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Special article

Operating position in colorectal surgery. The importance of the basics

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A B S T R A C T

Intra-operative positioning in colorectal surgery is very important from 3 points of view: the proper surgical approach and exposure, adequate anaesthetic requirements with maintenance of the airway, and the potential complications related to the position. In the present study, we analyse the indications, positioning, advantages and disadvantages of each operative position, their potential complications and how to avoid them. These complications can be of a diverse nature, the most common being injuries related to stretching or compression of peripheral nerves, followed by thromboembolic, haemodynamic, and ischaemic or compartmental syndromes related to ischaemia-reperfusion after a long time in the Trendelenburg position. Anaesthetists and surgeons should coordinate and take responsibility for the position of surgical patients.

Posición operatoria en cirugía colorrectal. La importancia de lo básico

Palabras clave:
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R E S U M E N

La posición operatoria en coloproctología es fundamental desde tres puntos de vista: correcto abordaje quirúrgico y exposición adecuada, requerimientos anestésicos y del mantenimiento de la vía aérea, y las complicaciones potenciales relacionadas con la propia posición. En el presente trabajo se revisan las indicaciones, colocación, ventajas e inconvenientes de cada posición operatoria, así como sus posibles complicaciones y cómo evitarlas. Éstas pueden ser de diversa índole, si bien las más frecuentes están relacionadas con lesiones por estiramiento o compresión de los nervios periféricos, seguidas por las tromboembólicas, hemodinámicas e isquémicas o síndromes compartimentales por isquemia-reperfusión tras un largo periodo en posición de Trendelenburg. Anestesistas y cirujanos deben coordinar y responsabilizarse de la posición operatoria de los pacientes.

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Introduction

The positioning of the patient is a fundamental step before starting the surgical act in itself, and in coloproctology, this is especially true, as there are different treatment paths and the spectrum of gravity oscillates between interventions with purely local anaesthesia to complex surgery in simultaneous and successive fields.

Its importance can be considered from 3 points of view: adequate operatory access and visibility, anaesthetic requirements, and potential complications related with the position itself.[1] The patient is vulnerable during the surgical act as once the anaesthesia is administered, they cannot transmit their feelings and their reflexes are abolished.[2] Aside from the specific preferences of the surgeon, the correct position on the operating table is not something trivial, and therefore, the surgery staff is responsible for the placement and surveillance of the operatory position of the patient.

In this special article, the peculiarities, advantages and disadvantages, and possible complications are reviews regarding the different operatory positions used in coloproctology.

Historical antecedents

Throughout history, there has been extensive iconography that illustrates coloproctology operatory positions.[3,4] With advances in anaesthesia and anti-sepsia, abdominal surgery begins its development and in 1835, Frederick Salmon founded in London the St. Mark's hospital,[5] the use of light and the global handbook on coloproctology. James Sims describes a position for rectal examinations where the patient lays on their left side, with their right hip and knee flexed against the abdomen, that is still used today, and Friedrich Trendelenburg presents, in 1880, his famous position for pelvic surgery, where the patient is placed on a specially inclined table, with their head on an inferior plane and with an assistant that holds the patient's legs over his/her shoulders.[3] Later, Joseph Mathews, the father of American proctology, improved the above position by placing supports for the feet,[6] Kelly provides the genupectoral position,[7] and Paul Kraske, the prone position.[8]

Selection of the operatory position for abdominal procedures

Supine position

This position is the most common for open surgery of the right and transversal colon.

The patients should have their arms tucked against the body or in abduction. It is helpful to place padding under the back so that the epigastric and hypochondrias can be elevated to make access to the supramesocolic compartment easier. The calcaneus area as well as the occipital region must be protected from pressure. Other pressure areas of the upper members should be padded to avoid the over-distension of the brachial plexus in patients with their arms in abduction. Normally, in open surgery, the surgeon situates him or herself on the right side of the patient and the assistants situate themselves in front of the surgeon. In laparoscopic surgery, the position is the inverse of the above mentioned, although the situation of the assistants depends on the available monitors.

Compressive lesions such as alopecia, pressure ulcers, and lesions of the ulnar nerve may be produced.

