Authors

Tina Oblak
MN
Ljubljana University Medical Centre, Slovenia

Professor Brigid M Gillespie
PhD, RN, FACORN
NHMRC Centre of Research Excellence in Wiser Wound Care and Menzies Health Institute Queensland, Griffith University Gold Coast campus Griffith University and Gold Coast University Hospital, Gold Coast Health, Queensland, Australia

Corresponding Author

Tina Oblak
MN
Ljubljana University Medical Centre, Slovenia
tina.oblak@kclj.si

The incidence of peripheral nerve injuries related to patient positioning during robotic-assisted surgery: An evidence summary

Abstract

Objective: To describe the incidence and anatomical locations of peripheral nerve injuries (PNIs) related to patient positioning during urologic, gynaecologic and colorectal robotic-assisted surgery (RAS).

Background: Incorrect positioning of extremities and lack of assistive devices in steep Trendelenburg (up to 45°) positioning during urologic, gynaecologic and colorectal RAS places the patient at potential risk of nerve injury.

Method: A structured search of recent systematic reviews published between January 2019 and August 2021 in the Cochrane Library, PubMed, ProQuest and Google Scholar databases using search terms 'patient positioning', 'robotic-assisted surgery', 'Trendelenburg', 'complication' and 'injury' with medical subject headings (MeSH) was conducted.

Results: The overall incidence rates of PNI associated with patient positioning during RAS varied from 0.16 to 10.8 per cent. The most common anatomical positions of nerve injuries in upper extremities related to patient positioning during RAS were identified in brachial plexus, ulnar, median, radial and humeral nerves. For lower extremities, nerve injuries were identified in the sciatic, femoral, obturator, femoral cutaneous and common cutaneous nerves.

Conclusion: Operating room teams should develop institutional policies to support perioperative practice that is based on the best available evidence.

Application: This evidence summary supports the need for frequent routine checks and constant monitoring of the patient's position through the operating procedure.

Key words: steep Trendelenburg, assistive devices, intraoperative complications, patient positioning, patient monitoring

Background

To provide optimal intraoperative exposure and visualisation, patient positioning during urologic, gynaecologic and colorectal robotic-assisted surgery (RAS) often requires the lithotomy positioning with steep Trendelenburg (up to 45°)[1–6]. Incorrect patient positioning or even extended operative time in this position places the patient at potential risk of several complications[4]. As expected, due to steeper angles of Trendelenburg positioning, patients have a greater tendency of cephalad migration (sliding down toward the direction of the head)[5]. The most observed complications are peripheral nerve injuries (PNIs) discovered in the upper and lower extremities[2,7]. Researchers, however, also report central nervous system complications,

haemodynamic and respiratory disturbances, ocular injuries and complications in the urinary and gastrointestinal systems[2,8,9].

Suboptimal positioning of extremities and lack of assistive devices increases the risk of nerve injury from stretch and compression, generalised ischaemia and metabolic disorders[1,2,7]. PNIs may have profound impacts on patients, as they can culminate in loss of limb function and thus compromise quality of life[7,10]. To ensure that patients are not exposed to injury, knowledge of injury mechanisms, anatomy and physiology and appropriate patient positioning as well as intraoperative attention to vital signs and assessment of specific risk factors (e.g. obesity, pre-existing neurological conditions, >240 minutes operative time) are essential[1,2,11–14].

Research question

Systematic reviews following rigorous methodological approaches, can take a substantial amount of time to complete, and they may not meet the specific needs of the end-user[15]. Evidence summaries are short, easily read documents that provide a succinct presentation of the available evidence in a particular clinical area. While they are not as comprehensive as literature reviews, evidence summaries are less time consuming to undertake. Further, evidence summaries have emerged to synthesise the evidence on defined questions and assist policymakers and practitioners in using the best available evidence to decide on clinical interventions[15–17].

