A Retrospective Chart Review on Oxygen Saturation During Shoulder Arthroscopies in Lateral Decubitus and Beach Chair Positions

Submitted by

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Biology

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Mentor Statement

DATE: February 12, 2012

TO: Oakland University Honor's College Faculty

FROM: Melodie Kondratek, PT, DScPT, OMPT
Associate Professor; Program in Physical Therapy

RE: Mentor Statement
Kayla Schmitt Thesis

TITLE: A Retrospective Chart Review on Oxygen Saturation During Shoulder Arthroscopies in Lateral Decubitus and Beach Chair Positions

Kayla first approached me to serve as her mentor for her research thesis in February 2011. I have been approached by several Honor's College students prior to this and declined each invitation. I accepted Kayla's request to be her mentor because of her exceptional presentation via email and in our first meeting. I was very impressed with Kayla's motivation, drive, and communication skills. I believed she was a self-motivated, active learner, who would explore her topic thoroughly. She has confirmed my impression and exceeded my expectations in every way. I have thoroughly enjoyed working with her, and anticipate she will make valuable contributions to the field of medicine.

This thesis project is a very ambitious project for a first time researcher. Kayla has done an exceptional job at each step in the process, including the planning stages, IRB application and approval, data collection, and writing. There are several key areas that I wish to comment on.

Commitment to learning: Kayla demonstrates a strong curiosity and drive to find answers to questions, including the big question about oxygen saturation in 2 different operative positions as well as understanding all of the little questions along the way. Kayla demonstrates good problem-solving and the ability to select the appropriate strategy from the list of possibilities.

Exploration of the topic: Kayla completed an extensive literature review, exploring the topic and developing her understanding of the medical literature. She used a variety of levels of evidence, including personal communication with experts (UnaSource Surgery Center medical team).

Use of constructive feedback: Kayla was open to feedback at every stage in this research project. She asked appropriate questions in a respectful and professional manner. It was apparent that she used each suggestion to increase her understanding of the topic as well as the research process.

Professionalism: Kayla has demonstrated professionalism in all interactions with me.

General: Throughout this research project Kayla has demonstrated excellent organization skills, attention to detail (grammar, spelling, sentence structure), and drive to complete this project in a quality manner.

I wish Kayla the very best in her future endeavors.

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I. Personal Statement to Oakland University's Honors College

Orthopedic surgery is an area of medicine that is particularly fascinating to me. This area of specialty focuses on the musculoskeletal system, pertaining to the diagnosis, treatment, rehabilitation and prevention of diseases and injuries. Performing this research greatly interests me and will benefit my education immensely, since my intentions are to attend medical school and get accepted into an orthopedic surgery residency. Coursework in my degree has prepared me well and increased my passion to explore medicine beyond my textbooks. Medical school and residency programs will take note of this research and feel acquainted with my admirations of the orthopedic field as well as my continuous desire to expand my knowledge in the field of medicine.

While working in the operating rooms at UnaSource Surgery Center, I noticed that orthopedic surgeons perform shoulder arthroscopies in two different operative positions. The reason this interested me is due to the fact that two rather different approaches are used to complete the same operative techniques. I came to the realization that I wanted to perform a retrospective chart review as well as review literature analyzing the pros and cons between the lateral decubitus and beach chair positions through my senior thesis. This paper was written in accordance with the format required for publication in *Arthroscopy: The Journal of Arthroscopic and Related Surgery,* the medical journal from which the majority of my references were taken. Additionally, the references used in this paper were cited according to the *American Medical Association Manual of Style* guidelines.

II. Abstract

Purpose: This review provides a comprehensive comparison between the lateral decubitus and beach chair positions utilized while performing a shoulder arthroscopy. The intention is to determine whether one position is more advantageous over the other while comparing set-up, cost, orientation, visualization, effectiveness of anesthesia and risk.

Methods: A retrospective review was performed of 32 de-identified charts, 16 from each operative position: lateral decubitus and beach chair. The 16 for each position contain exactly 50% male and 50% female patients, with ages ranging from 19 to 85. Data gathered includes oxygen saturation and oxygen administered at 15-minute intervals throughout surgery, as well as de-identified patient health history.

