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Review Article

REVIEW ARTICLE

Complications of robotic-assisted laparoscopic surgery distant from the surgical site

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Abstract

With the ever-increasing popularity of robotic–assisted laparoscopic surgery over the past decades, the literature reporting complications distant from the surgical site involving the use of this technology has also grown. The goal of this non-systematic review is to summarise these reports with a systems-based presentation of these complications. The most commonly observed complications were related to the peripheral nervous system and the most devastating occurring in cardiac and ophthalmic systems. There were no reports of patient complications directly related to the robot itself. While several of the reported complications are not unique to robotic surgery, they are included to maintain awareness of their possibility. The limitation of surgical time, judicious fluid administration, and constant vigilance of patient positioning are all recommended as possible preventative measures.

Key words: robotic surgical procedures; laparoscopic surgery; intraoperative complications; postoperative complications; patient safety

The inception of robotic-assisted surgery (RAS) has brought with it promises of an improvement upon the minimally invasive technique of conventional laparoscopic surgery through enhancements on the amount of control and mobility offered to the operator.[1–3] The benefits associated with laparoscopic surgery such as decreased hospital stay, expedited recovery time, reduced postoperative pain, and improved cosmetic outcome translate naturally to RAS.[2] However, it is controversial if RAS has truly produced an improvement. Overall it appears that for most surgeries, the robotic approach offers reduced blood loss, a reduced need for transfusion, and shorter hospital stay.[4] However, a consistent benefit has not been shown regarding a reduction in morbidity or mortality, and there is an increased cost associated with robotic procedures.[3] Furthermore, there has been discussion that the reduced hospital stay can offset some of the costs of RAS, but only if the initial investment in the robotic system is taken out of the equation.[5]

The unique logistics of the robotic surgical setup require extensive considerations such as specialised patient positioning combined with longer surgical times (i.e. tolerance of prolonged periods in the Trendelenburg position). In addition, patient characteristics such as morbid obesity, decreased cardiopulmonary reserve, vascular disease, ophthalmic disease, or pre-existing neurological disability, may increase the risk of complications and might be considered relative contraindications to RAS. This review article seeks to examine the complications and considerations unique to this novel field of surgery, with a focus on abdominal and pelvic procedures.

Methods

A literature search was carried out in two separate phases. The first was a literature search of PubMed, Embase, and SCOPUS utilising combinations of the keywords “robotic”, “robot-assisted”, “anesthetic”, “complications”, “Trendelenburg”, and “positioning”. Search exclusions were conference proceedings, and papers not in English or lacking English translations.

This yielded 1,738 citations, which were screened down (reviewers D.A.M., L.N.B.) to 78 articles. We catalogued complications and defined them as injuries not directly related to surgical action, which includes events such as haemorrhage, trauma to bowel, and postoperative urologic issues.

After this, a more focused search was performed on PubMed, Embase, and SCOPUS using keywords across all complications in order to ascertain more data regarding incidence, treatment, and recommendations for prevention. An additional 31 articles were selected with an emphasis on larger retrospective studies and prospective trials.

The complications found in the literature spanned essentially all organ systems. A systems-based approach was utilised to allow for a more organised presentation.

Neurologic complications

Neurologic complications associated with both positioning and procedural factors were a significant portion of those reported. The most commonly reported complication was related to position-related injuries of the peripheral nervous system (Table 1).

Peripheral nervous system

Peripheral nerve injury is an uncommon yet debilitating complication of both robotic and laparoscopic-assisted surgery. In fact, 16% of ASA closed claims database complaints are because of injury of one or more nerves.[6] One large retrospective series demonstrated a 0.16% incidence of peripheral nerve injuries in robotic–assisted laparoscopic prostatectomy (RALP) cases compared with a 0.1% incidence in non-robotic prostatectomies.[7] It is most often related to the steep Trendelenburg position required for robotic surgery and prolonged operative times when compared with traditional laparoscopic or open surgery. The possible mechanisms of nerve injury include compression, stretching, and ischaemia. Prolonged periods of compression can lead to Schwann cell damage and demyelination, leading to permanent nerve damage.[8] Peripheral nerve injuries described in the literature include the lingual and buccal nerves, brachial plexus, lateral femoral cutaneous nerve, obturator nerve, femoral nerve, common peroneal nerve, and sciatic nerve.[9–11]

Upper extremity injuries

Peripheral nerve injuries occur with an overall incidence of 0.25%, with brachial plexopathies accounting for 20% of all peripheral neuropathies reported to the ASA closed claims database.[9 12] The most frequent site of upper extremity neuropathy is the ulnar nerve, followed by the brachial plexus and median nerve.[8] These injuries are often attributed to excess pressure over the acromioclavicular joint.[10] The role of shoulder bolsters in brachial plexus injuries is controversial, with some papers offering them as preventative measures and others classifying them as possible causes.[8 10–16]

In one case report by Devarajan and colleagues,[12] three patients undergoing RALP suffered unilateral brachial plexopathies in abducted arms. These patients were all positioned in low lithotomy position on a beanbag, with the right arm adducted and left arm abducted at < 90 degrees, with both arms padded. All three patients experienced C5–C7 distribution numbness in the left upper extremity postoperatively. At six weeks postoperatively, two of the three patients had resolution of symptoms, but one patient had persistent pain, numbness, and grip weakness. This was thought to be because of the

Table 1 Summary of neurological complications of robotic-assisted laparoscopic surgery

Category	Complication	Incidence	Risk Factors	Prevention
Peripheral nervous system	Upper extremity nerve injury[8–10 12 13 17–22]	0.25–1.8%	Shoulder bolsters causing excess pressure over acromioclavicular joint[10]	Padding of shoulder bolsters[10]
			Bean bag use[12]	Discontinuation of bean bag use[12]
			Abduction of arms > 90 degrees[12]	Adduction of arms[12]
				Gel foam and egg crate padding (no difference)[22]
	Lower extremity nerve injury[8 13 21 26]	0.3–2%	Low BMI[8]	Not listed
			Prolonged time spent in lithotomy position[8]	
			Insufficient padding of leg supports[8]	
	Unspecified positioning injuries[7 17]	0.4–6.6%	Prolonged operative time[17]	Not listed
			One or more medical comorbidities[7]	
			Income < $35,000 annually[7]	
Central nervous system	Cerebral oedema[27–30]	Not listed	Steep Trendelenburg[31–34]	Limit time in steep Trendelenburg[28]
			Prolonged operative time[28]	Restrict steep Trendelenburg to 30 degrees maximum[28]
			Prolonged Steep Trendelenburg[28]	Fluid restriction[28]
			CO2 peritoneum of 16 mm Hg[28]	Limit operative time[28]
				Limit intra-abdominal insufflation pressure to 8 mm Hg[28]