

The Beach Chair Position

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Keywords:

Introduction

The beach chair or barbershop position is used to facilitate several forms of surgery, by placing the patient in a semi-sitting position. A standard operating table or a special "beach chair" table can be used. Typically the patient is placed in 10° to 15° of Trendelenburg, the hips are flexed to 45° to 90° and the knees are flexed to 30°. The feet are supported with a foot bar to keep the ankles at 90°. The head, neck and torso are supported in a neutral position by straps and or special attachments.¹

This position has been used to facilitate various forms of surgery:²

- Neurosurgery: Posterior fossa or cervical spine surgery.
- Orthopaedics: Shoulder surgery, either open or arthroscopic.
- Other: e.g. Thyroid surgery, Plastic surgery.

Advantages

In neurosurgery, the advantages of this position are better venous and cerebrospinal fluid (CSF) drainage, as well as better surgical access in some cases.³ While some neurosurgeons may still prefer the sitting position, the long list of potential complications has resulted in this position falling out of favour in neurosurgery.

In orthopaedic surgery, shoulder surgery can be performed in the lateral decubitus position or in the beach chair position. Since Skyhar et al⁴ popularised the beach chair position for shoulder arthroscopy in 1988, this has become the preferred position for shoulder work. The advantages over the lateral decubitus position are:¹

- No brachial plexus strain injuries, because the arm does not need to be held in traction.
- The patient's shoulder is in an upright, anatomical position.
- Better visualisation of the glenohumeral joint and subacromial space because the arm hangs naturally by gravity, distracting the joint and avoiding distortion of the intra-articular anatomy.
- Easier to perform examination under anaesthesia.
- The arm is out of the way of the anterior arthroscopic portal.
- Easy to convert to an open procedure if necessary, with no need for re-positioning and re-draping of the patient.
- Regional anaesthesia alone, without concomitant general anaesthesia is more feasible in the beach chair position

than in the lateral decubitus position. Also, converting from regional to general anaesthesia is more practically done in the beach chair position.

Disadvantages and dangers

The beach chair position does however have several disadvantages and is associated with potential dangers which need to be borne in mind:

a) Embolic events

Venous air embolism can occur when air or gas is entrained by veins above the level of the heart.³ This is most likely to occur in neurosurgery or open shoulder surgery. The volume of air entrained will determine the clinical effect:

- Small (≤ 10 ml): Only detected by TOE.
- Medium (10-50 ml): \downarrow ETCO₂, \uparrow HR, \uparrow BP.
- Large (≥ 50 ml or ≥ 1 ml/kg): RV failure & Cardiac arrest.²⁴

About 20% of the general population may have a patent foramen ovale, which would allow air to enter the arterial side of the circulatory tree, and possibly lead to a cerebro-vascular incident.⁵ A known patent foramen ovale is a relative contra-indication to the beach chair position.

Other potential embolic sources include atherosclerotic plaque, thromboemboli or fat.⁵

b) Nerve damage and pressure points

These injuries are more common in neurosurgery, if the head is not maintained in a neutral position but either hyper-flexed or extended^{3, 5}, or where a horseshoe head ring is used. Hyperflexion may lead to upper spinal cord or brainstem infarcts, with resultant death or quadriplegia.⁵

The horseshoe head ring could cause pressure on the lesser occipital or the greater auricular nerve, resulting in neuropraxia. It is recommended to secure the patient's head in a neutral position with adequate padding on a neutral cushion rather than using a horseshoe head ring.^{13, 23}

All other pressure points (buttocks, heels, non-surgical arm) must be padded carefully.³

c) Irrigant solution complications

Irrigant solution is introduced into the shoulder joint under pressure and could extravasate and cause edema. In severe cases this has led to airway obstruction.²³

Use of large volumes of adrenaline-containing solution may lead to dysrhythmias and haemodynamic complications.

d) Hypotension and cerebral hypo-perfusion

In 2005 Pohl & Cullen reported on 4 cases who suffered ischemic brain and spinal cord injury, after shoulder surgery in the beach chair position under general anaesthesia. These patients were all relatively healthy middle-aged people who all had an extremely low risk for cerebrovascular events.⁵ Three patients did not awaken post operatively and were left in a vegetative state. The 4th patient was brain dead by the end of the procedure. In this patient, deliberate hypotension had also been used, measured against a non-invasive blood pressure cuff positioned on her calf.

The likely cause for these catastrophic outcomes was thought to be secondary to cerebral hypoperfusion, either due to hypotension caused by the sitting position (these patients' blood pressures were allowed to drop by between 28% - 42% from preoperative values), or embolic causes (air or other emboli).