Results: Lateral decubitus patients recorded a higher initial peripheral oxygen saturation percentage at 0 minutes than beach chair patients (96.2% beach chair, 97.8% lateral decubitus). However, beach chair patients recorded a higher peripheral oxygen saturation percentage at 45 minutes, near the end of surgery, than lateral decubitus patients (97.9% beach chair, 97.3% lateral decubitus). Lateral decubitus patients required less oxygen to be administered to maintain healthy peripheral oxygen saturation levels throughout the entire surgery on average (2.2 L/min lateral decubitus, 2.7 L/min beach chair).

Conclusions: This study refuted the hypothesis that the peripheral oxygen saturation in beach chair-positioned patients is higher than in the lateral decubitus position. Broad analysis of literature supports that most surgeons prefer the same operative position throughout all of their arthroscopic shoulder procedures, regardless of the circumstances.

III. Introduction and Literature Review

Originally, surgeries were performed open, very invasively, requiring longer surgery times, along with longer and more painful recoveries. Since the new alternative of arthroscopic surgery came about, the minimally invasive approach has been chosen wherever possible instead of the older, open surgical approach.

Lateral Decubitus Set-Up

"Historically, a surgeon's preference for patient positioning has been based largely on training."[1] Two main methods have been developed for efficient and successful shoulder arthroscopies. The first is the lateral decubitus approach in which the patient is placed laterally on the operating table with the operative shoulder being exposed vertically.[1] With the operative shoulder exposed and angled up so the arm is suspended at an appropriate operative angle, the patient is supported on his or her side with use of a beanbag and/or other stabilizing devices such as straps. The head is maintained in a neutral position, often with use of a foam pad or a gel donut-shaped support. Pressure points are padded between the legs and between the feet with use of a foam piece. The non-operative arm is placed on an arm board, while the operative arm is either placed into a foam traction sleeve or another traction device. Either of these sleeves is connected to a traction device that is suspended by the aid of a hanging weight. The degree of abduction, which is movement of the arm away from the medial line of the body, as well as forward flexion of the shoulder are adjusted based upon the preference of the surgeon. Gross and Fitzgibbons made a now

standard modification in the lateral decubitus position which justifies tilting the operating table in order to position the glenoid parallel to the floor for appropriate visual orientation.[1] The glenoid, or more specifically the glenoid fossa, is the surface on the lateral side of the scapula in which the head of the humerus, the long bone in the arm, articulates in order to create the ball and socket shoulder joint. The gap between these two surfaces, referred to as glenohumeral, is the predominant space in which a shoulder arthroscopy surgery takes place. The lateral decubitus position is demonstrated in Figure 1.

Beach Chair Set-Up

The second method for shoulder arthroscopies is the surgical approach in the beach chair position. In this approach, the patient first lies supine on the operating table, and the table mechanically moves to obtain the correct operative position. The head, neck, and torso are supported in a neutral position with the aid of straps and attachments.[1] The table repositions in a way so that the patient appears to be lying in a beach chair. This is accomplished by angling the patient 10° to 15° back from a seated upright position, with the hips flexed between 45° and 60°, and the knees flexed to 30°. The operative shoulder is then secured in such a way that the glenoid fossa and the head of the humerus create a similar gap in the shoulder joint that allows for effective surgery as in the lateral decubitus position. Additionally, pressure points are padded with the aid of foam pieces and the non-operative arm is secured on an arm board, tucked, or restrained in an arm sling. A benefit to using a beach chair position is that a portion of the backboard of the beach chair can be removed to obtain access to the posterior aspect of the shoulder. The posterior aspect of

the shoulder is the intra-operative angle at which the surgery is most often approached from while in the beach chair position. The beach chair position is demonstrated in Figure 2.

Costs of Equipment

The cost associated with each position depends upon the equipment preferred by the surgeon and ultimately makes a huge difference. The cost of a beach chair ranges from $4,000 to $8,500.[1] Many surgeons utilize the beach chair attachments for the operating table, which are much less costly. Additionally, the mechanical arm holder for the beach chair position costs $8,000 to $12,000.[1] Once again however, many surgeons, including those operating at UnaSource, prefer a scrubbed assistant, rather than a mechanical arm holder, to retract and hold the arm in any position desired by the surgeon. The use of a scrubbed assistant rather than a mechanical arm holder, dramatically reduces the cost associated with the beach chair position and makes the beach chair position cost-comparable to the lateral decubitus position. Aside from the operating table required for both positions, the lateral decubitus position requires the supportive bean bag and side braces to prop the patient on his or her side, costing about $1600 as well as the traction bar to retract the operative arm laterally upward with a foam support and weighted pulley system costing in range from $2,000 to $4,500.[1] Ultimately, both positions are similar in cost and therefore cost of setup is less frequently argued between the two.

