Brachial plexopathy in laparoscopic assisted rectal surgery – a case series

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Abstract

Brachial plexopathy may be caused by malpositioning during surgery when the body's protective mechanism is lost under general anaesthesia. It is the second most common nerve injury reported in the anaesthetized patient. The exact incidence in colorectal surgery is unclear but there have been numerous cases reported of brachial plexopathy as an adverse event following colorectal surgery. Although it is widely believed that these injuries are preventable by paying special attention to vulnerable areas during patient positioning and by careful intraoperative monitoring, it appears that nerve injury may still occur. In our series of cases brachial plexopathy was still observed despite careful precautions taken to prevent nerve injury. The proposed mechanism of nerve injury in our series is most likely due to nerve stretch. We recommend certain precautionary steps to follow, as well as predisposing and perioperative factors to be aware of when anticipating a laparoscopic colorectal procedure. These may all contribute to minimising brachial plexopathy which most likely is under reported in laparoscopic colorectal surgery but is a preventable morbidity.

Key words: Brachial plexopathy; Laparoscopic colectomy; Trendelenburg position; Colorectal complications

Introduction

Injury to the brachial plexus causes weakness, sensory loss and loss of tendon reflexes in the distribution of the nerve roots C5 to T1. Brachial plexopathy (BP) may be caused by malpositioning during surgery when the body's protective mechanism is

lost under general anaesthesia. It is the second most common nerve injury reported in the anaesthetized patient [1, 2].

Romanowski and colleagues reported an estimated incidence of 0.16% in laparoscopic and robotic gynaecologic surgery [3]. The exact incidence in colorectal surgery is unclear but there have been numerous cases reported of brachial plexopathy as an adverse event following colorectal surgery. Brill and Walfisch in their series reported three cases of brachial plexopathy at the 12- month follow- up of 45 rectal cancer patients, an incidence of 6.7% [4].

Although it is widely believed that these injuries are preventable by paying special attention to vulnerable areas during patient positioning [5, 6], and by careful intraoperative monitoring [7], it appears that nerve injury may still occur.

We present a series of cases of brachial plexopathy that occurred following laparoscopic colectomy despite careful precautions taken to prevent nerve injury.

Case Series

The following five cases of brachial plexopathy following laparoscopic colectomy were observed within our Colorectal Surgery Unit over a period of 18 months (Table 1).

Case 1.

A 32-year-old female, with a body mass index (BMI) of 22kg/m^2 (weight 64kg/height 170cm), presented for a laparoscopic assisted anterior resection and suture rectopexy for the treatment of rectal prolapse. The patient had no previous surgery and no significant past medical history. The patient was placed in the Lloyd-Davies position with the right arm by the side and the left arm abducted to approximately 80 degrees from the trunk. Both arms had padded foam support and the left arm was restrained with a tie on an arm board. A beanbag was also placed under the patient with the side moulded to keep the right arm secure. The tails of the beanbag were wrapped around the shoulder across the posterior triangle of the neck but without significant direct pressure to the area due to careful placement of further padded gel supports. An upper body Bair® Hugger was also used for thermoregulation. The operating time was 2 hours and 15 minutes. The patient was in mild Trendelenburg (approximately 10 degrees) for most of the case, with steep Trendelenburg (25 degrees) and right tilt (approximately 20 degrees) for less than 60 minutes. There were no issues perioperatively and observation in the recovery room was uneventful except that, on regaining consciousness, the patient complained of pain in her left upper limb and numbness over the left hand, forearm and lower two thirds of the arm. Neurological assessment revealed decreased motor power 4/5 in the C6/C7 nerve roots with corresponding decrease in sensation in the C7/C8 dermatomes. A neurological referral was made and a formal assessment 48 hours postoperatively with a nerve conduction study confirmed a diagnosis of a left brachial plexus neuropraxia. Follow-up was organised with a neurologist and treatment consisted of physiotherapy and clinical observation.

Further follow-up at 5 months after surgery revealed resolution of all symptoms and signs of the injury.

Case 2.

