8 Positioning the Patient for Procedures

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8.1 Introduction

Many aspects of care across the entire spectrum of procedural sedation require careful assessment, planning, and collaboration [1]. Proper patient positioning is one aspect of this care. Positioning during procedural sedation should facilitate the technical ease of the necessary procedure, while minimizing the physiological impact upon the patient. Specific patient positions impose related and predictable physiological changes upon all patients. Such changes can be exacerbated by sedation and anesthesia, as well as the time needed to complete the procedure requiring sedation. These factors may combine to form a risk of injury due to procedural positioning. The risk of iatrogenic injury may also be influenced by intrinsic patient factors and extrinsic process factors [2].

Safe and effective procedural sedation is best accomplished through proactive vigilance and teamwork. This teamwork is facilitated by clear and consistent communication at each stage of procedural care: pre-sedation assessment, intra-procedural care, and post-sedation assessment [1]. Conscientious hand-off communication must be maintained at each care interval. The prevention of complications that may be imposed related to patient positioning is a significant responsibility shared by the entire procedural team. At times, strong patient advocacy is required to achieve a compromise between procedural efficacy and patient safety, to find the best positioning alternative to balance these concerns.

8.1.1 Importance of Positioning Safety

Patient safety should always be an utmost priority of healthcare providers. The normal human has protective reflexes that function unconsciously to minimize physical harm to vital systems. Examples of these reflexes include rapid withdrawal from painful stimuli, the corneal reflex, and the cough reflex [3]. Reflexive protection of bodily integrity can also involve the movement of an extremity that is static for too long to be comfortable. The discomfort can often be due to an overly stretched, flexed, or compressed position. Medications used for sedation, especially in combination with any preexistent disease states, can greatly alter the constellation of protective reflexes a patient may normally possess [4].

The sedation provider must assume primary responsibility for preventing harm during the time the patient's sensorium is altered. In essence, the sedation provider and the procedural

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team must function as protective reflexes for the sedated patient. Bony projections should be protected, and normal curvatures should be maintained in the spine as possible [2]. Extreme or unusual positions may be required, and could be unnatural or need to be maintained past the point of comfort. Time spent in these types of positions should be limited as much as possible. At other times position changes may be required during the procedure. Care must be taken to avoid mechanical injuries to the patient from changes in position, such as a hand becoming caught in a table mechanism when reclining or inclining the head of the table. All pressure points in contact with surfaces should be protected in some manner. This can be accomplished through mattresses, foam padding, pillows, or specifically designed positioning devices. Common strategies have emerged for specific positions that may be encountered during procedures, based on anecdotal and scientific data; these will be covered later in this chapter.

8.1.2 Alterations in Physiology due to Procedural Positioning During Moderate Sedation

In addition to the risk of iatrogenic injury, procedural positioning also can impose physiological changes in several bodily systems. The extent of these physiological changes is dependent upon several main factors: the necessary procedure, the length of the procedure, the physical status of the patient, concurrent medication regimen, the necessary position, the positioning devices used, and the type of sedation or anesthesia utilized, among others [4]. The bodily systems most commonly affected by positioning include the respiratory system, the cardiovascular system, the neurological system, and exposed or susceptible areas of skin and tissue.

8.1.2.1 Respiratory System Effects: Procedural Sedation and Positioning

Medications used for procedural sedation are commonly known to depress respiratory function in various ways. During moderate sedation, the goals for the respiratory system encompass the maintenance of a patent airway supporting spontaneous ventilation, with avoidance of hypoxemia and excessive levels of hypercarbia [5]. Supplemental oxygen is very often supplied for improved safety in sedated patients, and ventilation should be monitored in pursuit of these respiratory goals. Position changes naturally affect factors that support adequate airway maintenance, ventilation, and oxygenation. The respiratory alterations from procedural positioning may be reasonably anticipated and attenuated in a majority of moderate sedation cases. This is not as easily accomplished with general anesthesia, which introduces several more variables.

Adequate pulmonary function depends first upon a patent airway. Airway patency is primarily affected by patient neural and anatomic factors, airway muscle tone, bulbar reflexes, and level of consciousness [5]. Moderate sedation can alter the state of most of these patient factors, as can changes in patient positioning via the effects of gravity. Diminished muscular control of the oropharyngeal structures of the airway can lead to varying degrees of airway obstruction, and eventually will cause hypoxemia, hypercarbia, and apnea [2]. Gravity can either exacerbate or diminish the airway obstruction present due to sedation, dependent upon the patient position assumed in the procedure. In general, airway patency is improved during sedation in the sitting, lateral, and prone positions, and is diminished to variable degrees in the supine position [3, 4].

