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Anesthesia Concerns with the Beach Chair Position

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Abstract

The beach chair position has become a commonplace positioning technique for various procedures in the operating room. The purpose of this study was to review research related to the use of the beach chair position and general anesthesia along with the complications associated with it. There can be complications associated with this position that include venous air embolism, unrecognized cerebral hypoperfusion, blindness, and nerve injuries. The beach chair position causes many hemodynamic changes in the body; this is compounded when general anesthesia is used to further impact the stability of patients. Recent research has shown a death and three cases of severe brain damage related to patients in the beach chair position who were at low risk for these complications (Pohl & Cullen, 2005). The findings indicate that there are complications that can occur when placing patients in the beach chair position while under general anesthesia.

Many of those complications were not recognized by the surgical team. Patients who had the most severe complications were deemed to be at a low risk for such events prior to surgery. The number of patients in the studies was low, but if patients had complications related to this positioning technique, the outcomes were devastating to them. The beach chair position and general anesthesia can induce many unwarranted problems in patients. Complications can be numerous with lifelong implications to previously healthy individuals. Vigilance among providers in regard to patients' hemodynamics and positioning are keys in order to prevent complications. Due to the low number of cases found, further research is needed to corroborate these findings.

Chapter 1

Introduction

The beach chair position or "sitting up position" has become a common position for patients requiring a variety of surgical interventions, especially during shoulder surgery. Surgeons like the position as it provides them with a good surgical view. There are also requests from physicians to have the patients' blood pressure as low as possible to enable a bloodless surgical field to improve visualization. With the popularity of this position becomes an increase in need for vigilance among anesthesia providers in relation to control of the patients' blood pressure being especially important. General anesthesia in itself can cause wide fluctuations in blood pressure. Adding to this factor that the patient will need to sit up after induction of anesthesia, there are further decreases in blood pressure. General anesthesia causes peripheral vasodilation and blunting of the sympathetic nervous system responses to low blood pressure so we as providers must be vigilant in tight regulation of the patient's blood pressure to within 20% of preoperative values to avoid changes in cerebral perfusion. Cerebral perfusion is guided by blood pressure autoregulation mechanisms. If we as providers consistently decrease blood pressure, there can be ischemic brain injuries, loss of vision, spinal cord injuries and venous air emboli.

The purpose of this study is to determine the safest and most prudent practices in the administration of anesthesia in the beach chair position to maintain adequate cerebral blood flow in order to prevent catastrophic events. Even though these complications are uncommon, the results of these injuries can be emotionally and financially devastating to patients and their families.

Many articles cited the need for further research to clarify safe parameters for monitoring and range of vital signs for patients in the beach chair position. Pohl and Cullen (2005) cited four cases of ischemic brain and spinal cord injuries where correlations between the sitting position and head position were contributing factors to negative outcomes. Mazzon, (2009) described three cases of brain damage in patients in the beach chair position; all of whom had no risk factors for brain ischemia. Perioperative stroke mortality is approximately 60% compared with stroke mortality rates of 15-46% in the general population (Pohl & Cullen, 2005).

Financially there may be significant litigation along with the lost income for families. In anesthesia practice, 17% of all malpractice claims are due to cerebral injuries (Brun, Norwood, Bosworth, & Hill, 2009). Hospital costs can range from $8000-$23,000 for a 4-12 day course of treatment. Nursing home costs can be $20-50,000 per year if a patient experiences an anoxic event (Brun etal, 2009).

Because this positioning technique is widely used and accepted, physiological effects to patients, treatment options, and monitoring standards need to be clarified and provided to student nurse anesthetists, certified registered nurse anesthetists, and anesthesiologists.

Present data also suggest that the beach chair position may lead to severe cerebral desaturation; hypotension, which frequently occurs in the seated position, must be avoided (Dippmann, Winge, & Nielsen, 2010). Research also suggests that patients who have certain vascular disease or uncontrolled hypertension should not be placed in the beach chair position.

The potential for cerebral oximetry use needs further study for all patients, but its use is supported in patients at risk for cerebral ischemia, such as those with vascular diseases. The use of cerebral oximetry to guide treatment of cerebral desaturation can result in cost effective reductions related to neurological injuries and hospital stay. Casati, Spreafico, Puzu, and Fanelli, (2006) stated that "The advantages of these reduced costs are difficult to evaluate and compare with the costs of the technology and further large scale studies should be required to better evaluate the pharmacoeconomic aspects of routinely applying this new technology; however, in some specialist fields of our practice, the help of this new and noninvasive and user friendly monitoring should be extensively applied" (p.615).

Statement of Clinical Problem

General anesthesia renders the patient insensible to changes in their mentation or body habitus. We as anesthesia providers need to be educated and remain vigilant regarding the patients' needs physiologically during general anesthesia and the beach chair position. Providers need to have adequate knowledge regarding effects of general anesthesia on hemodynamics, cerebral perfusion, effects of $PaCO_2$, head and neck positioning, prevention of compression of nerves, and the use of proper monitoring devices during surgery in the beach chair position. The cases reported in the research were clear to point out that the patients were in good health and had few to no risk factors for perioperative injury. A study with patients in the sitting position during neurosurgery states that out of 554 patients, 25 or 4.5% had morbidity or died related to hypotension during the operation (Kwak, Lee, Lee, Kim, & Kim. 2010).

