ОБЗОР

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ANESTHETIC IMPLICATIONS OF PATIENT POSITIONING IN NEUROSURGERY

(PART I)

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Patient positioning in surgical procedures has serious implications on clinical outcome. While surgical approach and exposure are considered by surgeons, frequently, the importance of properly positioning the patient, accounting for the clinical situation and co-morbidities, is overlooked. This is particularly true in many neurosurgical procedures, which require prolonged anesthesia and immobilization.

Traditionally, it is the anesthesiologist's responsibility to look after the well being of the patient, and maintain an adequate physiological environment, promoting full recovery. In this review, we analyze the different positions common in neurosurgery considering and balancing between surgical exposure, hemodynamic implications, patient comfort and neurological outcomes. The latter should be given particular attention, as it might be difficult to differentiate between neurological deficits which are a result of the patient's position, and those that are part of the underlying condition or surgical complication. Some positions interfere with standard monitoring or necessitate temporary interruption of or ventilation and continuous IV treatment. These as should be taken into account as well, reducing the interruption to the minimum. Finally, several complications are associated with specific positions and the approach to these complications is discussed. The review has been divided into two separate parts. Here is the first part discussing problems, related to head, neck and body positioning including supine and lateral position. The second part discussing benefits and problems related to prone and sitting position will be discussed in the next issue of the journal.

Introduction.

Positioning of the surgical patient is an important part of anesthesia care. Proper attention to the physical and physiological consequences of positioning can help prevent serious adverse events and complications. The general principles of patient positioning of the anesthetized and awake neurosurgical patient are discussed in this review.

Ideal patient positioning involves balancing between surgical comfort, and the risks associated with the patient's position. Therefore, surgical positioning of the patient should be considered and thoroughly planned during the preoperative evaluation. Typically, patient positioning is addressed after induction of general anesthesia and placement of arterial and venous lines, and considered the joint responsibility of the surgeon and anesthesiologist. Positioning of the neurosurgical patient is particularly challenging taking into consideration adequate anesthetic depth, maintenance of hemodynamic stability, evidence of appropriate oxygenation, and proper functioning of invasive monitors. Often, in the process of preparing the patient for proper positioning, there are necessary interruptions in continuous monitoring and treatment regimens. Disconnection of intravenous or arterial catheters and the tracheal tube may be required during body positioning and rotation/movement of the operating table, generating a complete "blackout" state, while the patient lacks proper monitoring or oxygenation. Trauma patients, who might have concomitant chest or lung injury with hemo/pneumothoraces, are particularly dependent on functioning chest tubes for maintenance of hemodynamic and respiratory stability. Such patients should be continuously monitored, reducing the blackout period to the bare minimum necessary. Chest tubes should not be clamped in the process. Many neurosurgical procedures may durate several hours. In this situation, improper positioning may have much more serious sequels than those of short-lasting procedures. Furthermore, even when properly positioned, the patient may suffer complications attributable to the lengthy duration of the procedure and immobilization. General precautions should always be followed in all procedures:

1. Use a gel mattress in order to prevent excessive pressure on prominent parts of the body, which are prone to be injured as a result of prolonged external pressure. The gel redistributes mechanical pressure, such as that applied by bony prominences. Padding should always

be placed between the patient and any hard support surface.
2. Verify that the patients underlying surface is smooth, with no significant crevices or folds in the sheeting
3. Avoid applying pressure on skin surface with monitoring wires, stickers and catheters.
4. Eyes should be meticulously protected in order to avoid conjunctival dryness, abrasions and pressure on the eye globe.
5. Avoid contact between patient's skin and metal/conductive surfaces that may influence electrical currents, resulting in burns.

The intraoperative incidence of pressure ulcers is directly correlated to the length of surgery. Most patients can tolerate pressure for brief periods. Tissue hypoperfusion, ischemia, and necrosis may occur, if the pressure is continuously applied for prolonged periods of time. Certain conditions make patients more vulnerable to injury, such as age (ie, neonates, adults older than 70 years), cardiac disorders, cancer, diabetes, poor preoperative nutritional status, preexisting pressure ulcers, size (eg, small stature, thin, morbidly obese), smoking and vascular disease. Approximately 80% of all pressure ulcers occur in one of four anatomical locations: sacrum, ischium, trochanter, and heel. The safety belt shall be positioned at least five centimeters above knees. A belt positioned directly over or beneath the knees can compress the common peroneal nerve against the head of the fibula.