Lithotomy-Trendelenburg position (Lloyd-Davies)

This is the most-used position in surgery of the left colon and the rectum, in open as well as laparoscopic surgery. It was initially described by Lloyd Davies[9] in 1939. Some surgeons use it when they expect to liberate the splenic flexure of the colon, and they work situated between the legs of the patient. Normally, in open surgery, the surgeon is situated on the left side, with an assistant on the right and another assistant between the legs of the patient, and in laparoscopic surgery, on the right side. This enables rectal enema, the introduction of a stapler to perform anastomosis, and the ability to control it, either with endoscopy or using air inflation, as well as to perform an intra-operatory colonoscopy in the case of obstructive tumours or other pathologic processes.

When working in 2 fields is necessary, such as in rectal amputations through the abdomino-perineal pathway, the position must be modified for the perineal portion so that the vision is adequate[10] (Table 1).

The patient is placed in the dorsal decubitus position, with hips in near extension, knees flexed some 45º and with support for the calves. The coccyx should be just off the operating table. It is important not to flex the hips more than 10º to make the access to the transversal colon easier in laparoscopic procedures. There are various ways to position the lower limbs. One of the most common ways it to use the supportive leg stands under the calves of the patient, that should comfortably rest on top of them, and to not place them in the popliteal fossa, which would compress vascular-neural structures. The support of the fibula must be also protected with a cloth or a pad. The Trendelenburg position, today, means an inclination of the trunk with the head lower than the rest.[2] Around 15º are very useful for pelvic dissections. As commented before, the leg stands should be covered with padding to prevent compressive lesions, and also to prevent skin burns and to maintain body temperature.

Another method includes the use of ankle straps, which consist of 2 strips that hang the sole of the foot and the posterior side of the ankle from a metal post without direct contact with the patient. Finally, the ideal method used today is the use of Allen-type boot leg stands, where the leg rests on a surface covered by a soft material held by adjustable bands, whose advantages are the possibility to modify the position during surgery in a simple manner and the support of the sole of the foot, more physiological, that reduces the possibilities of nerve compression, especially of the peroneal nerve (Figure 1).

Table 1 – Recommended operatory position according to the intervention type

	Decubitus supine	Lithotomy-Trendelenburg	Lithotomy	Jackknife	Lateral decubitus
Right hemicolectomy	+++	–	+[a]	–	–
Left hemicolectomy	+	–	+++[a]	–	–
Complete colectomy	+	–	+++[a]	–	–
Laparoscopic surgery of the colon	–	+++	+++[a]	–	–
Complex pelvic surgery	–	+++	–	–	–
Anterior resection of the rectum	–	+++	–	–	–
Abdominal-perineal amputation	–	+++	+++	+++	–
Minor proctological surgery	–	–	+++	+++	+
Pelvic floor surgery through perianal area	–	–	+++	+++	–
Posterior approach (Kraske or York Mason)	–	–	–	+++	–
Endoanal surgery	–	–	+++	+++	+
Transanal endoscopic microsurgery	–	+	+++	+++	+++

[a]With low leg rests.

Figure 1 – Allen-type boot leg rests. A. Placement in lithotomy position. B. Placement in low position.

When this position is used, and more so if it is forced (access to the rectum, laparoscopic treatments), it is fundamental to avoid the cephalic sliding of the patient and also lateral sliding in laparoscopic procedures. To do so, diverse devices have been used, such as tether straps, tape stuck to the trunk or the pelvis and shoulder rests. All of these objects require a careful application to avoid compressing nerves or blood vessels. The sliding or movement of the patient can compromise a correct mechanical anastomosis by making it more difficult to insert the stapler, producing sphincter lesions, by not being able to perform an adequate anal dilation and, certainly, making a low manual anastomosis or a correct perineal dissection impossible, increasing the risk of recurrences. A *bean bag*-like device has become available recently that can be molded around the patient (shoulders, arms) and that, after being connected to suction, it hardens and stays firmly adapted, which impedes any sliding or movement of the patient while at the same time it serves as protection (Figure 2).[11,12] Additionally, tape can be used to fix the patient to the table if forced lateral decubitus positions are going to be used.