Need for Assistance

"Proponents of the lateral decubitus and the beach chair positions each claim that the position they defend is the easiest and fastest to employ, including the number of steps, amount of equipment, and assistance required to set up and perform the arthroscopy."[1] Regardless of which position is selected, both require extensive assistance. The lateral decubitus position requires the patient to be turned and secured with the traction device after being anesthetized. For the beach chair position, sufficient time is required to secure the head, neck and torso into appropriate restraints. Both positions may require a scrubbed assistant retract and position the arm even if a mechanical traction device or an arm holder is used. "To date, there is no objective, empirical evidence to support either group's claims of speed of setup or need for assistance."[1]

Orientation

Both of these surgical approaches are commonly used, however they are quite different in the approach, the viewing angle provided through the arthroscope, the effectiveness of anesthesia and certainly many other aspects that could be researched and analyzed. With regards to the orientation of the patient, supporters of the beach chair position argue that the upright, anatomic position is easier for teaching. However, proponents of the lateral decubitus position counter this argument by claiming that positioning the glenoid parallel to the floor, as the lateral decubitus position does, and then turning the camera 90° to orient to the upright position creates the same standard reference point.[1] Therefore, the more

acceptable orientation argument between the two positions remains a matter of surgeon experience rather than the patient's actual operative position.

Visualization and Portal Placement

The visualization provided through the arthroscope during surgery also plays a significant role in a surgeon's determination of the operative position. In the beach chair position, the scapula is easily stabilized unlike in the lateral decubitus position. With the increased ease of stabilization and the lack of the arm suspended in the operating field, proponents of the beach chair position argue that various arthroscope portals working in all portions of the glenohumeral joint and subacromial space of the shoulder are best approached in the beach chair position.[1-3] Specifically, the beach chair position has been argued to be the best position for anterior portal placement and rotator cuff repairs.[1] Additionally, the beach chair position enables the most accurate palpation of the patient's external anatomy while guiding placement of the arthroscope.[1] Di Giacomo et al[4] stresses the importance of highlighting bony landmarks after the traction has been applied while operating in the lateral decubitus position since the overlying skin can move considerably. The beach chair position still remains the easiest to palpate bony landmarks. Unlike the tension created while in the lateral decubitus position, the beach chair position eliminates the stress on the glenohumeral joint, unless the scrubbed assistant is instructed by the surgeon to create traction. This elimination of tension reduces the stress within the capsule, which is significantly important to capsular reattachment, assessment of ligamentous laxity, as well as re-approximation of tissues to assess appropriate repair.[1]

On the other hand, those in favor of the lateral decubitus position argue that the table and patient's head limit the surgeon's workspace in the beach chair position, and that portals from superior (top of the shoulder) and posterior (back of the shoulder) aspects are best approached in the lateral decubitus position. Advocates of the lateral decubitus approach also claim that the added traction in this position emphasizes the presence of aids with the repair of labral tears.[1] The labrum is a lip-like projection of cartilage off of the scapula that surrounds the glenohumeral joint of the shoulder. Interestingly, however, Gelber et al[5] states that capsulolabral reattachment is most commonly performed from anterior portal placements in order to decrease the risk of damaging neurovascular structures. Therefore, this finding suggests that the beach chair position would be preferred for capsulolabral reattachment. Regardless, the underside of the rotator cuff has been claimed to be much more visible in the lateral decubitus position than in the beach chair position, unless sufficient abduction, movement of the arm away from the midline of the body, as well as traction are applied by the aid of a scrubbed assistant.

To differentiate the main claims proposed between each position, beach chair has been most commonly supported when the need for an anterior (front) portal placement arises; and lateral decubitus has been advocated when a superior, posterior, or inferior portal placement is required.[1] Regardless of which position is selected, the decision ultimately comes down to surgeon preference again. Additionally, with my experiences in the operating room providing traction on the arm as the scrubbed assistant, often the type or

amount of repair that was planned may change once the surgeon looks through the arthroscope. Simply relying upon MRI's, X-rays, or basic manipulation of the shoulder joint doesn't guarantee exactly what repair may need to be performed. I have observed many orthopedic surgeons repair a wide variety of tears, capsular shifts, decompressions, releases, etc. all from the same operative position that they routinely operate in. Therefore, I think this strongly supports that the operative position largely depends upon the surgeon's preference when being trained as well as their understanding of the orientation while in each position.