Normal exchange of gases during pulmonary function depends on ventilation of the lungs, perfusion of the lungs, and a reasonable matching or balance between these two processes [3]. Ventilation and perfusion patterns depend upon intrinsic properties of the thorax/abdomen and extrinsic factors the lungs must accommodate. Intrinsic properties include chest wall and lung tissue compliance, lung volumes, intrathoracic pressures, diaphragm function, and abdominal compartment pressure [2, 3]. Extrinsically, gravity affects the distribution of ventilation and perfusion in the lungs, diaphragm function, and the distribution of abdominal contents [2, 3]. Because gravity can be a substantial factor altering pulmonary dynamics, positioning can significantly alter respiratory performance in sedated patients. These effects may be more pronounced in patients with preexisting pulmonary disease [4].

The sitting position generally produces few significant effects upon pulmonary dynamics and so is usually well tolerated. The supine position imposes notable reductions in lung volumes and capacities which can lead to altered gas exchange and decreased oxygen reserve [4]. The lateral position can lead to gravitational ventilation-perfusion mismatching. This potentially diminishes oxygenation in susceptible patients in the lateral position [4]. Compensation of lateral ventilation-perfusion mismatching is readily accomplished in patients without significant pulmonary disease. The pulmonary effects of prone positioning can be varied. If the weight of the body or a positioning device compresses the stomach in the prone position, abdominal compartment contents and pressure can limit diaphragmatic excursion and lung volumes [2]. If the abdomen is allowed to be free of pressure, the prone position can have advantageous effects upon lung compliance, lung volumes, ventilation-perfusion matching, and overall pulmonary function [2].

8.1.2.2 Cardiovascular System Effects: Procedural Sedation and Positioning

The overall function of the cardiovascular system is to produce an adequate supply of oxygenated cardiac output to furnish the various tissue oxygenation needs of the body. The maintenance of cardiac output and tissue perfusion are largely dependent upon the factors of vascular preload, heart rate, myocardial contractility, and systemic vascular resistance (SVR), also termed afterload [2]. Hemodynamic feedback systems and volume/pressure reflexes function to compensate for shortfalls in these critical factors and act to preserve cardiovascular stability [4]. For example, if mean arterial pressure falls, heart rate and SVR are increased to preserve tissue perfusion.

Alterations in some of these critical factors can occur merely from postural changes imposing the effects of gravity on the cardiovascular system [2]. These effects are normally compensated for by the physiological reflexes mentioned above. However, these mechanisms can be blunted or interfered with by disease states, treatment regimens, and the administration of sedation medications, among other factors [4]. Therefore, during procedural sedation, hemodynamic support may be necessary due to the combined effects of positioning and sedation upon the patient [4]. This is especially true of patients who may be intravascularly dehydrated, elderly, on cardiovascular medication, or with preexisting cardiovascular disease.

Anticipating postural changes in perfusion is predictable on a baseline normal model. As a general rule of thumb, mean arterial pressure changes around 2 mmHg for each inch of difference between the level of the heart and a body part [4], in the opposite direction. In other words, as the position of the head rises as compared to the heart, mean arterial pressure in the cranial vascular tree falls by 2 mmHg for each inch of elevation [4]. Therefore, postural hemodynamic changes in the supine and lateral positions are usually of little effect. Any position with legs in a dependent state can lead to hypotension, owing to gravitational pooling of blood in the venous system of the legs [3]. This would include the sitting and flexed lateral positions. Any position with the legs elevated above the level of the heart would increase venous preload and improve arterial pressures at least initially [3]. This would include the lithotomy and Trendelenburg positions. Prone positioning has the potential to diminish cardiac output due to increased intrathoracic pressure but is often well tolerated hemodynamically. Prone positioning devices that are rigid and increase pressures in the abdomen and thorax are more likely to affect the hemodynamic stability of patients [4].