The arms can be separated from the trunk being careful not to produce hyper-abductions or they can be tucked to the body, which is the more common in laparoscopic procedures. In any case, padding can be placed, preferably inflatable, below the buttocks of the patient to elevate the pelvis. Once the leg rests are placed, the legs should be raised or lowered simultaneously to avoid any traction of the lumbar-sacram ligaments. Also, the movements should be performed slowly to avoid hypotensions if the blood is accumulated abruptly in the legs.

The compression by the leg rests can produce lesions of the peroneal nerve and venous thrombosis; the Trendelenburg position can produce compartmental syndrome. Having the head lower than the rest of the body makes it harder to ventilate, especially in laparoscopic procedures, and it increases the oxygen requirements of the myocardium, and therefore it should be used with caution in at-risk patients. Also, it increases intracranial pressure and, therefore, favours reflexive hypotension, leading to gastroesophageal reflux and may affect the distribution of local anaesthesia when neuro-axial anaesthetic techniques are used. Other lesions are common for the supine decubitus position.

Figure 2 – Moldeable mattress that sticks to the patient when deflated (bean bag).

Operatory position for perineal procedures

Lithotomy position

This position enables perineal treatments to be carried out and its generic indications are for all proctologic surgery. It provides an adequate access to the recto-vaginal septum and the anterior face of the perineum. Likewise, when working via endo-rectal, it allows for easy access to the posterior face of the rectum and also for the combined treatment during the amputation of the rectum. An important advantage is the improved access to the airways that allows considering carrying out the intervention using deep sedation and local anaesthesia and reconversions to general anaesthesia when needed. It may be very useful to have a small instrumental table resting on the buttocks of the patient. The disadvantages are, on the one hand, the discomfort of the surgeon and, fundamentally, of the assistant, stuck between the leg rests of the patient; and on the other hand, the bleeding that spills onto the operatory field. Finally, it is difficult to obtain adequate lighting in some cases if no frontal headlights.[13,14]

The placement of the leg rests is similar to that mentioned above, but the limbs should be placed with greater abduction, flexed and externally rotated, so that elevation and prominence of the perineum is produced which will make the surgery easier.[1]

The possible lesions are similar to those described for the Lithotomy-Trendelenburg position regarding the lower limbs.

Jackknife position

It is also called the Kraske position and it is very useful for almost all proctological surgery. It allows for an excellent exposure of the posterior and anal perineum and the anterior face of the rectum in endo-anal procedures. The surgeon and assistants are comfortably situated on the sides of the patient, and the operatory field is less bloody and more easily illuminated than in the lithotomy position. Choosing one or the other depends on the side-effects, but it is ideal for ambulatory surgery or when local or regional anaesthesia is used. The new anaesthetic drugs, that possess an immediate effect and a fast elimination velocity, allow for improved control and to achieve adequate sedation. Complex anal-rectal procedures or those that require time, attention and good exposure, such as very low anastomosis and mucosectomies are carried out in a more comfortable and effective manner with this approach. On the contrary, logically, it does not allow for combined access and these cases require an intra-operatory change of position which lengthens the duration of the surgery and exposes the patient to possible problems. Concerning this aspect, today, a growing indication is to carry out the perineal part of the rectal amputation in this position as it is possible to obtain a more oncologically complete cylindrical specimen at the level of the plane of the elevating muscles, and it imposes affecting less the circumferential margin,[15] also, in some cases, a plastic perineal reconstruction is required.[16] Its indication can be systematic or selective, in cases of infiltrating neighbouring structures.

Various experienced people are needed to correctly position the patient, and the control of the airways is a priority. Before moving the patient, 2 pillows or inflatable pads are placed: the smaller one underneath the shoulders to avoid altering the breathing movements, leaving the abdomen free, and another one in the pelvic area, below the hips, to facilitate perineal exposure. This area should rest on the portion where the operating table is angled, lowering the lower limbs and also the upper part of the table (barber's knife or Sevillian). This way, the anal-rectal region is in an elevated position, which facilitates surgical access. The correct exposure depends on the form of the buttocks and the depth of the anus,[1,7] and therefore, for anal surgery, tapes should be placed at the level of the external portion of the ischiorectal fossas that point towards the cranium to attach them to the surgical table. In this way, a horizontalisation or exteriorisation of the anal orifice is carried out, that will help in cases where the shape of the buttocks is infundibular and, therefore, the anus is at a deeper position (Figure 3). The head is placed slightly lower than the heart and is turned to one side over a soft pad. A cloth or pillow should be placed below the ankles to prevent plantar flexion or compression of the toes. The arms should be carefully turned and placed in extension around the head, without compressing the ulnar nerves. For short surgeries, and with patients that have buttocks with a shallow crevice, angling the operatory table is not necessary.

