

Enteral Patch Repair of the Vena Caval Defect

—An Experimental Study—

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Introduction

Inferior vena caval injuries associated with blunt or penetrating abdominal trauma are lesions surgeons confront frequently and the numbers are steadily increasing. The seriousness of these vena caval injuries is obvious, since some reports emphasize that over 30 per cent of the patients will die before they reach the hospital and close to 50 per cent of the patients reaching the hospital eventually die^{1, 2, 3, 4}. Vena caval injury either by penetrating or blunt trauma to the abdomen is, indeed, a very serious problem, with mortality of over 50 per cent of the cases before admission to the hospital. Ochsner in 1961 reported 37 vena cava injuries with mortality rate of 47 per cent². Quast reported 53 per cent mortality out of 60 vena cava injuries in 1965⁵. Duke in 1965 reported 42 vena caval injuries with 40 per cent mortality⁴. Bricker reported the mortality rate of 50 per cent in his earlier series (1946~1964) of 61 cases and reduction of the mortality to 40 per cent in the latter series (1964~1970) of 82 patients in 1971⁶. Burns in 1972 reported 24 vena caval injuries with 42 per cent mortality⁷.

Contrary to the general understanding, injuries to the large veins present greater technical problems than do injuries to arteries. Isolation of the injured segment of the vein is a greater problem than that of the artery. Reports confirm this to be particularly true in abdominal vascu-

lar injuries when problems involving the vena cava compared with those of the aorta³.

The difficulty of the controlling the brisk bleeding of the low pressure system was the cause of the majority of the expired cases. The early diagnosis and prompt control of the hemorrhage is the most important measure to the successful management of these cases. Those patients survived the initial emergency measure need to have their vena caval injuries repaired adequately. There have been numerous methods of repairing the vena caval defects reported and are being utilized at the present time. For smaller simple defects of the vena cava the autogenous vein patch grafts and the prosthetic repair or the simple ligation of the vena cava have also been successfully reported^{8, 9}. The present study is an attempt of repairing the vena caval defect with the adjacent small bowel serosal patch. To keep the vena cava as close to normal anatomically and physiologically would be much feasible. This attempt was carried out in three adult mongrel dogs and the favorable results have been confirmed.

MATERIALS AND METHOD

Three adult mongrel dogs, weighing 15.0~17.0kg each, were used for this experiment and the dogs were kept fasting for 24 hours preoperatively. The dogs were anesthetized with endotracheal intubation using oxygen and nitrous oxide (2:2) and maintained with 1 per cent Halothane.

The operations were carried out as nearly like those on humans as possible. The abdomen was shaved and prepped with Betadine and draped with sterile sheets. The particular attention was paid during the operation for the absolute hemostasis and careful tissue management for the least tissue damage. The laparotomy was performed through the mid-line incision and the infrarenal vena cava was dissected off the retroperitoneum 6.0 to 7.0 cm in length. The vena cava was clamped with Satinsky vascular clamp and a segment of the anterior wall of the vena cava, 7.0×14.0 mm in size, was resected. A segment of the appropriate small bowel was selected and the corresponding size of the serosa of the antimesenteric border of the bowel was sutured to the edge of the vena caval defect with over and over continuous suture of 3-0 or 4-0 Dexon. The anastomotic suture line was dry except one or two points of bleeding which were easily controlled by putting extra stitches. Heparinized saline irrigation or systemic heparinization were not used either during or following any of the procedures. The abdomen was closed in single layer with No. 5 silk continuous sutures on the mid-line fascia and the skin was approximated with No. 3 silk sutures. The wound was sprayed with Benzoin tincture. The dogs were kept with intravenous saline solution during the procedure. Animals were kept nothing by mouth on the day of the procedure and were fed with regular vet diet from the following day. The animals recovered from anesthesia and the procedure without any complications and were active from the day following the surgery. The dogs were kept alive for 4 to 6 weeks and the reexploration was performed under the general anesthesia. The vena cavogram was obtained in each animal using 60 per cent Urograffin slowly injected through a catheter in the common iliac vein. An en bloc segment of the vena cava and the small bowel at the site of the repair was removed for the histological study.

RESULTS

Dog #1. The animal was reexplored on the 30th postoperative day and upon entering the abdomen there were very minimum adhesions in the abdominal cavity. The site of the anastomosis between the vena cava and small bowel was well healed and clean. An intracath catheter was passed into the right common iliac vein and 60 per cent Urograffin was slowly injected. The abdominal X-ray was taken which revealed the patency of the vena cava through the anastomotic site (Fig. 1). The gross specimen showed well healed anastomotic suture line and the patent vena caval lumen. The microscopic picture of the specimen revealed a newly formed intimal layer covered by a single layer of endothelial cells over the surface of the small bowel serosa patching the defect (Fig. 2).