There are 2 theories of cerebral blood flow: the siphon theory and the waterfall theory. In practice both are probably an over-simplification and the reality is most likely a combination. According to the siphon theory, blood flow above the level of the heart is "sucked" across the tissue, and back to the heart by the negative intrathoracic pressure on inspiration.² The appealing feature of this theory is that the pressure at heart level can be dropped to almost zero in a patient with a healthy vascular tree and cerebral perfusion will be maintained. According to the waterfall theory, a hydrostatic pressure head is required to "push" blood flow from the heart, though the tissue above heart level, and back to the heart. According to this theory, the pressure measured at the level of the head in the sitting position will be lower than that measured at the level of the heart.⁶ For every 2 cm above the heart, the Mean arterial pressure (MAP) will decrease by 1.5mmHg. Therefore the pressure at the external auditory meatus could be 15 mmHg lower than the value measured at the upper arm. Naturally the difference between a reading measured at the calf and the pressure at the brain will be even greater.

In a letter to the editor of the 2008 APSF newsletter, Munis disputes the importance of this hydrostatic difference. In his opinion, blood pressure is normally measured in a seated patient anyway. He argues that all our normal reference values do not take such a height difference into account, when considering normal values for blood pressure and Cerebral perfusion pressure (CPP).⁷ He is referring to an awake, non-anaesthetised patient, however.

Cerebral perfusion pressure = Mean Arterial pressure - Intracranial pressure. Cerebral perfusion pressure (CPP) decreases by about 15% simply by moving from supine to sitting in the non-anaesthetised person. This is rapidly compensated for

by a reflex increase in heart rate and systemic vascular resistance. CPP remains decreased under general anaesthesia, because of vasodilatation and myocardial depression caused by general anaesthetic agents. Impaired venous return due to intermittent positive pressure ventilation will further reduce CPP. To achieve the minimal CPP for which auto regulation is thought to be effective, MAP must be maintained higher than 65mmHg or higher than 80% of their normal resting MAP.⁵

This case report by Pohl and Cullen resulted in a lot of debate and several further studies by Anaesthesiologists and Orthopaedic surgeons.

- In 2011 Yadeau et al published a review of 4169 ambulatory surgery patients, who underwent shoulder surgery in the sitting position. Almost all of these cases were done under regional anaesthesia, either alone or with additional intravenous sedation. They all had no untoward gross neurological events.⁸
- In 2013 Pin-on et al published a retrospective study of 5177 patients who underwent either neuro- or orthopaedic surgery in the sitting position under general anaesthesia over an 8 year period, without a single catastrophic postoperative outcome. They found the mean decrease in intraoperative systolic blood pressure in shoulder surgery patients to be 14.4% at heart level measured by arterial line, and 19.7% at heart level measured by a non-invasive blood pressure monitor.(i.e. The blood pressures were maintained at levels \geq 80% of their starting values). They also found that about 50% of all patients did experience at least 1 or more transient episodes of a drop in systolic blood pressure greater than 40% below baseline levels.⁹ In 2009 Friedman et al did a survey of 287 members of the American Shoulder and Elbow Surgeons (ASES) Society. Over a 3.5 year period they performed about 200 000 beach chair procedures and 100 000 lateral decubitus procedures, mostly arthroscopic. No cerebrovascular events occurred in the lateral decubitus group, but 8 events occurred among the beach chair group. This equates to an incidence of 0.004% of cerebrovascular events.¹⁰

Seeing that hypo-perfusion related cerebrovascular events do occur (although rare), it is prudent to follow the following advice:^{3,11}

- i. Use the heart level as the gold standard reference point for blood pressure monitoring.
- ii. Place the NIBP cuff around the arm, at heart level, or if using invasive monitoring then place the transducer at heart level.
- iii. Aggressively treat perioperative blood pressure values lower than 80% of preoperative resting values.
- iv. Do not simply lower the blood pressure to a specific numerical point, without considering the patients particular preoperative resting blood pressure values, the site of the cuff and the position of the patient.
- v. Employ elastic stockings or calf compression devices to enhance venous return from the legs. Flex the hips to elevate the knees to the same height as the heart.
- vi. Move the patient into the sitting position slowly and incrementally after induction of general anaesthesia. Monitor

for hypotension and treat appropriately while positioning the patient.