On a different note, the need to switch from an arthroscopic to an open procedure sometimes arises in complicated surgeries. Referred to as 'conversion,' this situation is best managed while operating in the beach chair position, which provides greater flexibility and no repositioning or re-draping is required, as in the lateral decubitus position.[1]

Anesthesia

The positioning during shoulder arthroscopy may also affect the type of anesthesia that is used. An interscalene block, local anesthetic, in the operative shoulder is generally used for both positions. While observing anesthesiologist, Dr. Chaput, perform an interscalene block I noted the details. This block is attained by injecting local anesthetic into the neck region on the side of the operative shoulder. The interscalene block preferentially blocks nerves of the brachial plexus (C5-C7) as well as a variable degree of the cervical plexus (C3-C4). The brachial plexus constitutes the nerves to the arm. It is important to note that the local

anesthetic of the interscalene block is deposited around the upper roots (C5, C6) that innervate, supply nerve function, to the muscles of the shoulder, and in doing so spares the ulnar plexus (C8-T1) that supplies the hand and forearm.

Aside from the local anesthesia that most patients receive prior to surgery, general or regional anesthesia are the main two types of anesthetic used in the operating room to put the patient to sleep. Another benefit of the beach chair position is that regional anesthesia is possible, whereas it is rarely an option in the lateral decubitus position.[1-3] Patients that undergo regional anesthesia lack muscle paralysis, therefore allowing for control of the patient's head; but this can lead to undesirable consequences if the patient shifts during surgery, requiring assistance readjusting. However, the beach chair position does allow rapid conversion to general anesthesia if necessary since the beach chair provides easier access to the patient's airway than lateral decubitus.[1,6]

Risks and Complications

While both of these shoulder arthroscopic positions have been carried out successfully, there is evidence of patients waking up with neurological problems from the beach chair position. For instance, in a study of patients undergoing elective shoulder surgery who had similar anesthetic management, those operated on in the beach chair position obtained the same hemodynamic values as patients placed in the lateral decubitus position, but they experienced lower regional cerebral tissue oxygen saturation values intra-operatively and a higher incidence of cerebral desaturation events. [7] Hemodynamics is an important part of

cardiovascular physiology dealing with the forces that the heart must develop in order to circulate blood through the cardiovascular system. Glenn S. Murphy, MD states in a press release from CAS Medical Systems that although orthopedic patients in the beach chair position are at risk for cerebral hypoperfusion, no previous clinical trials have assessed changes in the cerebral tissue oxygen saturation levels in the patient population nowadays.[7] Cerebral hypoperfusion is referring to a decrease in the blood flow supplying the brain.

The retrospective study performed in this article pertains to oxygen saturation levels of patients during shoulder arthroscopies in both the beach chair and lateral decubitus positions. Oxygen saturation in this instance is referring to the measurement of the percentage of hemoglobin binding sites in the bloodstream occupied by oxygen. Hemoglobin is the oxygen-transport protein in red blood cells that carries oxygen from the respiratory organs to the rest of the body in order to provide energy for metabolic functions. Therefore, the higher risk of cerebral hypoperfusion in the beach chair position compared to lateral decubitus is referring to a significant decrease in the body's ability to supply oxygen to it's tissues for healthy functioning. This potentially fatal complication is often due to inaccurate monitoring of the blood pressure between these two different positions. Papadonikolakis et al[8] states that in the beach chair position, the blood pressure at the calf is significantly higher than it is at the head or the arm. The blood pressure readings differ fundamentally because of the hydrostatic gradients from calf to heart to head. With the patient in a beach chair position, blood pressure is commonly measured in the patient's calf since the intravenous line is in the patient's arm. This results in a false

assumption that the calf pressure needs to be decreased, resulting in insufficient blood flow to the brain. Often, surgeons request hypotensive anesthesia to decrease intra-articular bleeding further lowering blood flow to the brain.

