials in lower flow venous system (Bower, 1993; Akimaru *et al*., 2000; Marshall, 198). Autologous peritoneum is an interesting material to try for venous grafting. Its mesothelium originates embryologically from the same stem cell as the endothelium, giving the two surfaces several properties in common, e.g. prostacyclin production and fibrinolytic activity (Ribbe, 1988; Ribbe, 1988; van Hinsbergh, 1990). *Hinsbergh et al* showed that epithelioid cells obtained from omental tissue are mesothelial in character and produce various regulators of fibrinolysis: t-PAI-1 and PAI-2. *Akimaru et al*., (2000) resected a 2.5X2.5 cm, piece of peritoneum from 7 pigs and made an overall window (long axis:1.5cm) in inferior vena cava, then repaired that with the peritoneal patch fixed in alcohol.

At the end they concluded that the peritoneum is an accessible and safe substitute for reconstruction of the vena cava. Our results after two months showed five of ten patent grafts, two patents but with some degree of stenosis, while three of them was completely occluded. Reason for our stenotic grafts could be a reaction that had been augmented by the inclusion of the posterior abdominal wall muscle in the grafts (Although we tried, not to include the muscles in our tube graft). One probable reason for the occlusions is that the graft wall is thin and soft and easily may squeezing by external pressure as the intravascular pressure is low. Another reason for the graft failures might be thrombotic occlusions. Another possible reason for the occlusions of three grafts of our study might be the longitudinal suture line which might induce fibrosis. The light microscopical changes found in our study (even in-patient grafts) indicated that major reactions occurred along suture lines.

Conclusions

The Peritoneum is an accessible and safe substitute for reconstruction of Inferior Vena Cava at least in animal model. Autologous peritoneum is an interesting material to try for venous grafting. Use of autologous material probably will have a lower thrombosis rate and greater resistance to infection than prosthetic materials in lower flow venous system.

Disclosure: The authors declare no conflicts of interest.

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