8.1.3 Patient Comfort and Anxiety Effects

Many patients who require procedural sedation may have difficulty achieving or maintaining the required position, due to age or comorbidity factors. The patient should be informed of the position that is necessary for conducting the procedure, and information regarding potential concerns should be drawn out from the pre-procedure interview. A plan for positioning can be discussed proactively and should include the patient, procedural provider, the team members, and the sedation provider. Often the patient will have significant anxiety regarding aspects of the procedure, including positioning. Patient comfort can be optimized, complications avoided, and anxiety diminished by the creation of a plan with the procedural team and the patient. Compromises with positioning should be made if at all possible, in deference to any preexisting limitations. Once the plan is agreed upon, an explanation given to the patient will also greatly mitigate the level of anxiety present.

8.1.4 Incidence and Medicolegal Implications of Positioning Injuries

As stated previously, the bodily systems most susceptible to untoward effects due to procedural positioning include the respiratory system, the cardiovascular system, the neurological system, and exposed or susceptible areas of skin and tissue. The most common neurological injury suffered due to positioning is perioperative peripheral nerve injury [6]. The overall incidence of perioperative peripheral nerve injury is difficult to quantify, but it is thought to be well below 1% of sedation and anesthesia cases [2, 3, 6]. The incidence of perioperative peripheral nerve injury among cases with known complications, by review of anesthesia literature reveals a large collection of data in the American Society of Anesthesiologists Closed Claim Project, encompassing the data years 1990–2007 [6]. This body of work shows that peripheral nerve injuries account for 22% of the closed claims cases in the database; the only more common closed claim is the complication of death [2].

Among common injuries to susceptible skin and tissue are perioperative pressure injuries, which can include pressure or shear force ischemia, skin tears, and joint stresses [7]. Effective sedation can at times mask patient symptoms that would reveal a risk of skin, tissue, or joint injury. Preventing pressure injuries is a high priority for healthcare providers as these injuries can impart a large burden of morbidity and cost [7]. Literature regarding the well-defined incidence of such injuries related to either procedural sedation or anesthesia is scant and variably defined.

8.2 General Principles of Patient Safety for Procedural Sedation

A planned and proactive approach to assessment and intervention in the prevention of positioning injury is the best strategy, including the use of proven preventative adjuncts. The mattress type most often associated with pressure injuries seems to be gel mattresses, while the standard operating room (OR) and procedural table mattresses performed better [7]. Additional padding can be accomplished through the use of appropriately sized pillows, foam rubber pads, or warmed gel pads [7]. A key factor in the application of additional padding is not to produce compression to the structures from the bulk of the protective padding. If specialized positioning devices are to be used, it is imperative to know and follow the manufacturer's recommendations [1]. Proactive assessment and planning for positioning should occur during the following phases of care: pre-procedure, intra-procedure, and post-procedure.

8.2.1 Pre-procedure Phase

This phase should include a thorough assessment of intrinsic patient risk factors for complications, extrinsic/procedural risk factors, and documentation of any preexisting deficits or physiological alterations in the patient baseline status [1]. This should especially include peripheral nerve function or dysfunction, skin condition, joint range of motion limitations, and peripheral pulses. Documentation of the pre-procedural assessment and effective hand-off communication between team members is key to the prevention of positioning injury.

Collaboration among all team members and the patient regarding the positioning plan, as mentioned before, is key and should occur at this point in time. Planning for specific positioning devices, protective padding and effective monitoring should also take place, and specifically be led by the sedation provider [4]. An effective measure of imposed positioning stress can occur at this point, by having the patient conduct a trial assumption of the needed position necessary during the pre-assessment [3]. This can reveal the patient's physiological tolerance of the required position. Finally, staff members of sufficient number and specific expertise should be regularly scheduled as needed for the procedure and patient safety needs.

8.2.2 Intra-procedure Phase

Prompt and accurate communication among members of the intra-procedural team is very important. The execution of the positioning strategy should include the use of any special positioning equipment within the manufacturer's guidelines. Protective padding or support of all vulnerable areas should occur as needed, including bony prominences, joints, spinal curvatures, eyes, nose, breast, and genitalia [2]. Safety straps should be employed per the facility protocol. If the procedure requires the sedation provider be removed in distance from the patient's bedside, the placement of a visual clue to indicate adequate chest respiratory movement can be an excellent monitoring intervention. A visual clue could be as simple as a fluffed 4 × 4 gauze taped to the portion of the patient's chest wall that has the most respiratory excursion. The sedation provider must exercise consistent vigilance in initial positioning and subsequent monitoring to prevent injury [8]. Immediate re-assessment should occur with planned or accidental repositioning of the patient during the sedation. If extreme positions must be maintained for a prolonged time period, planned positioning breaks in a more anatomically neutral position should occur at agreed-upon intervals [1]. Standard re-assessment of positioning and injury prevention should occur at a regular basis during the sedation interval, including peripheral pulse assessment distal to areas of potential compression.