When the patient is in lateral decubitus position, however, the difference in blood pressure between the calf and the arm is within 5 mm Hg since there is no hydrostatic gradient, compared to a 94 mm Hg pressure variation in the beach chair position.[8] "Cerebral desaturation puts the brain at risk for ischemic injury, and when the beach chair position is considered, hypotension needs to be avoided and regional cerebral oxygenation should be monitored and optimized."[9] Ischemic injury is referring to a reduction in blood supply. In a case study performed by Pohl et al[10] in 2005, their analysis suggests that the beach chair position creates specific physiological conditions that may be conducive to cerebral and spinal cord ischemia during shoulder arthroscopies. Furthermore, in the lateral decubitus position, cerebral perfusion is much better than in the beach chair position due to the lack of a hydrostatic gradient; and the risk of inaccurately lowering the blood pressure to dangerous levels is eliminated.[8-11]

Summary and Hypothesis

In retrospect, the lateral decubitus position was the first approach taken to perform a shoulder arthroscopy due to the traction on the glenohumeral joint of the shoulder.[12] But in 1988, the first reported use of the beach chair position brought forth a multitude of reasonable advantages such as: a lower incidence of traction injuries to the peripheral

nerves and brachial plexus, a decreased risk of neurovascular complications during portal placement due to the upright, anatomic position, as well as a significant decrease in operative time and an easier conversion to an open procedure without needing to re-drape if complications arise.[13,14] Additionally, according to a study done by the Yonsei University College of Medicine in Seoul, South Korea, the beach-chair position combined with induced hypotension significantly decreased oxygen saturation in patients undergoing shoulder arthroscopic surgery under general anesthesia. [15]

Overall, the points discussed between the two positions, lateral decubitus and beach chair, do not propose that either position is significantly better than the other. The advantages and disadvantages for the beach chair and lateral decubitus are organized in Table 1. Varying circumstances, as well as a surgeon preference seems to be the main reason one position is selected over the other. “Regardless of the position, it is absolutely paramount that the patient be positioned carefully, with proper padding, head placement, and appropriately balanced suspension forces to minimize the occurrence of potentially devastating positioning complications.”[2] However, slight differences in oxygen saturation between the two positions are likely to be concluded since both positions are regularly selected for operation, outweighing the associated risks in most cases.

Analysis of literature reveals that the beach chair position is more likely to increase the risk for cerebral hypoperfusion (decrease in the oxygen being supplied to the brain) compared to the lateral decubitus. Although the measurements proposed for analysis in the

retrospective chart review pertain to oxygen saturation in peripheral tissues, rather than specifically cerebral perfusion, the purpose is to assess the effect shoulder arthroscopic positioning has on oxygen saturation. However, while cerebral perfusion may be decreased in the beach chair position, peripheral oxygen saturation is likely to be increased. After learning from personal communication that positioning is the most important aspect to successful surgery, the anesthesiologist explained that the unequal circulation in a patient's body while lying down in the lateral decubitus position would result in lower oxygen saturation. The peripheral oxygen saturation is measured through a pulse oximeter on the finger of the inoperative arm. Since the patient's inoperative arm while in the lateral decubitus position has body weight stacked on top of it as depicted in Figure 1, the increased pressure in the inoperative arm would cause a decrease in the perfusion of blood. *Therefore, I predict that the peripheral oxygen saturation in beach chair positioned patients will be higher than in the lateral decubitus position, without accounting for the additional oxygen delivered to the patient to maintain safe saturation levels.*

IV. Methods

Pertaining to the method details of the retrospective chart review, UnaSource Surgery Center's patient care team leader selected 32 shoulder arthroscopic patients. Selection of the charts was done by making a paper copy of the pre-existing data, blacking out any form of identification, and making a new copy from which data was gathered for analysis. While gathering data, the de-identified copies designated to this study were kept in the locked medical records facility at

UnaSource Surgery Center and have been properly shredded since the data was collected on the mere basis of statistics per patients 1-32. Of the 32 shoulder arthroscopic patients selected, 16 were chosen from each operative position: lateral decubitus and beach chair. The 16 that were selected for each position contain exactly 50% male and 50% female patients, with an assortment of ages ranging from 19 to 85. Also, de-identified patient health history data was gathered pertaining to each patient.

