PRONE POSITIONING FOR HEAD AND NECK RECONSTRUCTIVE SURGERY

Steven Ross Mobley, MD,1 Brian Thomas Miller, MD,1 Frank C. Astor, MD,2 Bradley Fine, MD,3 N. James Halliday, MD4

1 Division of Otolaryngology, Department of Surgery, University of Utah, 50 N. Medical Drive, 3C-120, Salt Lake City, Utah 84107. E-mail: steven.mobley@hsc.utah.edu
2 Department of Otolaryngology, University of Miami School of Medicine, Miami, Florida
3 Department of Anesthesia, University of Illinois, Chicago, Illinois
4 Department of Anesthesiology, University of Miami School of Medicine, Miami, Florida

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Abstract: Certain head and neck surgical cases require the patient to be positioned prone. Such positioning carries with it an attendant subset of risks and complications not otherwise encountered in more traditional supine positioning. Gaining awareness of these risks and complications, and developing proactive positioning strategies, will enable the surgical team to position the patient optimally for the procedure and provide for every consideration of patient safety.

This article consists of a specific literature review of those issues directly related to the anatomical and physiological concerns arising from prone positioning. Particular attention is paid to the cardiopulmonary, renal, ophthalmologic, and neurological vulnerabilities unique to this position.

Proper planning by the surgical team and utilization of the correct equipment are a necessity. A tailored approach to the needs of the individual patient and an intimate awareness of the potential pitfalls will contribute to better outcomes when using the prone position.

Keywords: reconstruction; considerations; positioning; prone; complications

Operative success often depends on proper surgical exposure. Correctly positioning the patient on the operating table enables the surgeon to work safely and comfortably, resulting in a better operation. In our comprehensive head and neck surgery practice, it is not unusual to place patients in the prone position (sometimes termed ventral decubitus), to gain surgical control of the posterior cervical and scalp areas.

Most operations on the head and neck are performed with the patient supine, giving adequate exposure to the anterolateral neck, face, and oral cavity as necessary. This position allows reasonable neck extension and rotation as required by the procedure. Areas such as the shoulders, nape of the neck, and occipitoparietal regions are better exposed by other surgical positions such as the lateral decubitus or prone position. These alternative positions may be advantageous in the case of locoregional excisions or for harvesting distant or regional flaps. The use of the prone position poses significant risks and morbidity that may not
be recognized by the surgeon inexperienced in its use. Safe use of the prone position requires particular expertise from the physicians and staff involved. A Medline search, 1965 to 2004, was performed to reveal 592 articles under the search term “prone position surgery.” Most of these articles pertained to spinal and ophthalmologic surgery, leaving the head and neck reconstructive surgeon with few relevant articles for review.1–3 This article represents the work of a multidisciplinary team from various institutions with a specific review of the articles most pertinent and important to those head and neck reconstructive surgeons who may use the prone position. The purpose of this article is to describe and discuss both the physiologic and anatomic considerations that a surgeon should be aware of when placing a surgical patient in the prone position. This article also serves to create awareness of the precautions, techniques, and equipment that are necessary to enable successful outcomes while minimizing the risk of complications.

**PHYSIOLOGIC CHANGES**

**Cardiopulmonary.** The prone position creates significant challenges to the cardiovascular, hemodynamic, pulmonary, musculoskeletal, and neurologic systems.4–7 Placement in the prone position leads to several changes in hemodynamic and cardiovascular physiology that are best understood by their effects on basic cardiac physiology.8 Turning a patient prone, without relieving restriction of the thorax and abdomen, can lead to increased central venous pressure, decreased venous return, and decreased cardiac output. Significant compression of the pelvis and abdomen can lead to venous pooling by increasing intra-abdominal pressure, or direct compression of the inferior vena cava.9 Decreased left ventricular filling can also occur as a result of the increased intrathoracic pressure caused by prone positioning. This can be manifested by reduced left ventricular volume, stroke volume, and cardiac index. There have been a limited number of studies evaluating respiratory mechanics and the prone positioned patient. A study from 1959 observed a 30% to 35% decrease in respiratory compliance and an increase in peak airway pressures when patients were positioned prone.10 A more recent study (1995), demonstrated that the prone position, if supported optimally, does not significantly alter lung or chest wall mechanics, while it actually improves lung volume and oxygenation.11 There are conflicting studies regarding the effects of the prone position on functional residual capacity (FRC). Early studies showed no significant changes, while a newer study demonstrated an increase of 350 mL in the FRC of a group of normal, awake patients.12 This increase in FRC may be explained by a decreased cephalad displacement of the diaphragm. Pelosi et al demonstrated obese patients that were placed in the prone position had better oxygenation as compared with those in the supine position.13 This is possibly explained by the relative improvement in the ventilation/perfusion ratio in the lungs afforded by the prone position. In the supine position, the heart occupies the anterior mediastinum, thereby decreasing anterior lung volumes. In contrast, by turning prone, the mediastinal contents are shifted further anterior, facilitating increased lung ventilation in the nondependent anterior regions.10,13