Many surgeons prefer the use of the beach chair position for surgery because it provides a clear surgical view and prevents brachial plexus injuries compared to the lateral decubitus position used before 1980. Surgeons also favor a bloodless surgical field that may require the anesthesia provider to deliberately lower the patient's blood pressure. This position has presented many challenges to the anesthesia provider, including cerebral hypoxia, nerve compression, spinal cord ischemia, and vision loss. As a patient is moved to the sitting position, gravity can decrease cerebral circulation by as much as 15%. General anesthesia causes vasodilation, with further blood pooling in the lower trunk and extremities, exaggerating this phenomenon.

General anesthesia also blunts the body's natural sympathetic response to hypotension; this may precipitate a decreased release of catecholamines causing a dramatic drop in blood pressure and therefore cerebral perfusion pressure (CPP). Cerebral perfusion pressure must be maintained at 80-150mmHg. CPP is dependent on mean arterial pressure (>65mmHg and less than 150mmHg) minus intracranial pressure (10-25mmHg). Any change in these pressures will affect cerebral perfusion. Normal autoregulatory functions of the body compensate for a drop in blood pressure, specifically mean arterial pressure. Mean arterial pressure of greater than 65 mmHg is a reflection of adequate perfusion to organs and tissues.

Anesthesia providers may manipulate the blood pressure in patients with volatile agents, antihypertensives, and changes in end tidal carbon dioxide levels. If there is inadequate perfusion to organs, ischemia can present postoperatively in the form of neurological deficits, blindness, paralysis, and nerve injuries. Neurological deficits can be due to lack of blood flow to the brain. Decreased blood flow to the optic nerve and vasculature of the eyes can produce blindness. Poor head and/or neck position can cause obstruction to venous drainage and spinal cord arterial obstruction resulting in paralysis. Prevention of these sequelae involves proper use of fluids, antihypertensive agents, proper positioning, proper monitoring of hemodynamics, and proper use of monitoring devices.

Purpose of the Project

The purpose of this study was to determine the safest and most prudent practices in the administration of anesthesia in the beach chair position to maintain adequate cerebral blood flow in order to prevent catastrophic events. The aims of this study were to: (a) Identify and compile evidence based data regarding safe monitoring parameters during surgery in the beach chair position, (b) Evaluate the prevalence of other complications/injuries incurred due to the use of the beach chair position such as nerve injuries, blindness, and spinal cord injuries, (c) Educate physicians and anesthesia providers to these complications of the beach chair position, and (d) Explore ways to provide safe anesthesia in the beach chair position.

Conceptual/Theoretical Framework

This project will use a physiological theoretical framework. The knowledge derived from a physiological framework is well tested through research and the relationship of the variables. The research derived from testing is needed to support the anesthetist's care to patients. The physiological framework can also be described as a practice theory as these theories describe a specific response to a specific nursing practice situation to include biology, chemistry, and physiology.

A physiological framework is useful because it can alert others in the profession to do more research and therefore incorporate a change in practice with confidence. The patient has a response to a specific situation with two variables, the beach chair position and general anesthesia, with the CRNA responding to the relationship between the two variables in order to correct a negative change in a patient's physiological status. This framework will be used extensively in this project to explain how the beach chair position impacts the anesthetized patient hemodynamically and how anesthesia providers can correct the challenges this position presents. The CRNA is the provider of care when the patient is under general anesthesia. The CRNA must monitor all body systems and their response to anesthesia while acting quickly to reverse physiological imbalances that can occur.

Several problems will be addressed related to patients in the sitting position such as hypotension, cerebral desaturation, venous air embolism, and nerve injuries. Prevention of these problems is important in avoiding injury or death to patients. In order to understand the problem, a few key terms will need to be understood by the reader. Autoregulation is a term used to describe the hemodynamic mechanisms the brain uses in order to maintain perfusion. The lower limits of autoregulation are generally accepted as a mean arterial pressure of 50mmHG in order to maintain adequate cerebral perfusion while high limits are generally accepted as 150mmHg. Cerebral perfusion pressure (CPP) is based on intracranial pressure (ICP) and mean arterial pressure (MAP). CPP=MAP-ICP so cerebral perfusion pressure is mostly based on mean arterial pressure as intracranial pressure varies little in a healthy human brain.

Mean arterial pressure is the average blood pressure in the systemic circulation. It is calculated by taking the diastolic pressure plus the pulse pressure divided by 3. Mean arterial pressure can decrease by 0.75 mm Hg for each centimeter change in height between the heart and the brain placing the brain at risk for hypoperfusion and ischemia if there is unrecognized hypotension by not taking into account the change in MAP between two regions (Nagelhout & Plaus, 2010). Intracranial pressure is the pressure within the cranial vault which includes the brain, cerebrospinal fluid, and blood. Adjustments in mean arterial pressure affect ICP due to the impact of blood flow. A normal ICP is 0-15 mm Hg. Venous air embolism occurs when the atmospheric air pressure is greater than the venous pressure in the body so air can enter the body's circulation causing emboli. Poor surgical technique and the sitting position are contributors to this problem.

Significance of the Clinical Problem

The beach chair position has become a widely used surgical positioning technique especially for shoulder surgery. It allows greater access to the surgical site, better view, and ease for the surgeon to go from an arthroscopic technique to an open repair. Unfortunately with this position, the risk of cerebral hypoperfusion, nerve injuries, and venous air embolism can occur if the anesthesia provider is not vigilant in maintaining blood pressure within 80% of preoperative values and consistently checking the patient's positioning for changes and/or pressure points. Present research has shown than even in the healthy patient, severe cerebral desaturation may occur by up to 40% while in the beach chair position. A 20% reduction in cerebral blood flow is associated with fainting (Dippman, Winge, & Nielsen, 2010).