Head Positioning.

Patient positioning for craniotomies and the majority of spine procedures requires particular attention, since the site of surgery is most vulnerable to the effects of positioning, while in most cases, access to the site remains limited during the surgery. Understanding the neurosurgical approach is of great importance for the anesthesiologist, and may influence the decision of whether the patient can tolerate the desired intraoperative positioning, and the necessary precautions.

Types of Craniotomies: In modern neurosurgery, 6 standard types of craniotomies are common, and are aimed to allow the best surgical approach to the region undergoing surgery, while keeping the exposed area minimal. The approach determines the optimal position: 1) anterior parasagittal 2) fronto-spheno-temporal (pterional) 3) subtemporal 4) posterior parasagittal 5) midline suboccipital and 6) lateral suboccipital.

Head fixation: For craniotomies, the head can be positioned on the horseshoe headrest (or doughnut), or skeletally fixed with the three or four-pin fixation device (Mayfield frame). Application of a skeletal fixation device and tightening of pins on the scalp has a profound stimulating effect, leading to tachycardia and hypertension. Since severe hypertension during pin fixation may cause rupture of untreated cerebral aneurysms, pins may be placed only after the anesthesia team has preempted the hemodynamic effects of fixation. Infiltration of the skin with local anesthetics should be preformed whenever possible, in awake as well as in the anesthetized patient, and the dose of local anesthetic should be recorded. In patients under general anesthesia, anesthesia should be deepened with either a bolus of intravenous anesthetic agent (e.g. propofol 0.5-1 mg/kg), short-acting opioids (fentanyl or remifentanyl), or the inhalational anesthetic concentration. The dose of the anesthetic given should be titrated to the estimated depth of anesthesia and arterial blood pressure. Therefore, standard monitoring and invasive blood pressure monitoring should have commenced before application of pins. In cases where invasive blood pressure monitoring is unavailable (e.g. during an emergency such as head trauma), a bolus of an anesthetic agent should be given before application of pins, titrated to the noninvasive blood pressure value.

Benefits of the skeletal head holder include immobility of the head, and surgical comfort. Risks associated with use of the head holder, include bleeding from the pin insertion sites, air embolism (particularly in sitting position, where placement of antibiotic ointment on pins is advocated for prevention of air embolism), and scalp and eye laceration. The risk of scalp or even cervical spine injury exists when inadvertent patient's movement occurs. As some craniotomies and spine procedures require that neuromuscular blocking agents not be used do to interference with electrophysiological monitoring, the risk in these cases may be even greater. Use of bispectral index monitoring of anesthesia depth may be warranted. At the end of surgery, the patient should be maintained in deep anesthesia throughout the repositioning process, until the fixation frame is removed.

Pressure alopecia has been described after using a horseshoe headrest.

Head and Neck positioning: Manipulation of the head and neck incautiously during positioning may have serious consequences, including quadriplegia and cerebral infarction. Even in healthy individuals, slight movement of the head and neck may lead to mechanical stress of arteries and veins supplying brain and cervical spinal cord. Blood flow in the vertebral arteries, which are located in the narrow foramina in the transverse processes along the cervical spine, decreases on the side ipsilateral to the direction of head rotation. Hyperflexion of the head and neck may decrease blood flow in vertebral and carotid arteries, leading to brain stem and cervical spine ischemia, resulting in quadriparesis and quadriplegia. Patients with osteophytes, arthritis, or vascular atherosclerosis also are at risk for cerebral ischemia secondary to inappropriate head and neck movement. During alignment, the head can typically be safely rotated between 0 - 45 degrees away from the body. Data from awake craniotomies shows that when patient's head is rotated more than 60 degrees in order to improve surgical access, motor deficit

may occur even prior to surgical manipulation of the motor cortex. Therefore, if possible, the head should be aligned with the body axis. If a more pronounced rotation is needed, placement of a roll or pillow under the opposite shoulder is recommended. Maintaining 2-3 finger-breadths thyromental distance is recommended during neck flexion. Excessive head flexion may reduce anterior-posterior size of the hypopharynx, causing ischemia of base of tongue or limit lymphatic drainage and lead to pharyngeal and tongue edema. This complication is more common when foreign bodies (TEE probe, large-bore nasogastric and endotracheal tubes, oral airway) are used. The patient's preoperative ability to move the neck without neurological consequences such as paresthesias, pain, or dizziness may limit or dictate the extent of intraoperative head and neck positioning. Hyperflexion, hyperextension, lateral flexion or rotation should be avoided.

