Concise Review

Avoiding Catastrophic Complications of Stroke and Death Related to Shoulder Surgery in the Sitting Position

Anastasios Papadonikolakis, M.D., Ethan R. Wiesler, M.D., Michael A. Olympio, M.D., and Gary G. Poehling, M.D.

Abstract: The beach-chair position in shoulder surgery provides advantages to the surgeon and anesthesiologist. However, cautious interpretation of the patient's blood pressure is essential, especially when the blood pressure cuff is placed at the calf. The calf pressure should be interpreted relative to the heart-level pressure to avoid iatrogenic cerebral hypoperfusion related to hypotensive anesthesia. Possible complications of cerebral hypoperfusion are permanent neurologic impairment, stroke, and death.
Key Words: Beach-chair position—Shoulder surgery—Complications—Stroke—Death

The beach-chair position for arthroscopic or open shoulder surgery has gained wide acceptance among orthopaedic surgeons.[1] Advantages include easier airway access, placing the anatomy in the standard upright position, and less bleeding in the upright position; it also facilitates checking the effect of different positions of the arm on the involved anatomy and enables use of the weight of the arm for traction. However, complications have been reported in *Arthroscopy*.[2] Recently, Pohl and Cullen[3] reported on 4 cases of shoulder surgery in the beach-chair position that resulted in death in 1 patient and severe brain damage in 3 patients. Stroke and brain death, loss of vision, and ophthalmoplegia have also been described.[4,5] Such complications are presumed to be attributable to errors in blood pressure reference points.[5] The purpose of this article is to point out the potential catastrophic complications associated with shoulder surgery in the beach-chair position and to describe methods of prevention.

Arthroscopic shoulder surgery can be performed with the patient in the beach-chair or lateral decubitus position. These 2 different positions have significant physiologic effects on the mechanisms of blood pressure regulation. In addition, the method of monitoring the blood pressure in these positions plays a major role in avoiding potential permanent or lethal iatrogenic complications. In the sitting position the blood pressure at the calf is significantly higher than it is at the head or arm. The blood pressure readings differ from calf to head primarily and fundamentally because of the hydrostatic gradients from calf to heart to head. This hydrostatic difference alone could be approximately 50 inches, or equivalent to a 94–mm Hg pressure variation from calf to head.

To achieve better visualization during shoulder arthroscopy, it is common to ask for hypotensive anesthesia to decrease intra-articular bleeding.[6] With the patient in the beach-chair position, the anesthesia team will frequently measure the blood pressure at the calf because the intravenous line is in the arm; therefore, there is a false assumption that the calf pressure should be reduced to what would have been measured

From the Departments of Orthopaedic Surgery (A.P., E.R.W., G.G.P.) and Anesthesiology (M.A.O.), Wake Forest University Medical Center, Winston-Salem, North Carolina, U.S.A.

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Address correspondence and reprints requests to Ethan R. Wiesler, M.D., Department of Orthopaedic Surgery, Wake Forest University Health Sciences, Medical Center Boulevard, Winston-Salem, NC 27157-1070, U.S.A. E-mail: ewiesler@wfubmc.edu

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TABLE 1. *Blood Pressure Monitored in Different Positions With Cuff at Arm and Calf*

Position	Blood Pressure (mm Hg)	
	Cuff at Brachium	Cuff at Calf
Supine	111/72	110/70
Beach chair	116/82	168/87
Standing	114/78	209/139

NOTE. In the beach-chair position, the blood pressure at the calf is roughly 23 inches or 58 cm below the heart, or 43 mm Hg higher than the blood pressure at the brachium. The resting systolic blood pressure of a normotensive individual is shown in different positions. The systolic blood pressure in the beach-chair position is 116 mm Hg at the brachium and 168 mm Hg at the ankle. If the blood pressure cuff is placed at the calf and the surgeon requests a blood pressure of 100 mm Hg, then the blood pressure at the arm will be 48 mm Hg and blood flow to the brain will be extremely low. On the contrary, in the lateral position the blood pressure at the cuff can be only 5 mm Hg higher than the blood pressure at the brachium. Thus the danger of reducing the blood pressure to critical values is minimized.

at the heart level. To reiterate, if the blood pressure cuff is placed at the calf, the blood pressure readings will be high, and the anesthesia provider may deliberately and mistakenly lower the blood pressure more than usual, resulting in insufficient blood flow to the brain. The blood flow to the brain may be further decreased if the surgeon requests hypotensive anesthesia in an attempt to decrease bleeding (Table 1). When the patient is in the lateral decubitus position, the difference in the blood pressure between the ankle and arm is within 5 mm Hg, because there is no hydrostatic gradient. Thus, in the lateral position, the risk of iatrogenic lowering of the blood pressure to dangerous levels is diminished.

Deliberate hypotension may have surgical advantages, but a failure to know how to correct for blood pressure measurement locations can be catastrophic. Avoidance of complications[7] can be achieved by the following:

- Using the heart level as the gold standard reference for blood pressure monitoring.
- Placing the cuff around the brachium, which is at heart level, or using invasive methods of blood pressure monitoring, such as an arterial line (in which case the arterial line transducer would be zeroed and then placed at heart level).
- Aggressively treating perioperative blood pressure values lower than 80% of preoperative resting values to enhance the margin of safety.
- Not lowering the blood pressure to specific levels (e.g., 100 mm Hg) without taking into consideration the position of the patient (beach chair), the location of the cuff, and any pre-existing hypertensive history that requires higher intraoperative blood pressures.

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