A 21-year-old female with a BMI of 19 kg/m^2 (weight 58kg/height 175cm), presented for a laparoscopic anterior resection and suture rectopexy for the treatment of rectal prolapse. She had no significant comorbidities apart from mild asthma. The patient was placed in the Lloyd-Davies position with the right arm by the side and the left arm abducted to approximately 80 degrees from the trunk. All precautions were taken with the use of gel foam paddings and a beanbag similar to case 1. The operating time was 3 hours and 5 minutes. The patient was positioned in a mild Trendelenburg (approximately 10 degrees) for most of the case with steeper Trendelenburg (25 degrees) and right tilt (approximately 20 degrees) for less than 60 minutes. There were no issues perioperatively and the period in the recovery room was uneventful. Eighteen hours after surgery the patient complained of numbness of the lateral aspect of her left forearm and index finger but on questioning stated that she was aware of these symptoms from 6 hours after her operation. Neurological assessment at 24 hours postoperatively revealed normal power and normal reflexes of the left forearm and arm. There was abnormality in sensation detected with an area of numbness and decreased light touch involving the lateral aspect of the left middle and index fingers. These symptoms were much improved at 36 hours and had resolved completely by 48 hours postoperatively.

Case 3.

A 77-year-old male with a BMI of 22 kg/m^2 (weight 70kg/height 180cm), presented for a laparoscopic anterior resection for rectal cancer. His past medical history included a stage 4 melanoma on his back removed 16 years previously, a traumatic

left eye injury requiring enucleation and a chronic inflammatory demyelinating neuropathy which had been present for 25 years and was under treatment with monthly injections of Immunoglobulin. Despite treatment he had a persistent neuropathy manifested by impaired fine movements of both hands and bilateral foot drop. The patient was placed in the Lloyd Davies position with the left arm abducted to approximately 80 degrees from the trunk. The operating time was 5 hours and 35 minutes. The patient was positioned in a mild Trendelenburg position (approximately 10 degrees) for most of the operation. Steep Trendelenburg (25 degrees) with right-sided tilt (approximately 20 degrees) was utilized for approximately 120 minutes. There were no perioperative issues but following extubation he complained of weakness in his left arm. Examination revealed reduction in power and sensation along the C6/C7 dermatome distribution. Neurological advice was sought and a diagnosis of left brachial plexus neuropraxia was made. A computerized tomography (CT) scan of the brain was normal. Treatment included reassurance and physiotherapy.

At follow-up 3 months after surgery, all symptoms and signs had resolved.

Case 4.

A 62-year-old male with a BMI of 28 kg/m^2 (weight 85kg/height 173cm), presented for a laparoscopic anterior resection for rectal cancer. The patient had no history of surgery and no comorbidities. The patient was placed in the Lloyd Davies position with the right arm by the side and left arm abducted to approximately 80 degrees from the trunk on an arm board. All precautions were taken as in the previously described cases with the use of gel foam paddings and a beanbag. The operating time was 4 hours and 45 minutes. The patient was positioned in a mild Trendelenburg position

(approximately 10 degrees) for most of the case with steep Trendelenburg (25 degrees) and right tilt (approximately 20 degrees) for approximately 80 minutes. There were no issues perioperatively and recovery was unremarkable. The patient began to complain of left forearm and hand pain and numbness 6 hours after surgery. Neurological review revealed decreased power in the left forearm, wrist and hand, with absent reflexes for the left triceps, biceps and brachioradialis. There was also impaired sensation in the distribution of the C5/C6/C7 dermatome. A CT scan of the brain was performed and revealed no abnormalities. Consultant neurology review confirmed the diagnosis of left brachial plexopathy involving C5/C6/C7 nerve roots. The patient was referred for physiotherapy and at follow-up at 3 monthly intervals, progressive improvement was observed. By 7 months all symptoms and signs had resolved.

Case 5.