Because general anesthesia renders the patient unable to express that blood flow has been reduced, it is up to the anesthesia providers to initiate steps to avoid and correct undesirable changes hemodynamically. The brain uses 20% of the body's oxygen requirements so insufficient oxygen supply to the brain can result in a brain injury (Fischer, Torillo, Weiner, & Rosenblatt, 2009). Cullen (2007) advocates that deliberate hypotension must be avoided, and understanding of the changes associated with the upright position, and the physical effects of gravity on BP in the brain is needed to prevent catastrophic neurological outcomes during shoulder surgery in the sitting position. The article also goes on to state that hypotension must be treated aggressively by controlling inhalation anesthetics, fluid management, and use of vasopressors. Cerebral blood flow must be optimized so any malposition of the head and neck can cause posterior brain circulation infarcts. The anesthesia provider must be aware of sudden cardiovascular collapse due to gas embolism.

Although it rarely occurs in the beach chair position, perioperative stroke can cause lifelong injury and/or death. In any position the patient is placed, intraoperative brain injury is the single largest category of malpractice claim (17%). Perioperative stroke has a mortality of 60% compared with 15-46% in the general population (Pohl & Cullen, 2005). Pohl and Cullen found four cases of cerebral ischemia and attributed this to reductions in cerebral perfusion due to the sitting up position. It has been suggested that patients be monitored with a cerebral oximeter to prevent hypoxia to frontal lobes of the brain. Rotation of the head and compression of venous drainage passages have been associated with three superficial nerve palsies, one case of paraplegia due to extensive ischemia of the spinal cord, one case of vision loss, and one hypoglossal nerve palsy (Mullins, Drez, & Cooper, 1992).

Educating anesthesia personnel, operating room staff, and surgeons to these dangers and steps to prevention are a critical step in avoiding catastrophic complications to patients and families along with minimizing the chance for litigation.

Chapter Summary

Unrecognized changes in hemodynamics and patient positioning can occur while the patient is in the beach chair position. Disastrous outcomes such as nerve injuries, cerebral desaturation events, vision loss, venous air emboli, and, in rare instances, death can occur. Vigilance and knowledge are the hallmarks to providing excellent anesthesia to the patient in the beach chair position. Prompt response to hemodynamic changes, interpretation of these changes with integration of monitor readings, and frequent patient positioning checks are necessary to prevent unanticipated postoperative problems.

Chapter II: Literature Review

A comprehensive literature review was performed using multiple search databases available through the Harley French Library services: PubMed, Cochrane Library, Cinahl, and Google scholar. The following key terms were used: shoulder, arthroscopy, beach chair position, hypoglossal, nerve, venous air embolism, spinal cord compression, spinal cord ischemia, deliberate hypotension, cerebral ischemia, cerebral anoxia, cerebral hypoxia, brain, hemodynamics, hemodilution, autoregulation, blood pressure, vision loss, paraplegia, neurosurgery, stroke, postural hypotension, sitting position, cerebral oximetry, cerebral perfusion pressure, intracranial pressure, mean arterial pressure, and general anesthesia.

The literature consisted of case studies, two larger scale retrospective studies 26 years apart, and some related relevant literature addressing specific interventions. For this project to be worthwhile, it is important to provide education to others in the anesthesia profession. Upon completion of this project, education was provided to first year anesthesia students and at the annual North Dakota Association of Nurse Anesthetists meeting. Providing this education will theoretically increase awareness of the problem and produce a heightened level of vigilance regarding the complications within anesthesia providers.

Review and Critique of Related Studies

<u>Case Studies and Related Relevant Literature.</u> All articles reviewed were retrospective in nature. Dippman et al. (2010) looked at two cases of patients in the beach chair position. In both case studies, similar surgeries were performed, there were identical anesthetic techniques, and both subjects were middle aged males. They contended that, based on near the infrared spectroscopy (NIRS), there is a 40% reduction in frontal lobe oxygenation of patients under general anesthesia in the

BCP (beach chair position) and stated that cerebral oxygenation should be monitored. They stated that, in case #1, if the cerebral desaturation had persisted, and had not been corrected by the use of ephedrine, it would have led to prolonged brain ischemia. They argued that hypotension should be avoided even in the healthy patient and cerebral oximetry should be monitored. This kind of case analysis should be done on a larger scale to provide more reliable data.

Prabhakar, Bithal, and Ghosh (2005) described a case study involving paraplegia of a 17-year old boy with a fourth ventricle tumor. The tumor was removed and the case took approximately five hours with the patient in the BCP. While the patient was in ICU, he developed quadriplegia over the course of a few hours postoperatively. They felt that there was no other reason for quadriplegia other than the spinal cord ischemia caused by muscle relaxation and altered autoregulation due to changes in intraspinal pressures. They advocated the use of sotamosensory-evoked potentials to prevent this kind of injury. Although further information on anesthetics used, blood pressure parameters of the patient, positioning devices etc. needed to be discussed, the fact remains that this child has permanent spinal cord damage.

Pohl and Cullen (2005) described four cases of ischemic brain and spinal cord injuries occurring in patients operated on in the upright position who were deemed at low risk for such events based on their medical history. They discussed factors in the BCP that need to be addressed such as PaCO2, hypotension, head position, embolism events, CVA risk factors, and patient positioning. None of the patients had histories of smoking or high blood pressure; one had risk factors for stroke to include hyperlipidemia and positive family history for coronary artery disease. They further stated that they feel that the factor most likely contributing to the reduction in cerebral perfusion was the patients' position in the BCP.