Dog #2. The animal was reexplored on the 30th postoperative day and the well healed anastomotic site was confirmed. The vena cavogram taken through a catheter into the iliac vein with 60 per cent Urograffin revealed good patent vena cava (Fig. 3). The histological specimen also showed the intimal layer of endothelial cells over the small bowel serosa.

Dog #3. The animal was reexplored on the 42nd postoperative day and the patency of the vena cava was confirmed by vena cavogram (Fig. 4). The histological section showed a well healed wound with newly formed intima over the bowel serosa covered by a layer of endothelial cells.

The Elastic and Masson Trichrome stains of the histological specimen showed forming of elastic fibers and collagen fibers in the newly formed intimal layer.

All three animals had uneventful recovery following the initial surgery and showed no signs of any clinical abnormalities grossly detectable. The



Fig. 1. Venacavogram showing the good patency of the vena cava.

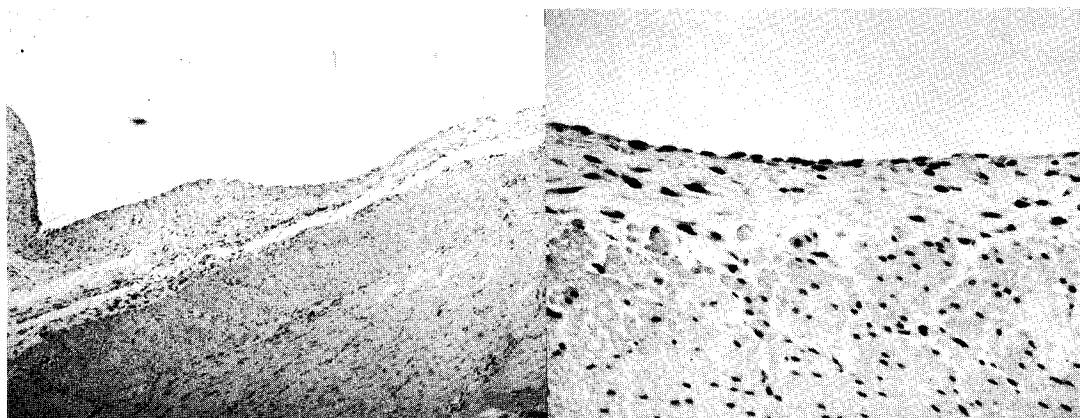


Fig. 2. Histological section showing the newly formed intimal layer and the single layer of endothelial cells covering the intimal layer.

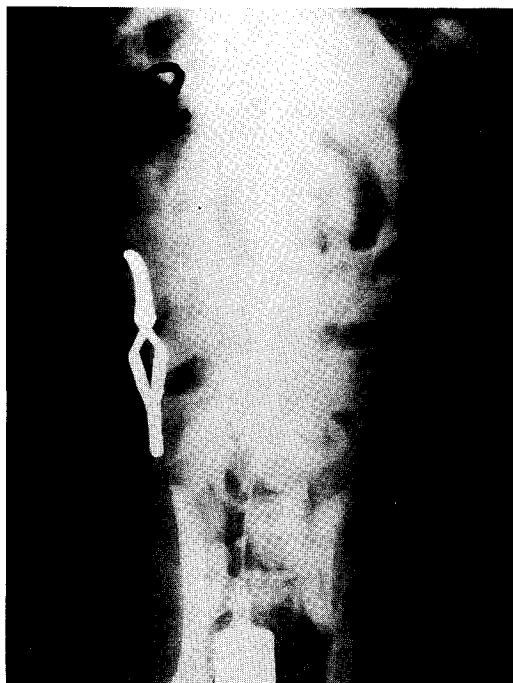


Fig. 3. Venacavogram showing the patency of the vena cava of dog #2

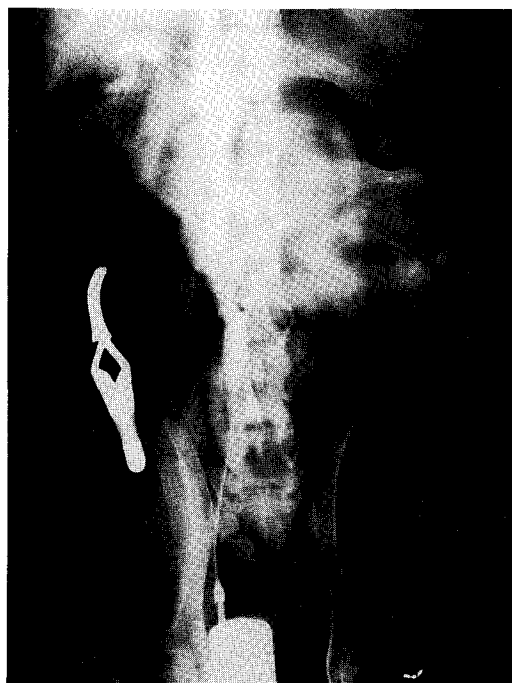


Fig. 4. Venacavogram of dog #3 showing patent vena cava.

question of postoperative thrombosis due to the low pressure venous flow in the vena cava was no matter of concern.