De-identified data gathered includes the patients' sex, age, operative position, presence or absence of cardiovascular diseases and/or diabetes, time under anesthesia, oxygen saturation and the amount of oxygen being delivered to each patient at 15-minute intervals throughout the operation. This inclusion is significant since oxygen deliverance is varied as necessary throughout surgery. Obviously oxygen saturation levels are vital and need to be maintained at a certain level, so noting the amount of oxygen delivered to the patient throughout surgery will assist in the analysis of the oxygen saturation levels between the two operative positions. Without accounting for the additional oxygen delivered to the patients in this retrospective chart review, statistical analysis can more accurately note the likely differences in the oxygen saturation between the lateral decubitus and beach chair. From this data, graphs and charts were generated in a variety of ways for proper analysis.

V. Results

Demographics are presented in tables and graphs. Graph 1 depicts the range in patient age among the 32 de-identified shoulder arthroscopic patients analyzed in this article. The youngest beach chair patient was 20 years old, the oldest was 79 years old, and the median was 56 years old. The youngest lateral decubitus patient was 19 years old, the oldest was 85 years old, and the median was 51 years old.

Graph 2 depicts the range in patient height among the 32 de-identified shoulder arthroscopic patients analyzed in this article. The shortest beach chair patient was 62 inches, the tallest was 72 inches, and the median was 68 inches tall. The shortest lateral decubitus patient was 62 inches, the tallest was 75 inches, and the median was 70 inches.

Graph 3 depicts the range in weight among the 32 de-identified shoulder arthroscopic patients analyzed in this article. The lightest beach chair patient was 125 lbs, the heaviest was 210 lbs, and the median was 165 lbs. The lightest lateral decubitus patient was 117 lbs, the heaviest was 290 lbs, and the median was 174 lbs.

Graph 4 depicts the range in time under anesthesia among the 32 de-identified shoulder arthroscopic patients analyzed in this article. The shortest time while operated in the beach chair position was 35 minutes, the longest was 75 minutes, and the median was 57 minutes. The shortest time while operated in the lateral decubitus position was 41 minutes, the

longest was 109 minutes, and the median was 59 minutes. This data is also presented in Table 2, including the data averages and standard deviations.

Graph 5 depicts the average percentage of peripheral oxygen saturation measured from the beginning of surgery in 15-minute intervals through 45 minutes of surgery between beach chair and lateral decubitus-positioned patients. Lateral decubitus-positioned patients recorded a higher initial peripheral oxygen saturation percentage at 0 minutes than beach chair-positioned patients (96.2% beach chair, 97.8% lateral decubitus). However, beach chair-positioned patients recorded a higher peripheral oxygen saturation percentage at 45 minutes, near the end of surgery, than lateral decubitus-positioned patients (97.9% beach chair, 97.3% lateral decubitus).

Graph 6 depicts the average oxygen administered to the patient via the laryngeal mask airway measured from the beginning of surgery in 15-minute intervals through 45 minutes of surgery between beach chair and lateral decubitus-positioned patients. Lateral decubitus-positioned patients required less oxygen to be administered to maintain healthy peripheral oxygen saturation levels throughout the entire surgery on average (2.2 L/min lateral decubitus, 2.7 L/min beach chair).

VI. Discussion and Conclusions

Based upon the graphs presented in this study, some significant observations were made. In Table 2, Graph 2 comparing the height ranges of patients, and Graph 3 comparing the weight ranges of patients, the data presented suggests that the lateral decubitus position more frequently accommodates taller and heavier patients than the beach chair position. Perhaps the lateral decubitus position is a less risky option for larger patients. However, in Graph 4 comparing the total time under anesthesia, patients operated in the lateral decubitus position were under anesthesia for a longer time (62.1 minutes on average in lateral decubitus, versus 55.6 minutes in beach chair. The maximum time under anesthesia recorded for lateral decubitus was 109 minutes. During this surgery time for one patient in the lateral decubitus position, roughly two patients could be operated on in the beach chair position. In reference to surgical time, increased productivity is supported through the beach chair position.