A 41-year-old male with a BMI of 28 kg/m² (weight 77kg/height 167cm), presented for a laparoscopic anterior resection for rectal cancer. The patient had a past history of hypertension, ischaemic heart disease, arthritis and diabetes mellitus (Type 2). The patient was placed in the Lloyd Davies position with his right arm by his side and left arm abducted to approximately 80 degrees from the trunk on an arm board. Gel foam paddings and a beanbag were used with similar precautions as previously described. The operating time was 5 hours and 15 minutes. The patient was positioned in a mild Trendelenburg position (approximately 10 degrees) for most of the case with steep Trendelenburg (25 degrees) and right tilt (approximately 20 degrees) for approximately 100 minutes. There were no perioperative issues and the patient was extubated and transferred to the recovery room. On regaining consciousness the

patient complained of left arm and forearm pains with paraesthesiae in his fingers. Neurological assessment revealed decreased flexion and extension at the left elbow with normal wrist and hand power. The reflexes were normal. There was impaired sensation in the distribution of the C5/C6/C7 dermatomes. A nerve conduction study was performed which confirmed a brachial plexus neuropraxia involving C5/C6/C7. Physiotherapy was advised. By 6 months after surgery all symptoms and signs had resolved.

The diagnosis of brachial plexopathy in our case series was made by clinical assessment. Two cases in our series were, however, confirmed by a nerve conduction study. This is certainly a subjective assessment but all neurological assessments were performed by experienced Consultant Neurologists. Two patients had a CT scan of the brain which was organised after initial assessment because of the suspicion of an intracranial pathology.

Discussion

BP due to malpositioning has been described for well over a century. It is the second most common nerve injury reported following surgery and apart from physical disability may have significant medico-legal implications [1, 2]. In colorectal surgery there have been several case reports of brachial plexopathy following laparoscopic colectomy [4, 8, 9]. All of these reports described injury secondary to improper positioning during surgery. The brachial plexus is vulnerable to injury during general anaesthesia for several reasons including its lengthy anatomical course from the neck to the axilla in a confined space between the clavicle and the first rib, its proximal and

distal fixation to the cervical vertebrae and the axillary fascia, and its close proximity to bony structures that might lead to significant compression [3, 9-13]. The mechanism of injury thus includes stretching, ischaemia, compression or a combination of these factors during surgery [9-13].

In view of the risk of brachial plexus injury during certain surgical procedures, particularly those entailing the Trendelenburg position and longer operating times, a number of precautions in terms of patient positioning have been utilized in an attempt to avoid this complication. As the risk of injury is increased if the arm is abducted more than 90 degrees and extended more than 30 degrees from the trunk, these positions are best avoided. The head should be kept in a neutral position, and neck extension and lateral flexion towards the opposite side should be minimised. Compression over the acromion and lateral pressure on the shoulders may stretch the plexus or directly push the head of the humerus against the plexus respectively and should be avoided [5, 9-11, 13]. The liberal use of gel paddings and a vacuum beanbag to avoid patient sliding when in Trendelenburg reduces the risk of BP [5, 13]. Shoulder braces and wristlets are hazards due to their potential to compress the clavicle thus stretching the plexus [8, 13, 15] and pulling of the humeral head downwards compressing the plexus [13].

Each case in our series involved positioning the patient in the Lloyd Davies position with the right arm by the side and the left arm abducted to approximately 80 degrees from the trunk and secured by an arm board. There was liberal use of gel padding and the beanbag aided in securing the right arm by the side as well as keeping the head in neutral position. Despite these precautions injury to the brachial plexus still occurred.

We presume the mechanism of injury to be one of a stretch induced nature possibly secondary to inadvertent excess abduction of the left arm or perhaps due to the head being extended and laterally rotated to the right at some point in time during the surgery. Another proposed mechanism is patient movement cranially and to the right with the left arm restrained, the beanbag does not stop movement of one to two centimetres which may be all that is needed to put traction on the brachial plexus.

Pre-existing patient factors may increase the risk of nerve injury. These include patients with peripheral neuropathy from diabetes, peripheral vascular disease or other causes [6, 13, 16]. Thin and malnourished patients with less fat cushioning are probably more vulnerable to compression injury [5, 6]. Congenital abnormalities such as the presence of a cervical rib have been recognised as risk factors for brachial plexus injury [17]. In our series, potential risk factors included pre-existing neuropathy (1 case), diabetes without neuropathy (1 case) and a low BMI ranging from 19 to 22 kg/m² (3 cases).