The purpose of this evidence summary is to identify clinical considerations in relation to patient positioning during urologic, gynaecologic and colorectal RAS procedures. Thus, we aimed to describe the related incidence and anatomical locations of PNI as well

Table 1: The characteristics and key findings of the systematic reviews

Author (year)	Types of included studies, time period	Review question	Findings	Limitations	Implications for practice and research
Bjøro et al. (2020)[11]	11 quantitative studies, including 6 registry-based, 3 longitudinal prospective, 1 RCT and 1 combined register-based with survey design. Articles published Jan 2000 to Feb 2019.	To determine: • the incidence of IPNI • risk factors for IPNI • pain and symptoms of IPNI in patients undergoing RAS laparoscopic urologic, gynaecologic and colorectal procedures in lithotomy positioning with steep Trendelenburg • the impact of IPNI on patients' function and quality of life	The overall incidence of IPNI ranges from 0.16% to 10.0%. The incidence of upper extremity injury ranges from 0.1% to 3.6%, and lower extremity injury ranges from 0.2% to 10%. Risk factors for IPNI related to positioning were prolonged operative time, patients' comorbidities and high ASA and BMI scores.	Most data were retrieved from registry-based studies, as retrospective reviews. Recording of IPNI was dependent on the reporting of symptoms, prospective standardised tools for reporting complications were not used in the studies. Studies were not designed to systematically record IPNI due to positioning or evaluate IPNI at the time of incidence.	Knowledge of mechanisms for injury, positioning, anatomy/physiology and evaluation of risk factors to ensure that patients are not exposed to IPNI is crucial. Further research should focus on: • reduction of IPNI associated with positioning in RAS • how IPNI affects patients' function and quality of life • the physiological consequences of IPNI related to the patients' positioning in RAS.
Cornelius at al. (2021)[6]	6 studies, including 1 prospective RCT and 5 retrospective cohort studies. Articles published Jan 1990 to Mar 2020.	To review: • the frequency of IPNI • the impact of positioning-related post-operative PNI in patients undergoing RARP	The incidence of PN associated with RARP varies from 1.3% to 10.8% for lower extremities and from 1.1% to 1.9% for upper extremities. Increased intraoperative time, ASA score, patients' comorbidities and positioning correlate with the incidence of post-operative PN.	Techniques for detecting and reporting PN and a detailed description of patient positioning were not standardised. Due to the low number of eligible studies and heterogeneity of study designs, it was impossible to draw recommendations regarding favourable patient positioning.	Further research should focus on: • prevention of PN after RARP • the impact of BMI • comparison between standardised Trendelenburg versus steep Trendelenburg position.
Das et al. (2019)[3]	7 studies, including 3 RCT and 4 case studies. Articles published Jan 2003 to Mar 2018.	To evaluate: • techniques, devices and equipment for patient positioning • the cephalad patient slide and neuropathy on patient outcomes in laparoscopic and RA gynaecologic surgery	The mean cephalad patient slide ranged from 1.07 ± 1.93 cm to 4.5 ± 4.0 cm. The overall incidence of neuropathy was 0.16%. The duration of surgery and BMI did not correlate with an increase in position-related injuries.	Due to the heterogeneity of the studies, a meta-analysis across studies could not be undertaken, limiting any definitive conclusions regarding the best technique and devices to prevent cephalad slide and neuropathy in RA laparoscopic gynaecologic procedures.	Further research should focus on: • head-to-head comparisons of anti-slide devices and techniques that also evaluate patient displacement • degree of Trendelenburg position and transient or permanent neuropathy • other relevant information – time to position the patient, cost of devices, impact of BMI, operative time.

Abbreviations: RCT – randomised control trial, IPNI – intraoperative peripheral nerve injury, PN – peripheral neuropathy, RA – robot-assisted, RAS – robot-assisted surgery, RARP – robot-assisted laparoscopic radical prostatectomy, ASA – American Society of Anaesthesiologists physical status classification system, BMI – body mass index.

as patient risk factors. Our research was underpinned by the research question: 'What is the incidence of PNI related to steep Trendelenburg patient positioning during RAS?'. This question was framed based on the PIO (Population, Issue, Outcome) framework:

P – patients undergoing RAS

I – steep (up to 45°) Trendelenburg patient positioning

O – PNI.