DISCUSSION

Injuries of the inferior vena cava are more frequent and lethal lesions among the major vascular injuries surgeons confront nowadays. According to some reports these injuries occur as commonly as one in every fifty patients with civilian gunshot wounds and one in every 300 patients with knife wounds¹⁾. The seriousness of these injuries cannot be overstressed, since many studies in the past report that over 30 per cent of these patients will die before they reach the hospital and almost 50 per cent of the patients who reach the hospital alive will eventually die^{2, 3, 4)}.

Numerous methods to repair the injuries of the inferior vena cava have been attempted with certain success in the past and with the tendency of increasing number of these injuries in these

days of highly mechanized living conditions, the necessity of simple and easily accessible means of vena caval repair is highly emphasized.

Suture repair of the defect, replacement of a portion of the vena cava with autogenous and homologous veins or prosthetic grafts, patch graft of the defect, packing with gauze, and ligation have been used and reported with satisfactory results in many instances^{2, 5, 10, 11)}. Of course, small defects of the vena cava can be easily repaired with suture closure, but the narrowing of the lumen may cause thrombosis and occlusion of the lumen following the repair. The ligation of the inferior vena cava below the renal veins usually does not cause too much morbidity postoperatively^{1, 4, 12)}, but to keep the vena cava as close to normal anatomically and physiologically following the repair would be much more desirable. If one is careful enough to utilize generous size of the enteral serosa for the repair, the narrowing of the caval lumen can easily be prevented. The free vein patch or prosthetic

patch can be easily obtained, but this enteral patch repair of the caval defect may prove to be another way of easily accessible method with least tissue damage. The formation of the neo-intima lined with layer of endothelial cells over the small bowel serosa seems to be enabling the normal function of the caval wall.

The ligation of the infrarenal vena cava is well tolerated with minor morbidity, but a simple defect of the vena cava could well be repaired by patch graft and this enteral patch repair, if this works in the clinical cases, could well be one of the applicable ways of repairing the defect, if not the better one.

SUMMARY

Injuries to the inferior vena cava and their management are being reported with increasing frequency in the civilian population nowadays. Repairs of the vena caval injury with suture, replacement of the segment of the vein with autogenous or prosthetic grafts, patch graft or ligation have been reported with success in the literatures. A small size defect can be repaired with either vein patch graft or prosthetic graft, but the small bowel wall can also be used to patch repair the defect of the vena cava. The experimental study in animal models revealed satisfactory results with no post-repair thrombosis or narrowing of the lumen. This experimental attempt may well be tried in the clinical cases with satisfactory results.

Key Words: Enteral patch, Vena caval defect, Endothelial cell

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=국문초록=

소장벽을 이용한 대정맥벽결손의 복원술식

—실험적 연구—

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세 마리의 한국산 잡종견을 전신마취하에 무균적 처치를 시행한 후 개복하였다. 신정맥 하방부위의 하공정맥을 5.0cm 가량 박리 노출하여 Satinsky 혈관 감자로서 잡은 후 하공정맥의 전방벽을 7.0×14.0 mm 크기로 절제 하였다. 이 정맥의 결손 부위를 인접해 있는 소장의 장막에 3-0 내지 4-0 Dexon 봉합사를 이용해서 봉합하였다. 실험동물들은 술후 4내지 6주간 생존시킨 후 재개복하여 총장골정맥을 통하여 60% Urografin을 주입하여 하공정맥조영술을 시행하였다. 세 마리의 개 모두에 있어서 하공정맥이 잘 개통되어 있음이 확인되었으며 봉합부위의 정맥과 소장벽은 병리검사를 위해서 절제 하였다. 조직학적 검사에서 정맥결손 부위에 봉합한 소장의 장막 부위에 새로운 내막층이 형성된 것이 확인되었으며, 이 내막층은 단층의 내피세포로서 피복되어 있었다.

이 실험의 결과 대정맥벽결손 부위를 소장벽을 이용 복원하므로서 대정맥 기능을 회복시킬 수 있는 가능성이 있는 것이 확인되었다. 아직 임상치험례는 없지만 이 방법이 대정맥 결손을 복원하는 방법중에 유용한 한 가지가 되리라 믿는다.