While analyzing Graph 5 representing the average percentage of peripheral oxygen saturation, lateral decubitus measured a higher initial peripheral oxygen saturation percentage at 0 minutes than beach chair-positioned patients. The lower saturation in beach chair patients could be due to the more extensive positioning required, which creates the hydrostatic gradient in the patient's blood flow. However, beach chair-positioned patients recorded a higher peripheral oxygen saturation percentage at 45 minutes, near the end of surgery, than lateral decubitus-positioned patients. The increased saturation of beach chair patients at 45 minutes in the surgery could be as a result of the increased oxygen administered to a patient just before

waking up. Graph 6 supports this observation. The average amount of oxygen administered to beach chair-positioned patients was maintained at a higher rate than lateral decubitus-positioned patients. On average throughout the entire surgery, lateral decubitus patients received less administration of oxygen to maintain a healthy oxygen saturation level.

My hypothesis was that the peripheral oxygen saturation in beach chair-positioned patients will be higher than in the lateral decubitus position, without accounting for the additional oxygen delivered to the patient to maintain safe saturation levels. From the data gathered, my hypothesis is refuted. This is likely due to the hydrostatic gradient present in beach chair positioned patients, resulting in unequal peripheral oxygen saturation between the upper and lower bodies. This hydrostatic gradient may decrease the perfusion of oxygen through the blood, corresponding to the decrease in the saturation of oxygen measured in the beach chair position in this retrospective study. Consequently, the leveled position of the patient in the lateral decubitus position may have eased the perfusion of oxygen through the blood, resulting in the increased peripheral oxygen saturation that was measured in the lateral decubitus position in this retrospective study.

While acknowledging the history of the patients and overall benefits of each position per the patient at hand, a certain position might benefit a more heavily set position, or a patient possessing a certain medical condition. For instance, Dr. Richard Leung suggests that patients with congestive heart failure should refrain from sleeping in the left lateral decubitus position, and should consequently avoid operations in the lateral decubitus position.[15]

Overall, shoulder arthroscopy continues to evolve to this day. In 2004 Hoenecke et al proposed a modified beach chair position, referred to as The La Jolla Beachchair.[6] Also, in 2007 Kim et al[16] discussed a similar modified beach chair position called the beach chair lateral traction position. In these modified beach chair approaches, the best aspects of the two current positions are combined. The design allows for the use of traction such as in the lateral decubitus position, but also orients the shoulder in the anatomically accurate and upright position. Additionally, this approach enables easy conversion to an open procedure if required. The patient is wedged on his or her side as in the lateral decubitus position with the aid of a wedged pillow. The table is then flexed at the hips with the back of the table elevated at approximately 30; and the foot of the table is slightly lowered. The same traction device utilized in the lateral decubitus position is used to retract the arm to the desired amount of abduction, away from the midline of the patient's body. A foam pillow is also used to align the patient's head in a neutral position.[6,16] In the clinical reviews performed by Hoenecke et al[6], no complications were encountered. Additionally, gas bubbles from electrocautery moved laterally out of view of the camera as in lateral decubitus position. Previously, one of the disadvantages mentioned about the beach chair position was the cautery bubbles obscuring the view through the arthroscope. In general, this modified beach chair position decreases expenses, allows for easy conversion to an open procedure, and improves orientation through semi-upright position. Surgeons operating in this modified position can therefore take advantage of the benefits associated with both operative positions.

Furthermore, while this study refuted that the peripheral oxygen saturation in beach chair-positioned patients is higher than in the lateral decubitus position, comprehensive analysis of literature supports that most surgeons prefer the same operative position throughout all of their arthroscopic shoulder procedures, regardless of the circumstances.

VII. References

1. Peruto CM, Ciccotti MG, Cohen SB. Shoulder arthroscopy positioning: Lateral decubitus versus beach chair. *Arthroscopy.* 2009;25(8):891-896.
2. Provencher MT. Avoiding complications in shoulder arthroscopy: Pearls for lateral decubitus and beach chair positioning. *Techniques in Shoulder & Elbow Surgery*. 2010;1(1):1-3.
3. Correa MC, Goncalves LBJ, Andrade RP, Carvalho LH. Beach chair position with instrumental distraction for arthroscopic and open shoulder surgeries. *J Shoulder Elbow Surg*. 2008;17(2):226-230.
4. Di Giacomo G, Costantini A. Arthroscopic shoulder surgery anatomy: Basic to advanced portal placement. *Operative Techniques in Sports Medicine.* 2004;12(2):64-74.
5. Gelber, PE, Reina F, Caceres E. A comparison of risk between the lateral decubitus and the beach-chair position when establishing an anteroinferior shoulder portal: A cadaveric study. *Arthroscopy.* 2007;23(5):522-528.