8.2.3 Post-procedure Phase

Vigilant assessment and monitoring should continue during the recovery, or post-procedure phase of care. The hand-off communication should include the length of the procedure, the position maintained during the sedation, and any relevant risk factors for positioning injury [1]. Preexisting alterations in physiologic status uncovered in the pre-procedure assessment should be emphasized as well. Once sedation has worn off, accurate documentation of any alteration in baseline function should take place and will be valuable for monitoring symptom progression and in diagnosis [7]. Any such alteration should be brought to the attention of the procedural provider and the team as soon as possible.

8.3 Descriptions of Commonly Required Patient Positions

8.3.1 Physiologic Alterations/Iatrogenic Risk

Positioning for radiological procedures may vary due to modality, type of procedure, patient condition, available equipment, and facility-specific requirements. The following descriptions of commonly required positions are the foundation from which some modifications may ensue, given that patient safety is observed.

8.3.2 Supine Position (Dorsal Decubitus)

The supine position is very frequently used for procedures requiring sedation and anesthesia. A patient in the supine position is lying recumbent, back flat on the mattress, facing upward. The head should be supported, and the neck maintained in a neutral position, by the use of a pillow or small positioning device such as a gel or foam donut [4]. Arms may be positioned at the patient's sides or may be placed on padded arm boards. If arm boards are used, the patient's arms should be abducted less than 90° at the shoulder, and the forearm should be placed in the supinated position [4]. When a single arm is abducted it is important to avoid rotation of the head, most especially to the side opposite the abducted arm [1]. If the arms are tucked and secured at the patient's sides, the elbows should be supported and not allowed to hang over the edge of the table [3]. In the arms tucked position, the hands should be in a neutral position with the thumbs up and the palms inward [4]. The legs should remain uncrossed, and, if possible, a pillow should be placed under the patient's knees for comfort. Bony prominences of concern include the heels, areas of the thoracic/lumbar/sacral/coccygeal spinal column, scapulae, elbows, and the back of the cranium [1]. In a case projected to last longer than 1 h, heel pads should be strongly considered. Figure 8.1 shows a patient positioned supine for a procedure.

8.3.3 Lateral Decubitus Position

The patient in the lateral decubitus position is essentially in a side-lying position, with the side down noted by preceding the term "lateral decubitus" with either left or right. Therefore, left lateral decubitus is a side-lying position with the left side down. The head and neck should be supported by pillows or padding devices in a neutral position, neither markedly flexed nor extended. The overall alignment of the body from the head through the hips should be along the same linear plane if at all possible [4]. To alleviate pressure on the down arm and shoulder, an "axillary roll" should be placed under the down thorax, on the ribcage just slightly below the actual axilla [3].

Fig. 8.1 Supine position

The down arm should be placed on a padded arm board and extended perpendicularly to the torso, with the elbow flexed less than 90° [1]. It is acceptable in short procedures for the down arm to be flexed and placed on the bed under the pillow as in a natural sleeping postion, if no patient discomfort results from this positioning. The up, or superior, arm can be secured to the down arm with adequate padding or pillows between the two arms, or the limb can be secured on a separate positioning device such as an elevated arm rest. If this is used, care should be taken that the suspended arm is in neutral position at the shoulder to avoid undue stretch on the neural plexus. It is recommended to place the cuff for monitoring noninvasive blood pressure (NIBP) on the up arm, as using the down arm can exacerbate any compression on vascular or neural tissue [4]. If the up arm is above the level of the patient's heart, the provider should realize that the NIBP readings may well be artificially low [2]. There should be padding provided between the legs to prevent pressure on bony prominences. Flexing either leg can help prevent pressure and stabilize the patient's position on the table [3]. Padding the lateral surface of the down leg which is in contact with the table, from the knee to the ankle, can protect vulnerable superficial nerve structures. Figures 8.2 and 8.3 show a patient in right lateral decubitus position, with axillary roll placed, and two options for arm positions depending upon needed exposure.