**Renal.** Renal perfusion may also be affected by prone positioning. Bradley and Bradley demonstrated that an increased intra-abdominal pressure greater than 15 mm Hg may considerably reduce renal perfusion and function in human volunteers.14 Other studies that examined the variables affecting renal perfusion and function indicated there were no negative effects from prone positioning.15 This could prove to be of increased importance when operating on patients at higher risk for renal dysfunction such as chronic hypertensives, diabetics, and renal transplant patients.

**Ophthalmological.** Visual loss after prone positioning is a rare yet devastating complication. There are a variety of studies and case reports looking at postoperative visual loss, attempting to delineate the risk factors.16–18 Prolonged hypotension, anemia, extended surgical time, embolus, and massive transfusion all have been associated with perioperative visual loss in either the supine or prone position. A subset of these patients developed blindness as a result of decreased perfusion, either due to direct pressure on the globe itself or from increased intraocular pressure. A recent preliminary prospective study of intraocular pressure and the prone position demonstrated that prone positioned patients had elevated intraocular pressures under general anesthesia when compared with awake baselines.19 The conclusion states “prone positioning increases intraocular pressure during anesthesia. Ocular perfusion pressure could therefore decrease, despite maintenance
of normotension.” Stevens et al reported 7 serious ophthalmic complications in 7 (0.2%) of 3450 patients undergoing spinal surgery, including posterior optic nerve ischemia, occipital lobe infarct, and central retinal thrombosis. In the series of 37 patients evaluated by Meyers et al, examining visual loss as a consequence of spine surgery, the range of pathology included optic neuropathy, retinal artery occlusion, and cerebral ischemia. Eleven of 37 eye-injured patients in this study had permanent bilateral blindness, underscoring the importance of the awareness of changes in ocular that occur during the use of the prone position.

ANATOMIC CONSIDERATIONS

Neurological. Focal pressure points and extremes of extension or flexion can lead to serious and potentially permanent injury to the cervical spine or brachial plexus during prone position surgery. Exaggerated head rotation or neck extension can lead to impaired cerebral perfusion. Prolonged pressure or strain placed upon the brachial plexus or its distal elements can lead to injuries ranging from transient paresthesia to permanent nerve injury with chronic loss of function. Special attention should be given to patients with larger breasts, as they present additional positioning challenges. It is important to understand that breasts will tolerate cephalad and medial displacement better than lateral positioning. Furthermore, direct pressure on implants pose a theoretical risk of rupture, and breast necrosis has been described after prone positioning.

Head and Neck. Facial, oropharyngeal, and ophthalmic problems associated with the prone position include blindness and other eye complications, ear injuries, intracranial insult, and neuropathies. The face-down position can result in pressure injuries to the eyes and ears. Prolonged pressure on the cartilaginous auricle can result in hematoma, chondritis, soft tissue ischemia, or necrosis. Direct contact, pressure, or dependent trauma to the orbit can cause corneal injury or abrasion, conjunctival edema and hemorrhage, chemosis, and potentially blindness.

Airway. One of the most acutely devastating complications of prone position surgery is displacement of the endotracheal tube. The prone positioned patient is particularly difficult to reintubate, and it is important to work precisely with the anesthesia team to prevent this potential disaster. With the patient face down, endotracheal tube position can be more difficult to monitor, and tube displacement or accidental extubation can occur. This event may lead to a technically difficult reintubation or even an emergency tracheotomy. Dependent edema of the head and neck can also be a consequence of prone position surgery. Severe postoperative macroglossia has been described by previous authors, with some patients going on to require tracheotomy.