The anaesthesiologist should make sure that his or her staff understand their responsibilities while moving the patients to the decubitus prone position. The turn should be

Figure 3 – Placement in jackknife position. A. Observe the anterior traction and the inflatable pad. B. Exposure of the perianal area.

Figure 4 – Anaesthesia in decubitus prone. A. Placement of the laryngeal mask airway. B. In situ laryngeal mask airway. C. Position of the patient. Observe that there are 2 inflatable pads or pillows, one below the shoulders and the other under the pubis (black arrows).

done in one head-neck-body plane to avoid causing forced movements or positions. The functionality of the equipment, the intravascular lines, the maintenance devices for the airways and the padding of the supportive areas should be verified before turning the patient.

All of this makes it so that each day, the local anaesthesia techniques with sedation or induction in the decubitus prone position are better understood, which allows for a direct placement of the patient him or herself, adopting a comfortable and painless position. This way, unnecessary manipulations and inadequate positions are avoided, but, above all, the repercussions on the sympathetic nervous system are reduced when moving the anaesthetized patient.

There are new tendencies regarding the maintenance of the airways (AW). This refers not only to the possibility to rescue the AW after an accidental extubation or excessive sedation in the prone position, but also during the anaesthetic induction. For both situations, the use of the laryngeal mask airway (LMA) has been described (Figure 4). The reasons and indications of this technique are well known.[18] The common technique is local anaesthesia with sedation. However, more complicated interventions can be carried out using neuro-axial anaesthetic techniques or general anaesthesia; recently, induction in the decubitus prone position has been incorporated using total intravenous anaesthesia with infusion controlled by a computer and maintenance of the

AW with LMA with the guided insertion technique that allows for a faster recuperation.[19,20]

Usually, the physiological repercussions of this position are well tolerated, except in patients with previous cardio-pulmonary diseases. Generally, the patients are re-positioned in the decubitus prone position on the operating table while they are under general or neuro-axial anaesthesia. Although this step produces minimal changes in the heart rate, the average blood pressure, the central venous pressure and the pulmonary wedge pressure, it does seem to cause a decrease in the cardiac index due to the decrease in the volume/beat and an increase in the pulmonary and peripheral resistances.[2] Leaving the abdomen free is very important, as the pressure on the abdominal wall could produce the cephalic displacement of the diaphragm, increase intra-thoracic pressures and decrease the capacity to distension of the thorax and of the residual pulmonary capacity. Also, it would favour the compression of the lower vena cava and the aortic artery.

In any case, there is a series of complications related with the positioning of patients in decubitus prone[21]: turning the head may make the drainage of the jugular vein difficult, which would facilitate its thrombosis and/or the blood flow of the vertebral and/or cerebral arteries. As the head is below the level of the heart, an increased flow to the brain is produced and prolonged surgeries can produce periorbital oedemas and visual disorders. Eye protection is also mandatory.

Abductions greater than 90º and excessive rotations of the shoulders that favour lesions of the brachial plexus should be avoided. Lesions of the ears, nose, penis, scrotum or breasts have been described as well as of the lateral-cutaneous thigh nerve by compression at the iliac spine level, and thrombosis of the axillary or subclavian veins.[2]

Lateral decubitus position (Sims)

This position is rarely used in our area, mostly only in trans-anal endoscopic microsurgery. It has been used very occasionally in elderly patients that do not tolerate the jackknife position.

The modified Sims position, with both legs flexed over the thorax and with the spine also flexed,[22] is used. A pillow must be placed below the hip to elevate the surgical area and protect the perineum of the leg that is left down with a pad.

Lesions of the peroneal nerve and of the brachial plexus may be produced by pressure or stretching, as well as lesions of the face and eyes.[2]

Complications related with the operating position in colorectal surgery

Ocular lesions

Ulcers or corneal abrasions may appear from contact with foreign objects. The eyes should be closed and humidified with saline solution, but any prolonged pressure, including that from protection, may produce vascular thrombosis and an undetected ocular contact can cause vision loss in only a few minutes.[23]

Skin and subcutaneous cellular tissue lesions

The pressure lesions of the soft tissues are more frequent in decubitus prone and they consist of pressure ulcers or alopecia from ischaemia (Table 2).