Search strategy

This evidence summary is based on a structured search of recent systematic reviews[3,6,11] published between January 2019 and August 2021 in the Cochrane Library, PubMed, ProQuest and Google Scholar databases. Search terms 'patient positioning', 'robotic-assisted surgery', 'Trendelenburg', 'complication' and 'injury' with medical subject headings (MeSH) were used to execute searches.

A summary of selected studies

The characteristics and key findings of the systematic reviews are summarised in Table 1.

Quality of selected studies

We did not undertake a formal quality appraisal of the included systematic reviews. Rather, our intention was to present a concise summary of the evidence in this area, that is user-friendly for busy clinicians. For a more detailed evidence synthesis such as a review of reviews (i.e. 'umbrella review'), the AMSTAR 2 (A MeaSurement Tool to Assess systematic Reviews 2)[18] has been designed to evaluate different aspects of reviews.

Table 2: The incidence of PNI associated with patient positioning during RAS

Author (year)	Number of studies in the review	Number of patients	The incidence of PNI		
			Overall	Upper extremities	Lower extremities
Bjøro et al. (2020)[11]	11	179.802	0.16% – 10.0%	0.1% – 3.6%	0.2% – 10.0%
Cornelius et al. (2021)[6]	6	63.667	1.1% – 10.8%	1.1% – 1.9%	1.3% – 10.8%
Das et al. (2019)[3]	7	2.024	0.16%	NR	NR

Abbreviations: PNI – peripheral nerve injury, NR – not reported.

A summary of the evidence

The incidence of PNI associated with patient positioning during RAS was reported in all reviewed studies[3,6,11] (Table 2). Overall incidence rates varied from 0.16 to 10.8 per cent. The cephalad patient migration was reported in one study[3]; the mean migration/slide distance using various devices ranged from 1.07 ± 1.93 cm to 4.5 ± 4.0 cm.

The most common anatomical positions of injuries in extremities related to patient positioning during RAS, as identified in systematic reviews by Bjøro et al.[11] and Cornelius et al.[6], are displayed in Table 3.

PNIs associated with patient positioning during RAS were related to patient risk factors such as high BMI (body mass index) and ASA (American Society of Anaesthesiologists physical status classification system), prolonged procedure time and multiple comorbidities (Table 4).

Implications and recommendations

Due to the heterogeneity of study designs, techniques and combinations of devices used, it is impossible to determine the best approach and assistive devices to prevent PNI. However, to minimise the incidence of PNI during RAS with steep Trendelenburg patient positioning, this evidence summary supports the need for increased attention to frequent checks and monitoring of patients during the RAS procedure. All the actions taken

Table 3: Common anatomical positions of injuries in extremities related to patient positioning during RAS

Upper extremities	Lower extremities
• brachial plexus[6,11]	• sciatic nerve[6,11]
• ulnar nerve[11]	• femoral nerve[11]
• median nerve[11]	• obturator nerve[11]
• radial nerve[11]	• femoral cutaneous nerves[6,11]
• humeral nerve[11]	• common peroneal nerve[6]

Table 4. Relation of patient risk factors and positioning during RAS

Author (year)	Patient risk factors			
	Higher BMI	Higher ASA score	Increased intraoperative time	Patient comorbidities
Bjøro et al. (2020)[11]	related	related	related	related
Cornelius et al. (2021)[6]	NR	related	related	related
Das et al. (2019)[3]	not related	NR	not related	NR

Abbreviations: BMI – body mass index, ASA – American Society of Anaesthesiology physical status classification system, NR – not reported.

What can operating room (OR) teams do to minimise the incidence of PNI related to patient positioning during RAS?

- Develop institutional policies based on the best available evidence to guide practice.
- Cautiously select suitable patients and evaluate their risk factors[4].
- Formulate a dedicated robotic OR team introduced by skilled preceptors[4].
- Increase knowledge of anatomy/physiology and extend understanding of the mechanisms of injuries[11].
- Where appropriate, use a modest angle for Trendelenburg positioning[5].
- Constantly observe the patient's position throughout the operating procedure and implement regular routine checks.

should be precisely documented using the surgical safety checklist for RAS[19]. Moreover, patients need to be fully informed about the potential risk of RAS-related complications.

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