8.3.4 Lithotomy Position

The patient in lithotomy position is usually placed in this manner for access to the perineum and associated structures. In the lithotomy position, the patient is essentially supine, but the legs

Fig. 8.2 Lateral position. Up arm extended

Fig. 8.3 Lateral position. Up arm flexed

are positioned and secured above the torso, with hips and knees flexed and the hips abducted [3]. Legs are held in place with the use of stirrups, supports, or padded positioning boots [2]. With all leg positioning devices used, care should be taken to avoid pressure in the popliteal fossa and on the bony prominences of the tibia and fibula at the knee and ankle joints [4]. The extent of leg elevation differentiates low lithotomy from exaggerated lithotomy. In low lithotomy, the legs are suspended only slightly above the torso and hip/knee flexion is not extreme. With an exaggerated lithotomy position, the legs are high above the torso and hip/knee flexion is much more exaggerated. The more exaggerated the position is from neutral, the higher the risk of positioning injury. Exaggerated lithotomy positions should be utilized for the least amount of time possible, with positioning breaks occurring during longer cases.

Fig. 8.4 Lithotomy position

Hips and knees should not be flexed greater than 90° to prevent neurovascular damage and undue joint stress [4]. When positioning the legs for lithotomy, the legs should be gently raised and lowered simultaneously to avoid undue stress on the hip joints. Controlled movements are very important, as sudden accidental movements of the legs in a sedated patient can cause injury or even joint dislocation [4]. The arms are often placed on padded arm boards or tucked as described in the supine position. If the arms are tucked and secured at the patient's sides, extreme caution must be taken when moving the patient or sections of the table, to avoid crush injuries to the hands and limbs [7]. Figure 8.4 shows a patient in low lithotomy position, using a positioning device sometimes called "bumblebee boots" to maintain the leg position necessary for the procedure.

In the following figure (Fig. 8.5) the angle of the hip joint is marked with red lines to show the area of concern for sustained or high degrees of hip flexion which can potentially lead to peripheral nerve or muscle injury.

8.3.5 Prone (Ventral Decubitus)

Prone positioning is used for access to the dorsal surfaces of the body, some intracranial procedures and for rectal procedures [4]. The patient in prone position is lying relatively flat, face downwards. For this reason, it is very important to know the patient's preexisting range of motion

Fig. 8.5 Angle of hip flexion in lithotomy position

in the arms and cervical spine [1]. For prone cases that strictly require little to zero patient movement, general anesthesia is recommended. Prone positioning for general anesthetics can involve several different positioning devices not necessary in sedation cases. For sedation in the prone position, it is common to allow the patient to assume the necessary position and adjust head, neck, arm, and leg position for optimal comfort prior to sedation. Nasal oxygen and monitors should be applied prior to the patient positioning, and free intravenous (IV) access should be assured. Comfort may be improved by the placement of a small pillow under the feet of the patient in prone position.

For short prone cases, it is acceptable for the patient's head to be rotated to the side if that is comfortable. This rotation is not acceptable if the case is prolonged, or the contralateral arm is abducted greater than 90°. Arms may be padded and tucked or may be placed at the sides of the patient's head, with less than 90° of shoulder abduction and elbow flexion. Alternatively, the arms may be differentially positioned, with one arm down by the patient's side and one arm at the side of the patient's head. The arms should never be on a horizontal plane higher than the torso. Breast and genitalia should be positioned to limit shear forces and pressure. If the sedated patient in prone position moves or shifts during the procedure, it is important to reassess the position prior to continuing, as visual inspection of many vulnerable areas is obscured.

8.3.6 Trendelenburg and Reverse Trendelenburg

The Trendelenburg position can be variation of any the base positions described above. However, it is most often associated with the flat supine position, with the patient lying recumbent and the foot of the bed inclined to varying degrees. Most often the angle of foot elevation is between 10 and 30°. This position may be assumed as a temporary hemodynamic intervention to treat hypotension by increasing venous return from the legs [3]. Brief periods of Trendelenburg positioning can often be used to facilitate central vascular access. Due to similar effects on other vascular or fluid beds, the position can increase central venous pressure, intracranial pressure, and intraocular pressures [4].