Pohl and Cullen (2005) also pointed out that the upright position in the nonanesthetized individual causes a decrease in venous return thus decreasing cardiac output by 20%. This response is blocked by autonomic nervous system compensatory mechanisms unless a patient is anesthetized: then this autonomic protective measure is blocked. They argued that the lower limits of autoregulation be individualized based on the patient's resting MAP and not on a fixed range as this range of safety has yet to be established. The internal jugular vein can also become obstructed with poor placement of the head and neck, thus decreasing venous drainage. In case number 2, there was a reduction in blood flow in the vertebral artery by malposition of the head; that caused an infarct in the posterior circulation to the spinal cord. The head of an awake patient can be adjusted with discomfort, but the anesthetized patient is rendered insensible to adjust their position so it is up to the provider to keep the head and neck in a neutral position. Pohl and Cullen cited another case described by Mullin, Drez, and Cooper (1992), a case of hypoglossal nerve injury from compression of the nerve from the mandible. Two fingerbreadths are needed between the clavicle and mandible in order to prevent compression of the hypoglossal nerve.

Pohl and Cullen (2005) also stated that the hemoglobin and hematocrit are not routinely checked preoperatively. If a combination of hypotension and anemia are present this can contribute to ischemic optic neuropathy. They made an important point regarding a patient's PaCO2:

> "Cerebral blood flow is directly related to PaCO2. Anesthetic drugs alter resting cerebral blood flow and, therefore, change the cerebral blood flow response to changes in PaCO2. In patients with low blood pressure, the cerebral vessels dilate and do not constrict when PaCO2 decreases, a mechanism that rather protect the cerebral circulation from the potentially devastating effect of the PaCO2 mechanism in a hypotensive state."(p. 468).

Fischer, Torillo, Weiner, and Rosenblatt (2009) supported the use of cerebral oximetry in response to the four cases of ischemic brain injury reported by Pohl and Cullen (2005). They discussed the use of cerebral oximetry in a patient having shoulder surgery in the BCP, and stated that all mean arterial pressures should be recorded in relation to those that are at the level of the patient's head to account for the changes in mean arterial pressure between the brachial arterial and cerebral arterial pressures. They estimated that, instead of using 50 mm Hg as the lower limit for their MAP, that it should be adjusted to 70 mm Hg to account for the changes related to cuff location. The practitioner may overestimate the patient's MAP but it may be lower than what is considered safe for that patient. After the patient was placed in the upright position, the patient became hypotensive with a MAP <70 mm Hg and a corresponding rapid decline in cerebral oximetry reading. The patient was treated with a neosynephrine bolus resulting in a correction of the blood pressure and cerebral oximetry. This patient had no neurological sequelae postoperatively. This case report was significant as it was the first to use cerebral oximetry to detect and prevent cerebral ischemia in the clinical setting.

Fischer et al. (2009) also argue that MAP cannot be the only reflection of adequate cerebral perfusion as there are other factors that affect blood flow to the brain such as hypertension that can shift the limits of autoregulation toward an increased blood pressure so the patient's tolerance to a lower limit of autoregulation is unknown. Not correcting blood pressures values below the accepted range of autoregulation can produce unrecognized cerebral ischemia. They advocate for the use of cerebral oximetry as a guide to prevent cerebral ischemia in patients in the BCP.

Other relevant literature includes studies that either do not involve BCP or focus on possible interventions to prevent complications. Watson (1974) discussed head rotation during surgery causing complete occlusion of the ipsilateral internal jugular vein in children. Cardiac catheterization under fluoroscopy with 60 infants and children revealed that with a 45 degree rotation there was narrowing of the middle internal jugular vein and with a 90 degree rotation there was complete occlusion of the vein in 41 children. All the children were undergoing the same operation and had similar comorbidities. Watson pointed out the negative effect of excess rotation of the head on internal jugular vein flow. Even though these patients were not in the BCP, the findings demonstrate the negative effects of poor head position.

Fuchs et al. (2000) also noted how the positioning of a patient's head affects blood flow. They studied differences in positioning effects on regional cerebral saturation. Three separate groups of people were identified, each group containing 14-48 members. The results showed that blood flow in the contralateral vertebral artery is lowered when the head is turned 60 degrees and flow stops when the head is turned 80 degrees. Blood flow is then increased through the Circle of Willis; if this mechanism is altered, there can be impaired blood supply to the medulla, brainstem, and cerebellar regions of the brain. They go on to say that body position changes affect venous pressure and can affect the regional cerebral oxygenation.

Bhatti and Enneking (2003) discussed one report of vision loss and opthalmoplegia after shoulder surgery. A lengthy discussion on the anesthetic technique and patient history included vital signs and preoperative health history. The operative course was discussed as uneventful until the patient was in the recovery room and had no vision in his right eye. His vision gradually improved over the next six months. His arterial blood pressure preoperatively was 173/98 for which he received labetolol and hydralazine. The patient's preoperative hemoglobin was 15.3 g/dL with minimal intraoperative blood loss. He had no hypotensive episodes during surgery but the cuff was placed on the distal lower extremity, so the author admits that hypotension could have occurred as the provider did not take into account for a change in cuff pressure related to the distance from the cerebral arteries and veins. The surgeon also requested that systolic blood pressure be at 100 mm Hg. The authors did not relate this finding with the vision loss *per se* but stated that intraoperative hypotension can contribute to postoperative vision loss.