Perioperative factors may increase the risk of nerve injury. Hypotension, hypovolaemia, and hypothermia during surgery may increase the risk of ischaemia to the vasa nervosum [6, 17]. Steep Trendelenburg and longer operative time are major risk factors for BP [3, 13]. In this series there were no perioperative issues in terms of hypotension, hypothermia or hypovolaemia in any of the cases. The Trendelenburg position was used in all the patients, but in two of the patients this was for less than 60 minutes and the longest time spent in steep Trendelenburg position in any case was 120 minutes in one patient. The operative times for this series of patients ranged from 135 minutes to 335 minutes.

The Seddon classification system of neural injury [14] (Table 2) is a practical way to classify these cases and describes three types of nerve injury: neuropraxia, axonotmesis, and neurotmesis. It correlates the degree of nerve injury with the symptoms, pathology and prognosis [12, 13].

Assessment of brachial plexus injury should include thorough neurological evaluation, supplemented as needed by other investigations such as nerve conduction studies and MRI scan of the cervical spine.

As seen in this series, postoperative BP usually results in a neuropraxia with a generally favourable outcome[6, 16]. A review by Ben-David and Stahl looked at 22 patients with intraoperative brachial plexus injury. All patients recovered to a significant extent and none suffered from chronic pain or deterioration. There was however some suggestion that male and diabetic patients had a worse prognosis [16]. In this series all patients had complete resolution of plexopathy. The longest delay to complete resolution was 7 months with no patients complaining of deterioration or residual pain. Four patients were assessed as having neuropraxia injury with one likely having an axonotmesis injury.

Conclusions

BP is an unusual but possibly under reported complication of laparoscopic colectomy. In this series, despite employing maximum precautions to prevent injury, BP, even if mild and spontaneously resolving, was observed.

As a result of these injuries we have recommended changes to patient positioning for colorectal surgical cases, particularly where Trendelenburg positioning is used, where operative times may be longer, in patients with pre-existing nerve damage and in those with a low BMI.

We now recommend that patients undergoing laparoscopic assisted anterior resection are placed in the Lloyd-Davies position with both arms kept by the side of the trunk after placement of gel or foam pads held in place by a carefully moulded beanbag. The tails of the beanbag are also moulded around the shoulder and posterior triangle of the neck and a pillow placed beneath the head to keep it in a neutral position. Gel paddings are also used around the shoulders for further padding.

These revisions in our technique may all contribute to minimising BP which is most likely under reported in laparoscopic colorectal surgery but is a preventable morbidity. However we believe it remains prudent to counsel patients regarding the uncommon but definite risk of such nerve injuries during major colorectal surgery procedures.

Conflict of Interest: None

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Tables

Table 1 Summary of Cases

Cas e	Sex/ Age(y ears)	BMI	Comorbidities	OT time (min)	OT Position	Brachial plexus injury	Resoluti on
1	F/32	22	Nil	135	Left arm abducted	C7/C8	5 months
2	F/21	19	Mild asthma	185	Left arm abducted	C7/C8	2 days
3	M/77	22	Melanoma, Chronic inflammatory demyelinating neuropathy	335	Left arm abducted	C6/C7	3 months
4	M/62	28	Nil	285	Left arm abducted	C5/C6/C7	7 months
5	M/41	28	Hypertension, IHD, Diabetes mellitus, Arthritis	315	Left arm abducted	C5/C6/C7	6 months

BMI:body mass index; OT:operating time

Table 2 Classification of neural injury type with associated characteristics*

Injury type	Aetiology	Clinical presentation	Pathology	Recovery
Neuropraxia	Compression or ischaemia	Motor deficits > Sensory deficits Autonomic function preserved	Axonal continuity preserved	Complete
Axonotmesis	Crush or stretch	Motor, sensory, and autonomic deficits	Damage to axons with preservation of neural connective tissue	Complete
Neurotmesis	Severe contusion, stretch or laceration	Complete loss of motor, sensory, & autonomic function	Axon, myelin, and connective tissue damaged, disrupted, or transected	Incomplete

* Summary of the Seddon classification [18].