Robotic Inferior Vena Cava Surgery

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Introduction

Initial robotic concepts were described in science fiction publications in the 1940s. Advances in microelectronics and computing in the 1980s was further complemented by acceptance of laparoscopic surgery in the 1990s. Later developments by the Defense Advanced Research Projects Agency (DARPA) targeted remote surgery for potential utilization in battlefield triage.

The Da Vinci and Zeus robotic systems were subsequently developed and approved for clinical use incorporating both an Automated Endoscopic System for Optimal Positioning (AESOP) robotic camera and the "Telepresence Surgical System" concept.

Robotic surgery has been widely adopted in urological, gynecological and now colorectal surgery. However, providers still remain apprehensive when vascular structures are involved.

Objectives

The objective of this study was to describe our initial experience with robotic surgery of the inferior vena cava (IVC).

Methods

All patients who underwent robotic surgery of the IVC between September 2011 and August 2013 were included. Patient data regarding clinical presentation, radiological imaging, operative intervention, treatment pathway and clinical outcome were recorded.

Results

Patient Demographics: Four patients were identified (male=3, mean age 51.5 years). Three patients with renal tumours (right=2) had tumour thrombus extending to the IVC. These three patients were commenced on therapeutic low-molecular weight heparin pre-operatively to minimise tumour thrombus propagation. A fourth female patient presented with a symptomatic IVC filter with associated migration and perforation.

Operative Procedure: Each patient was positioned in a modified 30° flank position with a 10lb bump under a table cushion. The table was flexed slightly with the patient positioned in reverse trendelenberg to facilitate space for the 4th arm of the robot to manoeuver. The ipsilateral arm was padded in sling position and flexed slightly less than 90°. The lower leg was flexed while the upper aspect was extended. The patient was secured with straps to permit extreme table rotation **(Figure 1)**.

The robot was then positioned on the ipsilateral side and approached the patient from the right shoulder. After creation of the pneumoperitoneum, a 12mm camera port was inserted followed by insertion of the remaining robotic ports under direct vision (5mm x 1, 8mm x 3 and 12mm x 1) **(Figure 2)**.

The operative procedure was performed in stages which included:

- Mobilization of the duodenum and right colon.
- IVC dissection.
- Vascular control of the IVC with ligatures and Rummel tourniquets.
- Creation of cavotomy.
- Mobilization and removal of the tumour thrombus or IVC filter.
- Closure of the cavotomy.

Conventional additional dissection was performed for nephrectomy when indicated **(Figure 3)**. Mean operative time was 229.3 minutes with an IVC clamp time of 32.3 minutes. Mean total peri-operative intravenous fluid administration was 3625mls with a corresponding blood loss of 337.5mls and urine output of 448.8mls **(Table 1)**.

Patient Outcome: All four patients had uncomplicated post-operative courses with mean discharge on post-operative day three. Adjuvant chemotherapy was administered to all renal tumour patients. All patients remain well with mean follow-up of nine (range 1-24) months.

Figure 1: Patient positioning for robotic IVC surgery.

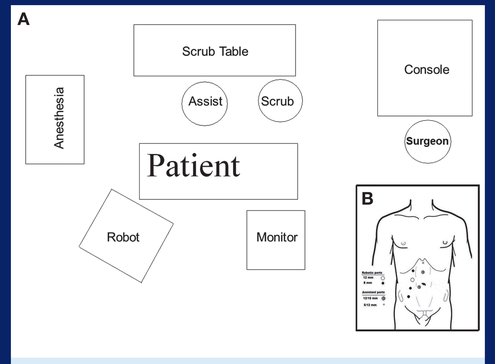

Figure 2: (A) Operative room set-up with (B) port insertion sites.

Sex and Age	Indication	Operative Time (mins)	IVC Clamp Time (mins)	Total IVF (mls)	Blood Loss (mls)	Urine Output (mls)	Complications
M 67	Right renal tumor	191	32	4500	400	410	None
M 62	Right renal tumor	203	28	4000	500	800	None
M 54	Left renal tumor	341	-	2000	200	400	None
F 23	IVC filter migration	182	37	4000	250	185	None

Table 1: Patient demographics and operative parameters.

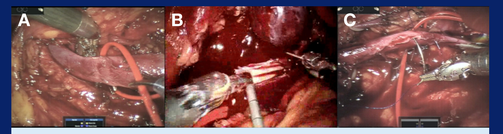

Figure 3: (A) After circumferential robotic dissection, the IVC was controlled with vessel loops. (B) IVC tumor enucleation. (C) Closure of the cavotomy.

Conclusions

Our initial experience suggests that robotic IVC surgery is a valid and safe modality providing satisfactory access to the IVC leading to shorter recovery and improved patient quality of life.

We advocate the use of a laparoscopic clamp for supra-renal IVC control, a Rummel tourniquet for the distal IVC and vessel loops for the renal veins.

Optimal robotic vessel ligation of IVC branches should be performed using silk ties rather than hemostatic clips.