In an editorial, Sia (2003) responded to the above article. He felt the cause was severe and prolonged cerebral perfusion. He stated that the gravitation effect of the patient's position was overlooked and that the blood pressure is reduced 0.77 mm Hg for every centimeter change in blood pressure cuff position. He further noted that the mean arterial pressure at the patient's head was lower than that required for autoregulation mechanism to be put in place to maintain cerebral perfusion pressure. The patient's autoregulation shifts to the right due to hypertension preoperatively. A shift to the right implies that the patient needs higher blood pressures in order to maintain cerebral perfusion as the body and brain has adjusted to these higher pressures. He also stated that the blood pressure should not be adjusted based on the surgeon's preference but rather the patient's need for adequate cerebral perfusion.

Bruns et al. (2009) state that cerebral oximetry can help prevent postoperative neurological injuries. They admit that there is not a "gold standard" for monitoring cerebral oxygenation but cerebral oximetry should be an additional tool for monitoring patients in the beach chair position and that more research needs to be done to assertive its effectiveness in preventing neurological injuries. They specifically highlight that this monitoring system is noninvasive and has the potential to be a cost saving device. At the time of publication, they stated the average cost of the cerebral oximeter pads to be approximately $375 per patient. Patients who did not have a cerebral monitor on stayed an average of 43 hours longer in the ICU; this amounts to at an average excess cost of $3,569 per patients, almost ten times the cost of the device.

Casati, Spreafico, Putzu, and Fanelli (2006) reported on the results from nine studies. Eight of the studies supported the use of cerebral oximetry. They admit that it is difficult to ascertain if the costs of cerebral oximetry reduce the costs of neurocognitive injuries and further studies are needed to determine if this does help contain costs in care. Limitations to cerebral oximetry are that there are areas of the brain that cannot be monitored because the monitor can only be applied to areas without hair follicles. Electrical interference from the use of electrocautery may interfere with monitoring.

Cullen and Kirby (2005) discussed markers for stroke and hypoxic ischemic encephalopathy: advanced age, male, hypertension, diabetes mellitus, hyperlipidemia, prior history of stroke, tobacco use, congestive heart failure, valvular heart disease, atrial fibrillation/flutter, peripheral vascular disease, prior carotid endarterectomy and coronary artery disease. Patients with these comorbidites are at greater risk for complications when placed in the BCP. They offered the following recommendations for prevention of complications: Mean arterial blood pressure values less than 80% of preoperative values should be treated to maintain perfusion. If an arterial line is used, measurements should be read at the level of the external meatus in order to ascertain the mean arterial pressure within the cerebral circulation. If noninvasive blood pressures are used the provider must accommodate the hydrostatic differences of the mean arterial pressure at the brachial artery to that of the circle of Willis for which a decrease in blood pressure, 0.77 mm Hg, for every centimeter of distance between the brachial artery and circle of Willis. Measures to correct for hypotension, a blood pressure of less than 80% of baseline, should be used; they include vasopressors, fluids, adjustments in IV and inhalational anesthetics, and increases of end-tidal CO2 and FIO2. The lower limits of autoregulation should be based on individual patient blood pressure parameters and not by the generally accepted values of 50-150 mm Hg; autoregulation is shifted to the right in cases where patients are hypertensive. They suggest that a range of normal lower limits of autoregulation is 70-93 mm Hg with a mean of 80 plus or minus 8 mm Hg; this deviates greatly from previous suggested limits. Cullen and Kirby also point out that deliberate hypotension to reduce blood loss and improve surgical views should not be used while a patient is in the beach chair position. They report on a controlled study cited by Sollevi (1988). It found no difference in blood loss or surgical field view with MAP of 75-85 and 55-60 mm Hg compared to a control group of patients with MAP of 90-100 mm Hg. The reduction in blood loss may only cause tissue hypoperfusion. They note that other factors such as surgical technique are more important in regard to perioperative blood loss; requests for deliberate hypotension from the surgeon should be avoided. Sollevi (1988) also corroborated the finding that hypotension for the control of blood loss should be avoided in patients with a history of ischemic heart disease, uncontrolled hypertension, cerebrovascular disorders, hepatic and renal disorders, hypovolemia, and anemia. Sollevi also stated that a mean arterial pressure of below 60 mm Hg is not associated with better blood sparing effects but may increase the patient's risk for cardiovascular complications. Papadonikolakis, Wiesler, Olympio, and Poehling (2008) also recommended the above interventions for avoidance of complications for patients in the beach chair position.

Lopes and Galvao (2010) pointed out the need for several factors to be addressed in order to prevent intraoperative surgical injuries: proper body alignment, reduce friction and sheering, check bony prominences, take precautions in areas with bony prominences, select positioning devices based what patients can tolerate, document all positioning procedures, and transport patients with adequate staff using equipment to aid in that transport to avoid injuries to patients and providers. Heizenroth (2001) further suggested that in the postoperative care unit the nurse should assess for range of motion, degree and equality of limb muscle strength, any signs or symptoms of numbness, tingling, or impaired sensation, and limb or joint pain not associated with the operative area. This data should be compared to the patient's preoperative condition. The anesthesia provider and PACU can assess this together.

Kwak et al. (2010) explored the option of using sequential compression devices on the lower extremities to recruit blood to increase a patient's preload to reduce hypotensive episodes when in the BCP. Porter, Pidgeon, and Cunningham (1999) stated that as much as 1500ml of blood may be pooled in the lower extremities due to the effects of gravity. The study showed that the incidence of hypotension can be reduced from 68% to 28% with the use of sequential compression devices when a patient is going from the supine to BCP. The sequential sleeves were from the patients' ankle to thigh and moved 125ml of blood during compression of the limb.