- vii. In high risk cases (e.g. known carotid artery disease) discuss avoiding the beach chair position altogether with the surgeon.
- viii. In ventilated patients, aim for end tidal CO₂ levels of 40-42 mmHg rather than the 30-32 mmHg range. This mild hypoventilation has been shown to effect higher cerebral saturation levels and less cerebral desaturation events.²⁵

As in all cases, patients with poorly controlled hypertension are more prone to hemodynamic instability and a more profound blood pressure drop during beach chair positioning.²¹

Regional Anaesthesia

- Rohrbaugh et al reported on a retrospective study of 15 014 patients who underwent shoulder surgery in the sitting position under interscalene block alone, or with propofol sedation. In this group only 1 patient suffered a neurologic deficit due to an ischemic stroke 24 hours after surgery.¹²
- Koh et al compared interscalene block with monitored sedation care to general anaesthesia in 60 patients, and also found a superior outcome for the former, when looking at cerebral deoxygenation events (CDEs) using near-infrared spectroscopy (NIRS).¹⁶

Interscalene block alone or combined with sedation thus appears to be safer than general anaesthesia because of a lower incidence of hypotension, and is very commonly performed. While arthroscopic surgery is less painful, open shoulder surgery is extremely painful, making interscalene blocks +/- general anaesthesia a standard of care.²⁰

Interscalene blocks require technical skill and are associated with several complications and dangers of their own however.

Bloodless field

To optimise arthroscopic surgery in particular, the surgeon will often request a bloodless field. This can be achieved by administering the arthroscopic irrigant solution under pressure (30-50 mmHg), and by employing deliberate hypotension.

A 49 mmHg difference between systolic blood pressure and intra-articular pressure should provide a safe and clear operative field. Current guidelines allow for a reduction in blood pressure of up to 20% below resting preoperative values.^{14, 23}

Rather than actively lowering the blood pressure, it is more common to simply allow a spontaneous drift down to within 20% of the preoperative mean. Gillespie et al have challenged the 20% hypotension cut-off level, having found no neurological deficit after short term lowering of the mean arterial pressure in a group of 52 patients by up to 42%. All these patients were monitored with intraoperative electroencephalography performed by a neurophysiologist however. If any electroencephalographic evidence of ischemia was seen, the blood pressure was immediately raised.¹⁴ Clearly, this is not a resource routinely clinically available. Deliberate hypotension in the setting of the beach chair position remains controversial with some authors

advocating strongly against its use, but overall the consensus being that the 20% limit should be respected.¹⁵

Monitoring during beach chair anaesthesia

Awake patient

Arthroscopic shoulder surgery in particular, is often ambulatory, and takes about 45 minutes. Regional anaesthesia alone, or with sedation and monitored care is extremely popular, with the awake patient providing an excellent monitor of neuro-cognitive function.²⁰

Blood pressure

It is adequate in most cases to measure the blood pressure with a non invasive blood pressure (NIBP) device on the arm. Invasive blood pressure monitoring is only required in particular patients with specific additional cardiovascular indications.

NIRS (Near Infra-Red Spectroscopy)

When available, NIRS monitoring is practical, simple to use and helpful.^{17, 19, 22}

A >20% reduction in regional cerebral oxygenation (rScO₂) is associated with regional and global cerebral ischemia. When this is caused by a decrease in mean arterial blood pressure, raising the blood pressure improves the rScO₂. A limitation is that the NIRS only measures a superficial area of the brain, the frontal lobes. Also the use of vasopressors, especially alpha stimulation by phenylephrine may not raise the rScO₂ even though the MAP rises, because vasoconstriction in the NIRS field could affect the NIRS reading.¹⁷

When using NIRS, following a trend and responding to changes from baseline values rather than looking at absolute numbers appears to be more valuable.¹⁸

A Cerebral Desaturation Event (CDE) should however be promptly acted upon by raising MAP. CDE is defined as a Scto₂ ↓ ≥ 20% from awake baseline OR any reading < 50-55% for ≥ 15 secs)

Transcranial Doppler

Not routinely used, because it has been found to be technically too difficult and 10%-15% of the population do not have a temporal bone window anyway.¹⁴

Somatosensory evoked potentials (SSEPs)

Only give information about one part of the brain, and are not a measure of global ischemia, and are therefore not very helpful for beach chair anaesthesia.¹⁴

Summary: Current practice guidelines

- GA or regional.
 - U/S guided interscalene block. (Asleep for open shoulder surgery)
 - NIBP on opposite arm.
 - Art lines not routine, only if specifically indicated.
 - Permissive hypotension: MAP ↓ < 20% of normal.
 - EtCO₂ 40-42 mmHg.²⁵
 - NIRS (INVOS): Trend Monitor or CDE's.
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Electroencephalography (EEG)

Is still the gold standard for monitoring cerebral ischemia. It is however not clinically practical because it requires a highly trained analyst to interpret the results in real time.¹⁴

Conclusion

The beach chair position is commonly used for shoulder surgery, and will continue to be popular with orthopaedic surgeons. The potentially catastrophic complications of cerebrovascular events are rare, but require vigilance and meticulous attention to detail to be avoided.

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