Ischemic lesions. Compartmental syndrome

Acute compartmental syndrome (ACS) is a feared complication, although it is fortunately rare in the lithotomy-Trendelenburg position that has been called the well leg compartment syndrome.[24] It consists of a muscular ischaemia and secondary necrosis from the increase in the hydrostatic pressure in the centre of a closed fascial compartment and it is found in up to 33% of the post-traumatic revascularizations of the lower limbs, as a consequence of an ischaemia-re-infusion phenomena from the accumulation of a secondary oedema to the increased capillary pressure, alteration of the vascular permeability, difficulty of venous return and the arterial flow. The severity is related with the duration of the ischaemia, which is minimal for periods shorter than 3 hours.[25]

Horgan et al[26] monitored the arterial pressure and the arterial flow in the lower limbs using a Doppler laser in complex pelvic surgery, and they illustrated that a cephalic inclination of 15º causes an immediate fall in the perfusion of the legs. Two hours after the intervention, the perfusion pressure in the muscular compartment increases 10 times without any increases in the cutaneous pressure.

Table 2 – Probability of lesions according to positioning during surgery

	Decubitus supine	Lithotomy-Trendelenburg	Jackknife	Lateral decubitus
Venous thromboembolic disease	Low	High	Low	Low
Compartmental syndrome	Low	High	Low	Low
Lesion of soft tissues	Low	Low	High	Low
Lesion of peroneal nerve	Low	High	Low	High
Lesion of ulnar nerve	High	Variable	High	Low
Lesion of cervical-brachial plexus	Low	High	Low	Low

Modified by Karulf.[2]

Additionally, the following factors can also influence the situation: the position of the hips and knees, the external compression as prophylaxis for the venous thromboembolic disease (VTD), the type of support used for the legs and the surgery duration.[27,28] Therefore, the maintenance of the Trendelenburg position must be controlled as if it produces ACS, it can even lead to an amputation, and its treatment, the fasciotomy, has non-predictable results. Also, unless it is carried out in the first 12 hours, there is no recuperation of neuromuscular function.[29,30] Among its causes, the following have been attributed: age, sex, muscular mass of the calves or the body mass index, the use of epidural analgesia, that redistributes blood flow, and previous arterial disease that, at the same time, may hide the signs and symptoms in the post-operatory period. It should be suspected in patients that present excessive post-operatory pain in the calf or in the anterior compartment, with muscle weakness and sensorial alteration. Preventing it by using the correct position is ideal, placing the calves slightly lower than the right atrium, so that they are not too high once placed in the Trendelenburg position,[27] without angling the hips excessively; avoid hypotension, make sure that nobody rests their limbs on the legs of the patient and, if the position was needed for more than 4 hours, turn the patient to the supine position every certain amount of time.

Wassenaar et al[31] recently reported 7 cases and, after applying preventive measures, they experienced no more complications. Although only around 42 cases have been published in literature reviews,[26,27,31,32] there are probably many more.

Vascular alterations

VTD is much more prevalent that ACS. The combination of disease with independent risk factors, such as cancer or inflammatory intestinal disease with major surgery of the pelvis, the position during surgery and pneumoperitoneum that makes venous return difficult in laparoscopic procedures, makes the use of preventive measures mandatory.[33,34] A serious problem related with the operatory position is the thrombosis of an aortic endoprosthesis; there are 2 cases reported where rectal surgery was carried out after implanting.[35] Likewise, the thrombosis of unknown peripheral aneurisms has been cited.[36]

Haemodynamic changes

The haemodynamic changes produced have been analysed with the modifications in operatory positions. The movement from a decubitus supine to prone produces a significant alteration in the cardiac index.[37] However, the pneumoperitoneum and the Trendelenburg position increase the preload and the intra-operatory fluids and intra-abdominal pressure must be carefully managed to prevent adverse haemodynamic effects during laparoscopic surgery,[38] which, together with the increase in the myocardium's need for oxygen[39] and the reduction of the pulmonary distension,[40] are important risks for cardiac patients. These changes are a consequence of an accumulation of factors: anaesthetic, mechanical, and neural factors and those secondary to the position, which make it difficult to establish the particular involvement of each one of them. The removal of the pneumoperitoneum and moving the patient back to the decubitus supine position revert these changes in a gradual manner.[41] The cooperation of an anaesthesiologist that is an expert in handling these physiological changes related with the operatory position and the modification of the intraabdominal pressure is fundamental to adequately use this—in many aspects—advantageous approach.