Large Retrospective Studies. A limited number of large retrospective studies were found. Standefer, Bay, and Trusso (1984) retrospectively studied 488 cases of people placed in the seated position for neurosurgery. More than half the patients were 30-59 years old with an American Society of Anesthesiologists classification of II or III. Complications associated with the seated position included risk of venous air emboli decreased cerebral blood flow attributed to hypotension, decreased stroke volume and various incidences of nerve damage. Venous air embolism was quoted at a range of 8-15% in patients undergoing a posterior fossa operation; the authors felt that Doppler monitoring is critical in this particular surgery. The Doppler exhibited the first sign of an air embolus in 20 of the 22 patients (91%). Interpretation of end-tidal carbon dioxide and an esophageal stethoscope would also be needed to aid in the detection of venous air embolism. A right atrial catheter is needed for prompt treatment of a venous air embolism in order to aspirate the air from the circulation and nitrous oxide should be avoided. Standefer et al. (1984) stated that if the head is elevated in neurosurgical cases, the patient should be routinely monitored for an air embolus.

Standefer et al. (1984) noted four cases of nerve injuries at a rate of 0.82% related to common peroneal nerve palsy that were attributed to ischemia to the nerves as a result of stretching or compression of the nerve. In one case the patient developed bilateral foot drop after posterior fossa repair in the BCP. The foot drop may be attributed to the sitting position because stretching and compression of nerve structures is more likely in the anesthetized patient due to reduced muscle tone, inability of the patient to express discomfort, and poor alignment of the patient's posture. Each of these patients fully recovered over the next 1-2 weeks. Two patients developed full thickness pressure ulcers in the lumbosacral region. One patient developed pressure points to the head from the headrest. Two other patients developed partial thickness ulcers all of which could have been avoided with proper padding, positioning, and attention by the surgical staff. The authors' final comments state that the sitting position can be safe if strict attention is paid to padding and head and neck positioning, with most of these injuries being avoidable.

Twenty-six years later, another large scale study was conducted by Murphy et al. (2010), who noted that patients in the BCP may be at risk for cerebral hypoxia due to decreases in cerebral perfusion pressure. A total of 124 patients who were undergoing shoulder surgery in the BCP with standardized anesthesia techniques were analyzed for cerebral desaturation events (CDE) using a cerebral oximeter. A cerebral desaturation event was classified as a less than or equal to 20% decrease in cerebral oxygenation from baseline or a less than or equal to 55% value for greater than 15 seconds. An ANOVA revealed that 80.3% of patients monitored in the BCP were found to have episodes of cerebral desaturation events while no patients in the lateral decubitus position had CDE's with a $p. < 0.0001$.

Murphy et al. (2010) compared the effects of the position on cerebral oxygenation results in patients in the lateral decubitus position and beach chair position. Anesthetic management was standardized in both groups of patients. Cerebral oximetry was measured continuously, with the research assistant instructing the anesthesia provider as to when a CDE occurred. For any reading of 55% or below the clinicians were instructed to treat the patient for a cerebral desaturation event with phenylephrine, ephedrine, fluid boluses, decreasing ventilations, or increasing inspired oxygen concentrations. The reductions in cardiac output, MAP, and cerebral perfusion pressure persisted up to 30 minutes after positioning. The patient's course was followed in the recovery room and included pain intensity, use of pain medication, use of antiemetics, and discharge times. Duration of anesthesia, patient core temperatures, use of crystalloids, and use of paralytics, patient demographics, preoperative hemoglobin, patient history, and ASA scores were recorded.

Another interesting finding was that the incidence of nausea was 50% ($p = 0.0001$) and vomiting 27.3% ($p = 0.011$) in patients having CDE's when compared to patients without CDE's (nausea 6.7% and vomiting 3.3%). The only attributable factor and common denominator in this scenario to cause an increase incidence of nausea and vomiting was found to be cerebral desaturation events.

Murphy et al. (2010) admit that the degree and duration of cerebral ischemia that is needed to cause a neurological event is unknown. Fortunately, none of the patients in this study experienced any neurological sequelae postoperatively despite the high prevalence of cerebral desaturation events. The low incidence is likely attributed to, in general, a shorter surgical time for shoulder surgeries compared to neurosurgery. They also point out that there are no universal standards to identify cerebral ischemia, and further research is needed in this area to provide these define the degree and duration of cerebral desaturation that may cause a brain injury. This study was important because it compares patients undergoing similar operations with similar health histories. Tange, Kinoshita, Minonishi, Hatakeyam, Matsuda, and Yamazaki (2010) also supported the statement that further studies are needed to clarify the margin of safety to prevent cerebral hypoperfusion in the beach chair position.

Critique of the Literature Reviewed

Further large scale research studies need to be done in order to determine specific parameters that the surgical team needs to follow when a patient is in the beach chair position. Other limitations to the research are that they do not compare patients with similar comorbidites and ASA scores. The two large scale studies by Standefer et al. and Murphy et al. included all patients in the sitting position regardless of the type of surgery they were having. New studies are needed that focus on this issue. Only one article was found that involved the use of sequential compression devices; they are a noninvasive, safe, and affordable option for the prevention of hypotension.

The articles found on this topic varied greatly in sample size, patient population, use of anesthetics, and surgeries included. Further research is needed to compare patients with similar comorbidites, anesthetic administered, and surgery performed. There are very limited numbers of large scale studies to determine the safety parameters and standardization of monitoring in patients in the beach chair position. Case studies are the mainstay of current journal article citations; they are informative and shocking but do not help the clinician in determining a standardized protocol when monitoring the patient in the beach chair position to prevent injuries and/or neurological sequelae due to cerebral hypoxia. There is support for the use of cerebral oximetry to monitor for cerebral desaturation events but more research needs to be done. Nerve injuries are not commonplace but do occur; larger scale studies need to be explored as it could be argued that since there is little research, there may be underreporting of injuries. Research needs to be continued as most of the research done has been retrospective case analysis where an injury has already occurred and investigators were looking into a cause not preventative measures. Prospective analysis is needed in this area of research to explore what works and does not work in preventing patient injuries in the beach chair position. Further studies are needed to determine safe lower limits of autoregulation and to what degree of cerebral hypoxia does neurological deficits occur.