Impairment of cerebral venous outflow, especially during prolonged surgery, can potentially cause intraoperative brain swelling, increased intracranial pressure (ICP), ischemia and cerebral infarction. Jugular veins and vertebral venous plexuses are the major venous pathways from the brain. Because jugular veins tend to collapse with changes of body position (e.g. in sitting position), vertebral venous drainage may predominate. Collapse or obstruction of jugular veins, and stretching or obstruction of the vertebral venous plexus should be avoided during head and neck positioning. Preventing impairment of venous return during head positioning includes apprehensive monitoring for positioning and external compression by the tape or lace fixating the endotracheal tube. Neck and facial edema may compromise venous outflow during surgery, and a lax string may become tense to further impede outflow.

Body Positioning.

Six basic body positions are common in neurological surgery: 1) supine 2) lateral 3) prone 4) concorde 5) sitting 6) three-quarters. Body position is associated with significant circulatory and respiratory changes, as well as neurological sequel, in both awake and anesthetized patients. These changes may affect blood-gas exchange and cerebral hemodynamics.

A. Supine Position (Dorsal Decubitus Position)

The supine position is the most frequently used position in neurosurgery and is used for a vast array of cranial procedures, carotid endarterectomies, and anterior approaches to the cervical and lumbar spine. Advantages: This is the simplest position because it does not require special instrumentation, is easily achievable, and usually does not require disconnection of the tracheal tube, lines and invasive monitors. Furthermore, being the most common position, most anesthesiologists are aware of respiratory and cardiovascular changes associated with the position, and may avoid possible pitfalls. Risks: Head rotation or flexion is often required in order to achieve optimal surgical conditions, which may be harmful to patients with cervical spine trauma, rheumatoid arthritis and osteoarthritis. Prolonged duration poses bony prominences i.e. heels, ischium, scapulae and occiput at risk of pressure ulcers. Cardiovascular and respiratory changes may have impact on patients with preexisting conditions.

Three variants of supine positioning are common in neurosurgery. The horizontal position is achieved with the patient lying on his back on a flat table. This position does not provide optimal positioning of the hip and knee joint and is poorly tolerated even for a short time by awake patients. Skin to metal contact should be prevented and arms must be padded or restrained along the body or positioned on arm boards. Bony contact points at elbows and heels should be padded. The lawn chair (contoured) position is a modification of the horizontal position with 15 degree angulation and flexion at the trunk-thigh-knee and provides better physiological positioning of the lumbar spine, hips and knees. Respiratory changes associated with shifting of dependent lung areas and reduction of functional residual capacity (FRC) is less significant. A blanket, soft (gel) cushion or pillow can be placed under the knees to keep them flexed. The lawn chair position is associated with improved venous return to the heart, due to improvement of venous drainage from the brain, caused by the slight head leg elevation. The head-up tilt or reverse Trendelenbourg position usually involves a 10-15 degree repositioning from the horizontal axis to provide optimal venous drainage from the brain.

Hemodynamics and Ventilation: Two factors, influenced by body positioning, affect hemodynamics: i) Vertical height - Elevation of every 2.5 cm vertically above the reference point (heart) draws a 2 mmHg decrease in mean arterial blood pressure. ii) Venous return - being a low pressure compartment, the venous return to the heart depends on body position. Head-down tilt increases venous return from the lower extremities, but increases venous congestion in the upper part of the body. If the head is tilted below the level of the heart, venous pressure in the cerebral veins increases in proportion to the hydrostatic pressure gradient. Even after short procedures, postoperative headache, congestion of the conjunctivae and nasal mucosa may be observed. Improved venous drainage from the brain is achieved by positioning the head above the level of the heart using the reverse Trendelenburg position or flexion of the table or headrest. As mentioned earlier, the head may be safely rotated 0-45 degrees (excluding cases with a clear contraindication). If a greater rotation is necessary, use of pillows under the contra-lateral shoulder is advised, reducing the rotation of head relative to torso.