Nerve lesions

Nerve lesions can be compressive or from extension. The peripheral neuropathy is a significant source of morbidity and one of the most important causes of problems in the use of anaesthesia. It can be prevented if the patient is placed in relatively neutral positions with good protective padding and by avoiding prolonged surgeries.[42,43] The possibility to return to normal function depends on the degree of damage. Transitory lesions appear from a short compressive lesion. Neuropraxia is a temporary paralysis or sensorial loss with demyelinization of the peripheral fibres. Remyelinization occurs in 1 to 2 months and there is a great probability of success. If the degree of the lesion is greater, with total damage to the axons in an intact nerve sheath (axonotmesis), its prognosis is much worse.

- Compressive lesions. The common peroneal nerve (branch of the internal popliteal sciatic nerve) exits laterally near the head of the fibula. Its superficial branch innervates the peroneal muscles and provides sensitivity to the lower two thirds of the calf and the foot dorsal. The deep portion innervates the extensor muscles and the feeling between the first and second toe. There is a risk of compressing it to the head of the fibula with leg rests against the calves. Damaging it causes a club foot.[2,44] The femoral nerve (L2-L4) moves in a deep plane along the inguinal ligament, innervates the quadriceps muscles and provides sensitivity to the anterior side of the thigh. It can be damaged by retraction or by flexion of the hip and compression of the inguinal area.[45] It then continues as the saphenous nerve innervating the medial portion of the leg and can be compressed at the level of the internal face of the knee. Weakness of the quadriceps muscles and the lack of sensitivity in the internal face of the sole of the foot are indicative of these lesions. The cutaneous thigh nerve (L2-L3) runs along the lateral face of the inguinal ligament. It provides feeling to the lateral face of the thigh and its compression can produce a burning sensation, tingling or numbness (meralgia paresthesica), that generally go away spontaneously.[46] The genitofemoral nerve (L1-L2) innervates the femoral triangle and part of the scrotum, the vulva and the upper-internal face of the thigh. Retraction or inguinal compression can damage it, causing sensorial alterations.
- Lesion by extension. The sciatic nerve (L4–L5, S1–S2–S3) can be compressed in the gluteus region when placing the patient on a hard surface.[2,47] Its extension, by flexing the hips excessively, it can be directly damaged or the

damage can be done to the arteries that feed it, and an intervention must be carried out in less than 6 hours. The damage produces weakness or paralysis of the ischiotibials and the muscles below the knee, with sensorial alterations in the areas of the common peroneal and tibial nerves. The obturator nerve (L2-L4) innervates the abductors and provides sensitivity to the medial portion of the thigh. Damage to this nerve can be caused from retraction or extension with the abduction of the hip more than 30º and external rotation. To reduce the risk, it is recommended to simultaneously flex the hip while positioning the patient.[48]

In a review of 1210 patients after major pelvic surgery, 23 (1.9%) post-operatory neuropathies were observed; 73% recuperated completely.[47]

The neuropathy of the brachial plexus is a rare syndrome with a published incidence of 1.6 cases/100 0000 produced by extension secondary to hyperabduction. The symptoms usually go away in 8 to 12 weeks.[49] Finally, lesion to the ulnar nerve is also one of the most frequent lesions, and generally, it has a good prognosis.[50]

Conclusions

The correct positioning of the patient on the operating table for coloproctologic surgery is of great importance, as it does not only improve surgical exposure and therefore, the results, but it also helps to reduce the inherent complications due to inadequate positioning or movement, that are estimated to be present in around 1/1000 patients; most likely, the peripheral nerves are those that are exposed to the greatest amount of risk. Anaesthesiologists and surgeons should direct, cooperate and take responsibility for the operatory positioning of patients, which should be reported in the anaesthesia and operatory records to reduce legal implications.

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