Trendelenburg positioning may also be assumed due to procedural requirements. If this is the case, often there is some device used to prevent continued slipping of the patient towards the declined head of the bed. This may involve the use of shoulder braces. Prolonged pressure from shoulder braces should be distributed across a wide surface area of each shoulder to minimize potential neurovascular compression or stretch injuries [1].

Reverse Trendelenburg positioning is the exact opposite of Trendelenburg, meaning that the head of the bed is inclined to varying degrees. This position may be assumed for patient comfort, especially for ease of breathing, in situations where the head of the bed (HOB) may not be singularly elevated. Otherwise, the position is usually only encountered when procedurally necessary. The same considerations for the base position apply in reverse Trendelenburg, but some cardiovascular effects may be revealed due to the change in gravity's effects from the elevation of the HOB.

Figures 8.6 and 8.7 show a patient model positioned in Trendelenburg and reverse Trendelenburg positions, respectively.

8.3.7 Specialized Positioning Equipment

Depending upon the needed procedure for which the patient requires sedation, there may be highly

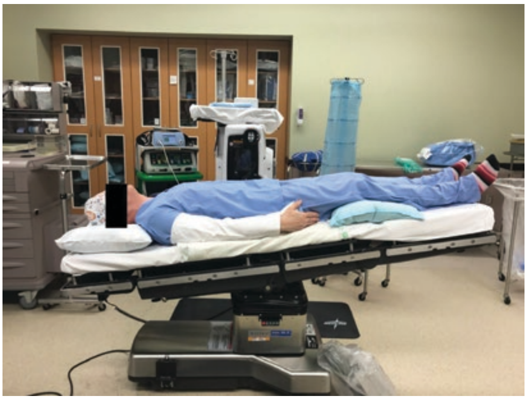

Fig. 8.6 Trendelenburg position

Fig. 8.7 Reverse Trendelenburg position

specialized positioning equipment utilized. The wide array of these devices makes it impossible to include an exhaustive list of the same. However, one example would be devices made specifically to stabilize an extremity during a procedure, such as an arm rest which facilitates radial artery puncture and access.

8.4 Nerve Injuries Related to Procedural Positioning

Peripheral nerves are particularly vulnerable to positioning injury, especially if the patient is sedate enough that it allows the assumption of positions that would normally cause the patient discomfort or distress. The physiologic structure and function, as well as the anatomical positions of peripheral nerves, can lead to vulnerability to injury from various stressors due to positioning.

8.4.1 Physiology/Pathophysiology of Nerve Injury

Proper peripheral nerve function generally depends upon neuronal structural integrity, electrochemical homeostasis, and an adequate blood supply [3]. Peripheral nerves contain groupings of nerve fibers and supporting microvasculature, encased within protective connective tissue bundles. Individual fascicle groupings within a peripheral nerve are enclosed by the endoneurium and the perineurium [4]. Several of these fascicle groupings can be bound into a peripheral nerve that is structurally supported and housed by the epineurium [8]. The entire peripheral nerve is covered by other connective tissue that gives it protection and the ability to resist frictional forces encountered when moving across joints and tissue [4].

The primary mechanisms of peripheral nerve injuries are compression, stretch, and of course shearing or transection of the nerve bundle [8]. Compression can lead to nerve tissue injury due to direct neuronal trauma, arterial occlusion, or venous outflow obstruction. Any edema in peripheral nerves is poorly tolerated due to the fact that there is no lymphatic drainage available [4]. Neuronal compression may also result from improper placement or prolonged use of the NIBP cuff. The NIBP cuff should be placed high on the upper arm so that the area near the bony prominences of the elbow are not frequently compressed, which can lead to radial and ulnar nerve injury [8]. During a prolonged case, it is suggested to alternate arms for NIBP measurement if possible. Even though all nerve tissue has some elasticity, it is limited. Therefore, positions that impose either a large degree or prolonged amount of stretch upon peripheral nerves can also impose neuronal damage [6]. Stretch injuries can cause actual destruction of nerve fibers, alter electrochemical neuronal conduction pathways, or disrupt the vascularity supplying the nerve [4]. The common theme among these injury mechanisms is that each of them result in some manner of ischemia or hypoperfusion to the nerve tissue. Another cause of perioperative nerve dysfunction to consider is metabolic imbalance leading to an unfavorable electrochemical gradient for neuronal transmission [3, 9].