Chapter III: Project

The purpose of this project was to educate clinicians on possible negative outcomes of patients in the seated position along with possible cost effective solutions thereby avoiding injury and litigation. Prevention of any injury to patients should be taken seriously by all operating room staff. Vigilance is necessary, in order to avoid negative patient outcomes as described in this paper. Several ideas regarding the prevention of injuries to patients in the beach chair position will be discussed. This project asked: What should be included in the standards of care when monitoring and providing anesthesia to patients in the BCP?

A power point presentation on this project was done at the North Dakota Association for Nurse Anesthetists. The audience included certified registered nurse anesthetists and student nurse anesthetists. The presentation summarized the problem and its potential solutions and/or monitoring needs of the patient in the beach chair position. The presentation will be included in this project as an appendix.

The presentation focused on complications that can occur in the beach chair position, ways to prevent these injuries, and what is needed in terms of further research. Research studies were briefly discussed.

Implications

This project's content could provide education for a wide number of health care professionals and to patients themselves who would be requiring surgery in the BCP. Preoperatively, knowledge regarding the risks of the BCP would be useful for physicians who use this technique in surgery and for their nurses in the clinic to educate patients and possibly screen those at risk for injury. Anesthesia providers and circulating nurses would benefit from this knowledge in order to position patients with adequate padding and alignment of the spine and neck structures. Teamwork is of utmost importance when positioning a patient for surgery. The patient's anatomic and physiological needs are recognized with the team of nurses, anesthesia providers, and the surgeon taking into account surgical visualization of the site, equipment used, and patient variables. Lopes (2010) noted that the main risk factors for problems in the perioperative stage include general anesthesia, age, weight, immobile patients, body temperature issues specifically hypothermia, and preexisting health conditions. Anesthesia providers may opt to the use of cerebral oximetry, sequential compression devices, and chart every 15 minutes regarding patient positioning checks. Post anesthesia recovery room nurses would benefit from this information in order to be aware of problems that can occur to these patients specifically in the BCP in the PACU that were not apparent in the operating room such as neurological deficits, nerve injuries and or areas of pressure.

Chapter Summary

There are many interventions that can be used to prevent complications in the BCP. Further research in all areas is still needed. Practice guidelines are not delineated per se, but the anesthetist should be aware of compounding variables when placing patients in the BCP. All attempts should be explored and implemented in the patient's individualized plan of care to prevent injury and provide safe anesthesia services.

Chapter IV: Discussion and Implications

As stated before, there are many complications that can arise from placing the patient in the beach chair position. Clinicians, operating room staff, and surgeons should be aware of these potential complications and take measures, such as implementation of policies, in order to take a preventative approach. The institution of proper policies would theoretically reduce and/or eliminate the chance for harm in the beach chair position. Policies would include areas related to documentation. The CRNA should document head position, absence of eye pressure, absence of arm/leg/foot pressure and mean arterial pressures every fifteen minutes. Patients should be screened preoperatively for potential problems in the beach chair position. Screenings could include obesity, age, comorbidities, and preoperative blood pressure readings.

Further research on this topic needs to be done to provide a basis for evidenced based practice guidelines so that they can be initiated and standardized. Large scale prospective studies are needed in order to validate the current research and strengthen the argument for instituting specific guidelines that also have the advantage of providing individualized care to each patient.

Education on this issue is a priority for current anesthesia practitioners and students to become competent anesthesia professionals. Avoiding deliberate hypotension, knowledge of physiology, anatomy, effects of medications, frequent position checks, providing proper padding, and body alignment for the patient in the beach chair position are all points that can be incorporated into the education of a student nurse anesthetist.

Policy and practice changes can be made if more research is done to validate these preliminary findings. Documentation of mean arterial pressures with each blood pressure reading can be included on the anesthesia record. Documentation of patient position and checking points of pressure every fifteen minutes can help prevent injuries and provide accurate and proper documentation if an injury occurs. Quality assurance should be monitored with chart audits done on patients in the beach chair position to assess for proper documentation of the above criteria to assist in monitoring the relationships between adverse events and proper monitoring by the nurse anesthetist.

Current research suggests that anesthesia provider be vigilant with positioning of the head and neck in these patients along with the use of a cerebral oximeter in some cases in order to give the provider a real time percentage of cerebral oxygen levels, therefore averting cerebral anoxic events.

Preventing injuries in the beach chair position should be of paramount importance to surgeons and anesthesia providers in order to prevent negative patient outcomes, litigation, increased hospitalization costs, and, in severe cases, possible nursing home admissions due to poor recovery from injuries or death. Definitive hemodynamic measures need to be in place and followed and further studied to determine what is acceptable. Proper positioning is also of great importance. Every effort must be made available to the surgeon, OR staff and anesthesia providers to prevent injuries to patients in the beach chair position.

This project was limited by the small numbers of large scale studies on patients in the beach chair position. There are few articles citing the use of cerebral oximetry, which could become a safe noninvasive monitoring device to prevent cerebral desaturation. The safety of the lower limit of autoregulation (50 mm Hg) has been challenged; some authors recommend that the lower limit be set at 70 mm Hg. Few standardized studies comparing similar patient statuses and the use of the same anesthetic drugs while in the beach chair position have been conducted.