In awake hemodynamically stable subjects, body position does not usually cause profound changes in blood pressure, due to intact baroreceptor (from aortic arch and carotid sinus) reflexes and

renin-angiotensin-aldosterone system. Any depression of these reflexes, such as during anesthesia, or exhaustion of the compensatory mechanisms (severe shock), may lead to hemodynamic instability following changes in body positioning. When steep anti-Trendelenburg (head up) position is used, it is recommended to position the arterial line transducer at the level of the brain's basilar circulation (in the level of ear), in order to maintain adequate cerebral blood flow and avoid cerebral ischemia.

Supine position for anterior cervical spine deserves special attention. Incidence of post procedural airway compromise is reported to be as high as 6%. The risk for airway compromise is even greater, following surgery performed in a combined anterior-posterior approach. Potential causes of airway obstruction include pharyngeal edema (most common cause), hematoma, recurrent laryngeal nerve palsy, cerebrospinal fluid leak, angioedema, and graft or plate dislodgment. Although leak test should be preformed prior to extubation, most often, edema is not evident by the time of extubation, and develops 24-36 hours after extubation, requiring reintubation in up to 30% of the patients. Predisposing factors contributing to development of this complication are: surgery involving more than three vertebral bodies, blood loss greater than 300 ml, exposures involving C2-C4, and duration longer than 5 hours.

B. Lateral Position

The lateral position is used for procedures requiring access to postero-lateral areas such as: temporal lobe craniotomy, skull base and posterior fossa procedures, and retroperitoneal approach to thoracolumbar spine.

Advantages: This position provides the best surgical approach to the temporal lobe.

Risks: Major effects of this position are related the effects of prolonged unilateral pressure, i.e. brachial plexus injuries, stretch injuries, pressure palsies, and the effect of a dependent compressed lung (ventilation perfusion mismatch).

Hemodynamics and Ventilation: The lateral position has significant effects on the ventilation perfusion ratio due to the effects of gravity on the dependent lung. Perfusion is greatest in West Zone 3, but tissue elevated more than 18 cm above bed level, in the dependent lung remains poorly perfused. During general anesthesia and positive pressure ventilation, the non-dependent lung zones are better ventilated, ventilating non-perfused alveoli, thus increasing the ventilation-perfusion mismatch and eventually leading to possible hypoxemia.

Unilateral pressure, necessitates additional attention when positioning the patient's dependent (lower) arm because of the potential danger for axillary artery compression and brachial plexus injury. The dependent arm can be positioned in the hanging or ventral position, rested on a low padded arm board inserted between the table and head fixator. Alternatively, the forearm can be hung on a pillow and towels wrapped over the arm and forearm. The shoulder should be abducted, and the elbow flexed. An axillary roll, inflatable pillow or a gel pad should be placed under the upper chest (not directly in the axilla) in order to decrease the pressure on the dependent shoulder and prevent arm ischemia, brachial plexus injury, and compartment syndrome. It is also critical to support the patient's head with a pillow or gel pad in order to minimize angulation of the cervical spine. This may be achieved by simultaneous inflation of both inflatable pillows under the chest and the head. Palpation of radial pulse on the dependent forearm, or, monitoring blood pressure contour if an arterial line is present, may be helpful in verifying optimal positioning. The nondependent (upper) arm may be positioned on the "airplane" armrest or on a pillow placed anterior to the patient's body.

At the lower extremities, particular attention should be given to the pressure applied by the non dependent leg on the dependent leg. Pillows should be placed between the patient's legs to help protect the common peroneal and saphenous nerves from excessive pressure . Peroneal nerve injury may also occur as a result of compression of the dependent knee against a hard surface, and should therefore be clear from the tubing of the intermittent compressing device. The nondependent leg should be extended or slightly flexed maintaining it in a neutral position.

Summary.