8.4.2 Patient and Procedural Risk Factors

There is a general consensus regarding risk factors intrinsic to the patient's condition that increase the risk of peripheral nerve injuries. These include preexisting peripheral neuropathy, diabetes mellitus, hypotension, hypovolemia, hypothermia, peripheral vascular disease, extremes of body habitus, malnutrition, tobacco use, alcoholism, liver disease, chronic and poorly controlled hypertension, anemia, atypical anatomical structure, age greater than 65 years, and male gender [2, 4, 6, 8]. Males are particularly more likely to develop perioperative ulnar neuropathy as compared to females [6]. Procedural risk factors include the specific position used, the length of the procedure, and specific positioning devices used [8, 9].

8.4.3 Recommendations

For the prevention of neurological injuries of the upper extremities related to positioning, the following general recommendations have been noted in the literature [2, 4, 6, 8–10]:

- Arm/shoulder abduction in the supine position should be limited to less than 90° on padded arm boards.
- The arm should be in supinated position (palm up) when abducted on padded arm boards; if this is not feasible, then neutral (thumbs up) is the next best option.
- Avoid pronation of the arms and hands in the supine position.
- Position the arms to avoid pressure on the ulnar groove of the elbow and the spiral groove of the humerus (posterior flat surface of the upper arm).
- Avoid both hyperextension and marked flexion of the elbows.
- When tucking arms at the sides, maintain the arms and hands in neutral position (thumbs up and palms inward).
- If using shoulder braces during prolonged Trendelenburg positioning, use a device that distributes the load across the width of the shoulder and avoid the supraclavicular fossa.
- Avoid placing the NIBP cuff near the elbow where it may compress neural structures within the cubital tunnel.

For the prevention of neurological injuries of the lower extremities related to positioning, the following general recommendations have been noted in the literature [2, 4, 6, 8–10]:

- Limit the amount of hip flexion and extension during positioning.
- In lithotomy position, use the least amount of hip and knee flexion that facilitates the procedure, and keep this flexion below 90°.
- Avoid compression against the fibular and tibial heads at the level of the knee during positioning, especially using devices to maintain lithotomy positioning.
- Provide positioning "breaks" for prolonged lithotomy position cases: one suggestion is a 10–15-min break every 3 h, or sooner if risk factors dictate [8].

8.5 Respiratory Compromise Related to Procedural Positioning

Every year there have been increases in the volume of sedation cases conducted outside the operating room, in various settings [11]. These can include, but are not limited to, radiology, endoscopy, diagnostic or interventional cardiology, and dental settings. The most common complications to be found in procedural sedation are hemodynamic compromise, respiratory compromise, and needed upgrade of care [2, 11]. The outcome most consistently associated with needed upgrade of care is prolonged respiratory compromise [3, 11]. Nearly all medications used to induce procedural sedation can lead to respiratory compromise. Of note, it has been found by some authors that the locations that have the highest number of respiratory complications are the radiology and cardiology settings [11]. So, vigilance in assessing respiratory function during the sedation procedure is key to patient outcomes.

8.5.1 Patient and Procedural Risk Factors

Patient risk factors for respiratory compromise include preexisting pulmonary or cardiac disease, history/risk factors for sleep apnea, obesity, abnormal airway anatomy, alteration in level of consciousness, elderly patients, concurrent medical regimen, and overall medical complexity. Many times, patients receiving procedural sedation for procedures outside of the OR have been disqualified for more definitive procedures under anesthesia, due to preexisting comorbidities [4, 11]. For these reasons, among others, it is imperative that standard monitoring requirements and due vigilance is exercised in procedural sedation. Supplemental oxygen and suctioning equipment should be immediately available and used as needed. Medications and airway equipment to facilitate emergent airway support or endotracheal intubation should be immediately available [2–4].

Positioning should facilitate not only the procedural needs but provide access to the patient by the sedation provider as necessary. This is especially true in order to maintain a patent airway, and to allow for vigilant re-assessment. The supine position leads to more airway obstruction than either the lateral, prone, or semi-recumbent positions [11]. When feasible, the flat supine position should be avoided to mitigate the risk of respiratory compromise from airway obstruction. The supine position should also be avoided if the patient cannot tolerate lying flat due to comorbidities. Although lateral positioning has been found to have a correlation with the incidence of hypotension [11], it should be noted that placing the NIBP on the non-dependent arm can provide artificially low BP readings.

