Original Article

No Increased Risk of Cerebrovascular Accident With Beach-Chair Versus Lateral Positioning for Shoulder Arthroscopy

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Purpose: To assess the incidence of adverse cerebrovascular events following shoulder arthroscopy in the beach-chair position when compared with the lateral position. **Methods:** Records of 5 shoulder surgeons were searched using Current Procedural Technology codes to identify patients who underwent arthroscopic shoulder surgery in both the beach-chair and lateral positions between 2015 and 2020. Using both Current Procedural Technology codes for cerebrovascular accident (CVA) imaging as well as the *International Classification of Diseases*, *Tenth Revision*, codes for CVA and late neurologic sequela, patient charts were analyzed in the 30-day postoperative period. The anesthesiology record also was queried for data regarding the blood pressure management intraoperatively, recording mean arterial pressures (MAPs), and vasopressor administration. Patient demographics, comorbidities, and complications were compared between the 2 cohorts using the Student 2-tailed *t*-test for continuous variables and χ^2 analysis for categorical variables. Significance was set at $P < .05$. **Results:** There were 711 patients included in the analysis, with 471 in the beach-chair cohort and 240 in the lateral cohort. Baseline demographics were similar between groups, except for age and American Society of Anesthesiologists physical status classification, with the lateral group being significantly younger ($P < .001$) and lower American Society of Anesthesiologists physical status classification ($P = .001$) than the beach-chair group. Mean body mass index, history of CVA, transient ischemic attack, hypertension, and peripheral vascular disease were not significantly different. There were no documented CVAs in either cohort. There was no significant difference in the number of postoperative radiologic scans to evaluate for CVA ($P = .77$) or neurologic sequelae ($P = .48$) between groups. The beach-chair cohort had fewer instances of MAP <65 mm Hg, greater mean minimum MAP, but a greater percentage of patients who received blood pressure support. **Conclusions:** There were no significant differences identified in the incidence of CVA between patients undergoing arthroscopic shoulder surgery in the beach-chair and lateral positions. **Level of Evidence:** Level III, retrospective cohort study.

The many benefits of beach-chair positioning for both open shoulder surgery and shoulder arthroscopy have led to its more frequent use as compared with lateral decubitus positioning. These benefits include anatomic positioning, improved visibility, ease of setup and intraoperative repositioning, and simple conversion to an open procedure (in the case of arthroscopic surgery). However, this positioning is not without risks, and although rare, the associated complications can be catastrophic. With patients sitting in an upright position, the sequelae are typically secondary to hypotensive events leading to cerebrovascular hypoperfusion. Anecdotes and case reports of patients experiencing neurovascular events, such as cortical infarcts, hemispheric watershed injuries, and spinal cord and medullary infarcts following surgery in this position have been noted.[1]

Moerman et al.[2] demonstrated in a prospective study using near infrared-spectroscopy that cerebral desaturation events had an 80% incidence rate in the beach-chair position in their study population. However, observed cerebrovascular desaturation events have not

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been shown to have regular, anticipated clinical correlations. Yadeau et al.[3] demonstrated in their retrospective and prospective analysis that despite frequent episodes of hypotension, no strokes were observed in an ambulatory setting with 4,169 patients. In addition, studies have illustrated that these desaturation event incidence rates were greater with general anesthesia, yet patients had no neurologic events and had no difference compared with the control group in cognitive testing at follow-up.[4,5]

In a safety review article from 2019, Murphy et al.[6] indicated that multiple studies have suggested an imbalance in supply and demand for cerebral oxygenation, but the actual association between this imbalance and negative outcomes are not clearly understood. Furthermore, they stated additional studies, "are needed to define the incidence of adverse neurological adverse events in the beach chair position...."

The objective of this present study is to assess the incidence of adverse cerebrovascular events following shoulder arthroscopy in the beach-chair position when compared with the lateral position. We hypothesized that there would be no difference in rates of cerebrovascular accident (CVA) between the 2 groups.

Methods

All patients who underwent shoulder arthroscopy at a single facility by 5 fellowship-trained sports medicine shoulder surgeons between 2015 and 2020 were identified using Current Procedural Technology (CPT) codes. Not all surgeons were active at our institution for the full study period. Per known surgeon preference, we were able to identify procedures performed in the lateral and the beach-chair positions. This was verified through chart review of operative reports. This study received institutional review board approval (IRB HM20020293 Short-term Incidence of Stroke following Beach Chair Positioning for Orthopaedic Surgery).

These charts were then queried for the CPT codes for CVA work-up imaging, including computed tomography scan of the head, magnetic resonance imaging/angiography of the brain, and magnetic resonance angiography of the neck (Appendix Table 1, available at www.arthroscopyjournal.org) as well as the *International Classification of Diseases*, *Tenth Revision* (ICD-10) diagnosis codes relevant to CVA (Appendix Table 2, available at www.arthroscopyjournal.org) in the 30-day postoperative period. We also queried the ICD-10 codes for late neurologic sequelae in the 90-day postoperative period (Appendix Table 3, available at www.arthroscopyjournal.org).