Chapter Summary

This topic is one that can be of value because it has the potential to save lives, save harm to patients, change department policies, avoid possible litigation, and elevate the safety of all patients undergoing surgery in the upright position. Further large scale research studies are needed to provide a concrete set of evidence based practice guidelines that practitioners can follow and be able to defend their choices when placing a patient in the beach chair position.

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Appendix A

Anesthesia Concerns in the Beach Chair Position

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The Problem

- The beach chair position has become a commonplace positioning technique for various procedures in the operating room. There can be complications associated with this position that include venous air embolism, unrecognized cerebral hypoperfusion, blindness, and nerve injuries.
- The beach chair position causes many hemodynamic changes in the body which is compounded when general anesthesia is used to further impact the stability of patients. Recent research has shown a death and three cases of severe brain damage related to patients in the beach chair position who were at low risk for these complications (Pohl et al., 2005).

The Problem continued

- A study with patients in the sitting position during neurosurgery states that out of 554 patients, 25 or 4.5% had morbidity or died related to hypotension during the operation (Kwak et al,. 2010).
- If there is inadequate perfusion to organs, ischemia can present postoperatively in the form of neurological deficits, blindness, paralysis, and nerve injuries. Neurological deficits can be due to lack of blood flow to the brain. Decreased blood flow to the optic nerve and vasculature of the eyes can produce blindness. Poor head and or neck position can cause obstruction to venous drainage and spinal cord arterial obstruction resulting in paralysis.

The Problem continued:

- Surgeons doing procedures in the beach chair position may favor lowering blood pressure values to maintain a bloodless field and have a better surgical view.
- This can cause a conflict between what is safe for the patient and what the surgeon may want in terms of blood pressure control.

The Problem continued

- Few large scale studies done to assess the numbers of patients who experience complications related to the BCP.
- There is argument on what the lower limits of autoregulation should be.

Purpose of the Study

- The purpose of this study was to compile research related to the use of the beach chair position and general anesthesia along with the complications associated with it.
- This study indicates that there are complications that can occur when placing patients in the beach chair position while under general anesthesia. Due to the low number of cases found, further research is needed to corroborate these findings.

Who is at risk for complications in the BCP?

- 1. Advanced age
- 2. Male
- 3. Hypertension
- 4. Diabetes mellitus
- 5. Hyperlipidemia
- 6. Prior history of stroke
- 7. Tobacco use
- 8. Congestive heart failure
- 9. Valvular heart disease
- 10. Atrial fibrillation/flutter
- 11. Peripheral vascular disease
- 12. Prior carotid endarterectomy
- 13. Coronary artery disease
- Patients with these comorbidites are at greater risk for complications when placed in the BCP.

Other risk factors

- Patients with a history of ischemic heart disease, cerebrovascular disorders, hepatic and renal disorders, hypovolemic, and anemic patients.
- It is important to note that in the research done for this project, there were a number of patients who were healthy with no comorbidities and still experienced problems postoperatively due to the BCP.

Clinical Pearls.

- A mean arterial pressure of below 60 mm Hg is not associated with better blood sparing effects but may increase the patient's risk for cardiovascular complications.
- Measures to correct for hypotension, a blood pressure of less than 80% of baseline, should be used which include vasopressors, fluids, adjustments in IV and inhalational anesthetics, and increases of end-tidal CO2 and FIO2.

Clinical Pearls

- The internal jugular vein can also become obstructed with poor placement of the head and neck, thus decreasing venous drainage.
- Two fingerbreadths are needed between the clavicle and mandible in order to prevent compression of the hypoglossal nerve
- Deliberate hypotension to reduce blood loss and improve surgical views should not be used while a patient is in the beach chair position.

Pearls continued

- If a combination of hypotension and anemia are present this can contribute to ischemic optic neuropathy.
- Mean arterial blood pressure values less than 80% of preoperative values should be treated to maintain perfusion.
- If noninvasive blood pressures are used the provider must accommodate the hydrostatic differences of the mean arterial pressure at the brachial artery to that of the circle of Willis for which a decrease in blood pressure, 0.77 mm Hg, for every centimeter of distance between the brachial artery and circle of Willis.

Pearls continued

- If an arterial line is used, measurements should be read at the level of the external meatus in order to ascertain the mean arterial pressure within the cerebral circulation norms.
- The lower limits of autoregulation should be based on individual patient blood pressure parameters and not by the generally accepted values of 50-150 mm Hg as autoregulation is shifted to the right in cases where patients are hypertensive.
- Using sequential compression devices on the lower extremities to recruit blood to increase a patient's preload to reduce hypotensive episodes when in the BCP.

What should we be monitoring?

- Head position
- Checking points of pressure
- Spine alignment
- Eyes-are they taped and free of pressure?
- Blood pressure-is the MAP within 20% of preoperative values and document it.
- Cerebral oximetry has also been suggested but further research is needed to validate the cost/benefit ratio and to establish concrete values for cerebral ischemia.

What can we do?

- Providers need to have adequate knowledge regarding effects of general anesthesia on hemodynamics, cerebral perfusion, effects of $PaCO_2$, head and neck positioning, prevention of compression of nerves, and the use of proper monitoring devices during surgery in the beach chair position.

In Conclusion

- This topic is one that can be of value because it has the potential to save lives, save harm to patients, change department policies, avoid possible litigation, and elevate the safety of all patients undergoing surgery in the upright position.
- Further large scale research studies are needed to provide a concrete set of evidence based practice guidelines that practitioners can follow and be able to defend their choices when placing a patient in the beach chair position.

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