DISCUSSION

Preventing complications associated with the prone position requires thorough preoperative planning. The initial evaluation of the patient should include a focused history of systemic disease, including hypertension, diabetes, coagulopathy, cardiovascular or pulmonary problems, cervical arthritis or neuropathy, or ophthalmologic problems. Patients at risk of cardiac problems should undergo consultation with the anesthesiologist to help determine the need for invasive cardiac monitoring. The inherent potential disturbances in cardiopulmonary physiology resulting from the prone position should provide a lower threshold for preoperative anesthesiology consultation. It is also important to assess the patient’s neck range of motion and any associated arthritis as part of the preoperative evaluation. Obtaining informed surgical consent should not only cover the customary discussion of factors directly relevant to the surgery but also address the specific potential complications arising from positioning as outlined in this report. The anesthesia and operating room teams need to be alerted with ample time when the prone position is to be used to ensure that experienced medical personnel are present and available. The team should decide in advance on the special equipment and room configuration to be employed. This would include the type of operating room table to be used, the type of head support and padding to be placed, and a discussion of space utilization within the operating room. No single system has proven superior to another, and choice of what to use should be tailored to the physique of the patient and the nature of the procedure. After entering the operating room, intubation should proceed with the patient in the supine position on a stretcher placed along side the operating table. After intubation, we prefer to further prepare the patient with antiembolism stockings, Foley catheterization, and protective eye goggles (Opti-GardTU...
Eye Protector, model No. 28310, Dupaco, Oceanside, CA) over well-lubricated eyes.

Rotation from the supine position on the stretcher into the prone position on the operating room table requires a "logroll" technique and should be accomplished with the assistance of multiple staff. With the entire surgical team present, 1 to 2 members should be dedicated solely to head and neck positioning, eye protection, and endotracheal tube monitoring (Figures 1 and 2). Larger patients can easily require up to 6 people to make a safe transition to the operating room table. Routine vigilance should be exercised by the anesthesiology service to frequently check for secure endotracheal tube placement throughout the procedure. Once the patient is turned prone, the remaining staff should focus attention on the upper extremities, abdomen, and pelvis.

Carefully padded support (Action patient positioning chest rolls, model No. 40616–40621, Action Products, Hagerstown, MD) will allow the patient’s abdomen to hang freely, lessening visceral congestion and improving cardiac and pulmonary dynamics. Padded support will lessen compression forces on the abdomen and thorax, allowing better venous return and cardiac output. This optimized positioning prevents loss of functional residual capacity of the lungs, increases pulmonary compliance, and helps avoid the need to use higher ventilation pressures—a source of potential complications.

To prevent brachial plexus injury, each humerus should be positioned anterior to the thoracic cage and adequate padding used to support the arms (Figure 3). Palpation of the pectoralis major muscle tendon along the anterior border of the axilla will indirectly monitor any undue tension on the brachial plexus. The tendon should be relaxed when palpated medially to laterally. Slight flexion at the hips alleviates any unnecessary tension of the low back. Attention must also be paid to the knees, ankles, elbows, and wrists, ensuring neutral positioning and optimal padding. Attention to the genitalia is important, especially with a Foley catheter in place. Untoward outcomes can result from kinking, twisting, or tension on the penis or scrotum.

Patients with a history of arthritis need to maintain the neck in the sagittal plane in order to avoid severe rotation or overextension. The head should be placed above the level of the heart to prevent increased venous stasis. For reconstructive surgery of the head and neck, use of skull clamp devices with penetrating pins should be
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REFERENCES


CONCLUSION

In our practice, the prone position has allowed more effective posterior neck, shoulder, and parietocipital dissections, which has resulted in improved outcomes. The prone or ventral decubitus position offers distinct and significant advantages when reconstruction of this region is entertained. Advances in modern reconstructive head and neck surgery demand expert knowledge from its practitioners. It is imperative that the reconstructive surgeon understand the pathophysiologic mechanisms that are associated with prone position in order to prevent complications. This expertise may require consideration of the prone position as part of an intelligent armamentarium of options when posterior head and neck exposure is essential. Experience with the prone position in spinal surgery associates most untoward events with diabetic patients, prolonged operating time, blood loss, and hypotension. It is therefore imperative that surgeons understand the associated pathophysiology in order to prevent complications. When considering this position, meticulous preoperative planning, teamwork, and proper equipment are essential tenets to successful procedure and improved outcomes.