The anesthesia record also was queried for the intraoperative blood pressure readings as well as the perioperative medication administration, including preoperative regional anesthesia and any vasopressor medications, and their frequency, used during each case.

Statistical analysis was performed using R-studio software, version 1.0.143 (R Foundation for Statistical Computing, Vienna, Austria) with the assistance of our institutional Biostatistics Consulting Laboratory. Patient demographics, comorbidities, and complications were compared between the 2 cohorts using the Student 2-tailed t test for continuous variables and chi-square analysis for categorical variables. Significance was set at $P < .05$.

Table 1. CPT Codes Included in Each Cohort

CPT Codes	Code Description
Lateral	
23455	Capsulorrhaphy, anterior; with labral repair (eg, Bankart procedure)
23465	Capsulorrhaphy, glenohumeral joint, posterior, with or without bone block
23466	Capsulorrhaphy, glenohumeral joint, any type multidirectional instability
29806	Arthroscopy, shoulder, surgical; capsulorrhaphy
Beach chair	
29805	Arthroscopy, shoulder, diagnostic, with or without synovial biopsy
29807	Arthroscopy, shoulder, surgical; repair of SLAP lesion
29819	Arthroscopy, shoulder, surgical; with removal of loose body or foreign body
29820	Arthroscopy, shoulder, surgical; synovectomy, partial
29821	Arthroscopy, shoulder, surgical; synovectomy, complete
29822	Arthroscopy, shoulder, surgical; debridement, limited
29823	Arthroscopy, shoulder, surgical; debridement, extensive
29824	Arthroscopy, shoulder, surgical; distal claviculectomy including distal articular surface (Mumford procedure)
29825	Arthroscopy, shoulder, surgical; with lysis and resection of adhesions, with or without manipulation
29826	Arthroscopy, shoulder, surgical; decompression of subacromial space with partial acromioplasty, with coracoacromial ligament (i.e., arch) release, when performed
29827	Arthroscopy, shoulder, surgical; with rotator cuff repair
29828	Arthroscopy, shoulder, surgical; biceps tenodesis

CPT, Current Procedural Technology.

Table 2. Patient Demographic Data

	Lateral (N = 240)	Beach Chair (N = 471)	*P* Value
Age, y, mean ± SD	34.6 ± 12.2	57.2 ± 13.8	<.001*
BMI	29.5 ± 7.2	30.5 ± 7.1	.07
ASA class, n (%)	2.1 ± 0.7	2.3 ± 0.7	.001*
1	47 (19.6)	50 (10.6)	–
2	122 (50.8)	243 (51.6)	–
3	68 (28.3)	171 (36.3)	–
4	3 (1.3)	7 (1.5)	–
Comorbidities			
Hx CVA	0	0	–
Hx TIA	0	0	–
Hx DM	23 (9.6)	86 (18.3)	.002*
Hx HTN	5 (2.1)	12 (2.5)	.3
Hx PVD	0	3	.2
Operative time. min	93.4 ± 43.3	95.2 ± 40.6	.6
Preoperative block†	228 (95)	452 (96)	.6
Ambulatory OR	159 (66.3)	323 (68.6)	.5

NOTE. Continuous variables recorded as mean ± SD, and categorical variables recorded as number (percentage).

ASA, American Society of Anesthesiologists physical status classification; BMI, body mass index; CVA, cerebrovascular accident; DM, diabetes mellitus; HTN, hypertension; Hx, history; OR, operating room; PVD, peripheral vascular disease; SD, standard deviation; TIA, transient ischemic attack.

*Statistical significance.

†Preoperative regional anesthetic block administered.

Results

A total of 711 patients were included in the analysis, with 471 (66.2%) in the beach chair-cohort and 240 (33.8%) in the lateral cohort. All procedures included in the study can be found in Table 1. There were some baseline differences in demographics between the groups, namely age and American Society of Anesthesiologists class, with the lateral group being significantly younger ($P < .001$) and lower American Society of Anesthesiologists class ($P = .001$) than the beach-chair group. Mean body mass index, history of CVA, transient ischemic attack, hypertension, and peripheral vascular disease were not significantly different (Table 2).

There were no documented CVAs in either cohort. There was no significant difference in the number of postoperative radiologic scans to evaluate for CVA between groups ($P = .8$), with only 2 patients in the lateral group and 3 patients in the beach-chair group undergoing scans in the postoperative period. There was 1 patient in the beach-chair cohort with documentation of neurologic sequelae. This patient was presenting with recurrent headache, who had history of CVA at age 4 years with longstanding residual left-sided weakness, that was first recorded in the chart (using ICD-10) during the postoperative period, but did not represent a new neurologic sequela. However, this did not represent a significant difference between the groups ($P = .4$) (Table 3).