Positioning of the patient for neurological surgery is an important part of anesthesia care and poses many technical and physiological challenges. As discussed, recognition of the physiological changes with positioning and careful and meticulous positioning may decrease unwanted complications and provide better outcome for the patient.

Recommended literature

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ТҰЖЫРЫМ

Нейрохирургиялық ем-шараны орындау үшін науқасқа ыңғайлы жағдай жасау емдеу жетістіктеріне бірталай әсер етеді.

Сол уақытта оталап жету оташының айрықша ісі, анестезиолог дәстүрлі турде науқастын дұрыс орңықтыруна, клиникалык ситуациясына және қосалқы ауруларына байланысты, сонымен қоса науқастың жағдайын бір қалыпта ұстауға, тез арада және толық оянуына жауапкершілік жүргізеді. Бұл әрине, көп уакыт жансыздандыру және жылжымаушылықты талап ететін нейрохирургиялық операцияларда маңызы зор. Бұл талдамада біз, нейрохирургияда қолданылатын әр түрлі позицияға анализ жасай келе, ыңғайлықпен оталап жету арасындағы тепе-теңдігін еске ала отырып жайғасымның гемодинамикамен вентиляцияға, науқастың жайлы жағдайына әсер ететіндігі. Науқастың жайлы жағдайына ерекше көңіл аудару керек өйткені операциядан кейнгі науқастың дұрыс емес жайғасымынан болған неврологиялық тапшылық хирургиялық әдіс нәтижесінде болған неврологиялық тапшылықтан қиын ерекшеленуі мүмкін.

Кейбір жайғасымдар стандартты мониторингті қолдануға кедергі жасайды, немесе мониторды, өкпенің жасанды вентиляция аппаратын немесе көк тамырға жіберілетін инфузияны және анестетиктерді уақытша сөндіруді талап етеді. Сондай жағдайларда жоғарыда аталған манипуляциялардың уақытын ең аз уақытқа дейін қысқартуға әрекет жасау керек. Науқастың арнайы жайғасым-қалпына байланысты болған асқынулар, олардың диагностикасы және ем тәсілі осы талдамада айтылады

Осы талдама екі бөлімге бөлінген. Бірінші бөлімде арнайы нейрохирургиялық операцияларға тән: бастың, мойынның және денеге байланысты проблемалар талқыланады, арқамен жату, қырымен жату қалыптары да осының ішіне кіреді. Екінші бөлімде – ішімен жату қалпы, отыру қалпы талқыланады, ол журналдың келесі нөмерінде шығарылады.

SUMMARY

Придание правильного положения больному для выполнения нейрохирургических процедур имеет значительное влияние на успех лечения.

В то время, как хирургический доступ является прерогативой хирурга, анестезиолог традиционно несёт ответственность за правильное положение больного в соответствии с клинической ситуацией и сопутствующими заболеваниями, так же как поддержание стабильного состояния больного и обеспечения быстрого и полного пробуждения. Это особенно важно для большинства нейрохирургических операций, которые требуют длительного наркоза и иммобилизации.

В данном обзоре мы анализируем различные позиции, используемые в нейрохирургии, принимая во внимание балансирование между удобством хирургического доступа, влиянием позиции на гемодинамику и вентиляцию, удобство для пациента. Последнее заслуживает особого внимания, поскольку послеоперационный неврологический дефицит, как следствие неправильного положения больного, может быть трудно отличим от неврологического дефицита, являющегося следствием хирургического вмешательства.

Некоторые позиции препятствуют адекватному использованию стандартного мониторинга или требуют временного отсоединения пациента от монитора, аппарата искусственной вентиляции легких (ИВЛ) или внутривенных инфузий и анестетиков. В этих случаях следует стремиться сократить время вышеперечисленных манипуляций до минимума.

Осложнения, связанные со специфическими положениями больного, их диагностика и лечение также дискутируются в этом обзоре.

Данный обзор разделён на две части. Это первая часть, в которой обсуждаются проблемы, связанные с положением головы, шеи и тела, включающие положения на спине и на боку, специфичные для нейрохирургических операций. Вторая часть, где обсуждаются положения на животе и «сидячее положение», будет опубликована в следующем номере журнала.