8.6 Skin and Tissue Injuries Related to Procedural Positioning

Specific positioning needs during procedures requiring sedation can impart an increased risk of injury to skin and soft tissues. The necessary procedural sedation can impair the patient's own protective reflexes and functional discomfort [3]. Compression and shear forces imparted to the skin and soft tissues impose the risk of injury, including pressure injuries. Pressure injuries impart a large burden of cost to both the facility and the patient, and can confer significant morbidity as well [4, 7]. Therefore, mitigation of these injuries is most beneficial.

8.6.1 Patient and Procedural Risk Factors

Risk factors for skin and soft tissue injuries intrinsic to the patient include extremes of body habitus, poor nutritional status, cardiac disease, vascular disease, diabetes mellitus, renal disease, anemia, hypoproteinemia, age greater than 65 years, female vs. male gender, and overall medical complexity [3, 7]. Procedural or extrinsic risk factors include the total length of the procedure, total duration of sedation, total time with diastolic BP less than 50 mm Hg, positioning during the procedure, and incidences of sustained hypothermia [3, 7]. Positions that predisposed to skin or tissue injuries included prone > lateral > supine [7]. Studies have been equivocal in imparting increased risk according to gender. The use of general anesthesia has been confirmed as a specific risk factor for the development of pressure injuries, especially general anesthesia of a duration greater than 4 h [7]. Tissue areas at high risk of developing pressure injuries include the sacral area, flank, back, elbows, and cheeks [7].

8.6.2 Recommendations

Several recommendations can diminish the risk of skin and soft tissue injuries during procedural sedation. Careful pre-procedural assessment should guide the optimization of each patient's physical and nutritional status [4]. Vigilant, careful positioning and monitoring during the procedure is paramount. Maintaining hemodynamic stability, especially the avoidance of sustained hypotension, will guard against the development of pressure injuries [3, 7]. Monitoring of the patient's body temperature should be instituted, especially in elderly patients having procedures lasting greater than 1 h. Prevention of hypothermia, including the use of active warming therapies, is beneficial in guarding against soft tissue injury [7]. The use of standard mattresses is recommended over the use of specialized gel mattresses, but foam or gel padding of specific pressure areas is recommended [7]. Planning with the entire procedural team to expedite the time necessary for the procedure and sedation can diminish the time period the patient spends at risk for tissue injury.

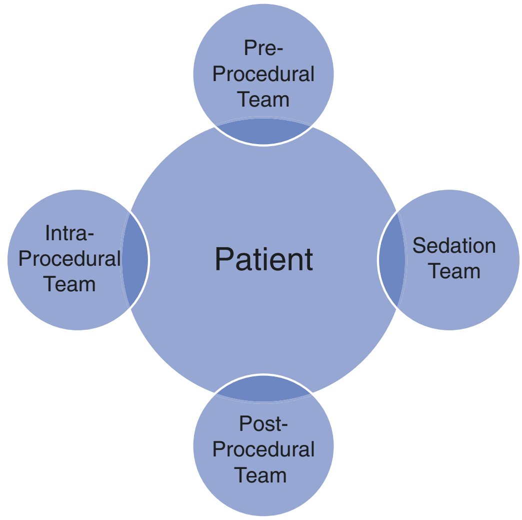

Fig. 8.8 The interface of the phases of procedural sedation and team members

8.7 Conclusion

Proper patient positioning for procedural sedation is a planned and proactive balancing act that weighs the need of procedural ease and efficiency against patient safety and comfort. As with many aspects of excellent and thoughtful care, individualized alterations upon basic tenets and procedures of safe positioning make it possible to have excellent patient outcomes. This planning of care requires collaboration and accurate communication within the procedural sedation team. The team includes pre-procedural staff, intra-procedural staff, and post-procedural staff and consists of technologists, ancillary staff, nurses, physicians, and advanced practice nurses/providers (Fig. 8.8). Important information relevant to position planning includes (but is not limited to) the preexisting physiological or pathophysiologic status of the patient, pertinent laboratory or imaging findings, assessment findings, knowledge of special operating factors needed for a successful procedure, likely duration of the sedation/procedure, necessary depth of sedation, and any specialized positioning aides to be used. Vigilant monitoring and assessment of the patient during all phases of care yield the best chance of an optimal outcome for both the patient and the procedural team.

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