There was a lower percentage of patients who experienced hypotension (mean arterial pressure [MAP] <65 mm Hg) in the beach-chair cohort, although this was not found to be significant ($P = .1$). The patients in the lateral cohort also had significantly more frequent episodes of hypotension with an average of 1.7 ± 2.8 compared with 1.2 ± 2.1 in the beach-chair group ($P = .01$). There was no significant difference in the average minimum MAP between groups ($P = .4$), but there was

Table 3. Cohort Data of CVA and Blood Pressure

	Lateral (N = 240)	Beach Chair (N = 471)	*P* Value
CVA	0	0	–
Postoperative imaging	2	3	.8
Neuro sequelae	0	1	.5
Patients with MAP <65 mm Hg	105 (43.8%)	188 (40%)	.1
MAP recordings <65 mm Hg per case	1.7 ± 2.8 (Var = 7.9)	1.2 ± 2.1 (Var = 4.5)	.01*
Minimum MAP, mean ± SD	66.2 ± 10.3	67.0 ± 10.3	.4
Received vasopressor	106 (44.2)	294 (62.4)	<.001*

CVA, cerebrovascular accident; MAP, mean arterial pressure; SD, standard deviation; Var, variance.

*Statistical significance.

a significantly greater percentage of patients who received blood pressure support in the beach-chair group ($P > .001$).

There were no significant differences in the anesthetic technique between groups, with 96% of patients in the beach-chair and 95% of patients in the laterally positioned group receiving a preoperative interscalene block. There was also no significant differences in the operative time between groups, with an average time of 93.4 ± 43.3 minutes (lateral) and 95.2 ± 40.6 minutes (beach-chair) ($P = .6$).

Discussion

The most important finding of this study was that no strokes were observed in 711 patients undergoing shoulder surgery in the beach-chair position, despite frequent occurrences of hypotension and administration of vasoactive medications. By Hanley's "rule of three," which gives the upper limit of the 95% confidence interval for the probability of adverse event that has not yet occurred, we can calculate that the maximum risk = 3/n (when n >30), giving us 0.64% in beach-chair cohort.[7] Eypasch et al.[8] remind us that surgeons should keep this rule in mind when complication rates of zero are reported and "when they have not (yet) experienced a disastrous complication from a procedure."

Although there was no significant difference in minimum MAP measurement, there were more patients with MAPs less than 65 mm Hg in the beach-chair group, and a significantly greater percentage of patient required vasopressors; however, this did not manifest clinically as CVA. Intraoperative hypotension is a relatively common finding, with Murphy et al. citing the incidence as 47% to 51% in the 8,396 patients they reviewed from 2 large-scale studies they reviewed. Some authors have posited that cerebral blood flow is more important that blood pressure as a marker for cranial perfusion.[3] Decreased cerebral oxygen perfusion has been measured via near-infrared spectroscopy,[9] continuous-wave near-infrared spectroscopy,[2,5,10-12] cerebral tissue oxygen saturation,[4] electroencephalography,[13] and middle cerebral artery flow via Doppler.[12] Isolated case reports in which patients suffered cerebral infarcts with residual neurologic deficits are rare but are an important consideration.[1,14] Although cerebral oxygen desaturation occurs at rates of up to 76% to 80%,[2,9] numerous studies found that decreased cerebral oxygen perfusion in the beach-chair position did not significantly correlate with any postoperative clinical findings.[3-6,9,11-13,15,16]

Some previous studies have focused solely on ambulatory surgical patients, but we hoped to include patients who had a full spectrum of medical comorbidities, including cases both from our ambulatory and main hospital operating rooms. Although the patient population undergoing arthroscopic shoulder surgery is generally quite healthy, we wanted to be able to generalize our results to a wider population.

Surgeries performed in the beach-chair position allow for numerous benefits, such as better positioning, visibility, ease of set up or repositioning, and converting to open surgery. Numerous studies have shown decreased cerebral perfusion in this position and concerns remain regarding long-term neurologic sequelae.

Limitations

Limitations of the study include the reliance on both CPT and ICD-10 coding for accurate data mining. However, there is well documented literature that supports the use of these codes and their level of accuracy for sufficiently robust research.[17,18] It is also notable that the baseline demographic data differs between our 2 groups, which may have an effect on the differences see; however, this is not surprising, as generally younger, healthier people have capsulorrhaphy procedures compared with other arthroscopic shoulder surgery such as rotator cuff repair. Also, the absence of stroke in this patient cohort could be due to sample size, where a larger study would likely document a non-zero stroke rate. The results here may not be generalizable to a lower-volume community setting, particularly if anesthesiologists are inexperienced in treating patients in the beach-chair position

Conclusions

There were no significant differences identified in the incidence of CVA between patients undergoing arthroscopic shoulder surgery in the beach-chair and lateral positions.

Disclosure

The authors (C.N.O., K.M., A.B., J.S., B.T., A.R.V.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

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