6. Hoenecke HR, Fronek J, Hardwick M. The modified beach chair position for arthroscopic shoulder surgery: The La Jolla beach chair. *Arthroscopy.* 2004;20(2):113-115.
7. Beach chair position shoulder surgery associated with rise in neurologic events. 2010. http://www.orthosupersite.com/view.aspx?rid=65813.
8. Papadonikolakis A, Wiesler ER, Olympio MA, Poehling GG. Avoiding catastrophic complications of stroke and death related to shoulder surgery in the sitting position. *Arthroscopy.* 2008;24(4):481-482.
9. Dippmann C, Winge S, Nielsen HB. Severe cerebral desaturation during shoulder arthroscopy in the beach-chair position. *Arthroscopy.* 2010;26(9,S1):S148-S150.
10. Pohl A, Cullen DJ. Cerebral ischemia during shoulder surgery in the upright position: A case series. *J Clin Anesth*. 2005;17(6): 463-469.
11. Tange K, Kinoshita H, Minonishi T, Hatakeyama N, Matsuda N, Yamazaki M, Hatano Y. Cerebral oxygenation in the beach chair position before and during general anesthesia. *Minerva Anestesiol*. 2010;76(7):485-490.
12. Rains DG, Rooke GA, Wahl CJ. Pathomechanisms and complications related to patient positioning and anesthesia during shoulder arthroscopy. *Arthroscopy.* 2011;27(4):532-541.
13. Skyhar MJ, Altchek DW, Warren RF, Wickiewicz TL, O'Brien SJ. Shoulder arthroscopy with the patient in the beach-chair position. *Arthroscopy*. 1988;4:256-259.

14. Lee JH, Min KT, Chun YM, Kim EJ, Choi SH. Effects of beach-chair position and induced hypotension on cerebral oxygen saturation in patients undergoing arthroscopic shoulder surgery. *Arthroscopy.* 2011;27(7):889-894.
15. Leung RST, Bowman ME, Parker JD, Newton GE, Bradley TD. Avoidance of the left lateral decubitus position during sleep in patients with heart failure: Relationship to cardiac size and function. *J Am Coll Cardiol.* 2002;41:227-230.
16. Kim KC, MD, Rhee KJ, Shin HD. Beach-chair lateral traction position using a lateral decubitus distracter in shoulder arthroscopy. *Orthopedics*. 2007;30(12):1001.

VIII. Tables, Figures, and Graphs

Table 1. Beach Chair Versus Lateral Decubitus: Advantages and Disadvantages		
	Beach Chair	***Lateral Decubitus***
Advantages	1. Upright, anatomic position; easier to orient	1. Much less expensive equipment
	2. Easily stabilize the scapula	2. Patient's head and operating table do not obstruct the surgeon's workspace
	3. Various arthroscope portals are accessible; arm is not blocking anterior portal	3. Traction emphasizes labral tears and aids in labrum repairs
	4. More accurate palpation of external anatomy for portal placement	4. Underside of rotator cuff is much more visible
	5. Less tension enables more accurate reattachments and repairs due to unstrained ligamentous laxity	5. Traction increases glenohumeral joint space
	6. Regional anesthesia can be used	6. Cautery bubbles do not obstruct view
	7. Operative arm is greatly mobile	7. Decreased risk for neurovascular complications since no head restraint is used
	8. Re-draping is not required if open conversion is necessary	8. Better cerebral perfusion
	9. Shorter operative time	
Disadvantages	1. More costly if beach chair and mechanical arm are used rather than attachment and scrubbed assistant	1. Non-anatomic position
	2. Patient's head and operating table limit the surgeon's workspace	2. Scapula is less stabilized
	3. Labral tears are less accentuated	3. Arm obstructs anterior portal
	4. Underside of rotator cuff is difficult to view without sufficient abduction and traction	4. More ambiguous palpation of external anatomy for portal placement
	5. Glenohumeral joint space is decreased without aid of retraction	5. Increased tension can damage peripheral nerves and brachial plexus
	6. Cautery bubbles and fluid obscure view	6. Regional anesthesia is rarely tolerated
	7. Head and neck malpositioning can result in neurovascular complications	7. Mobility of operative arm is limited
	8. Risk for cerebral hypoperfusion	8. Repositioning and re-draping is necessary if open conversion is required
		9. Longer operative time

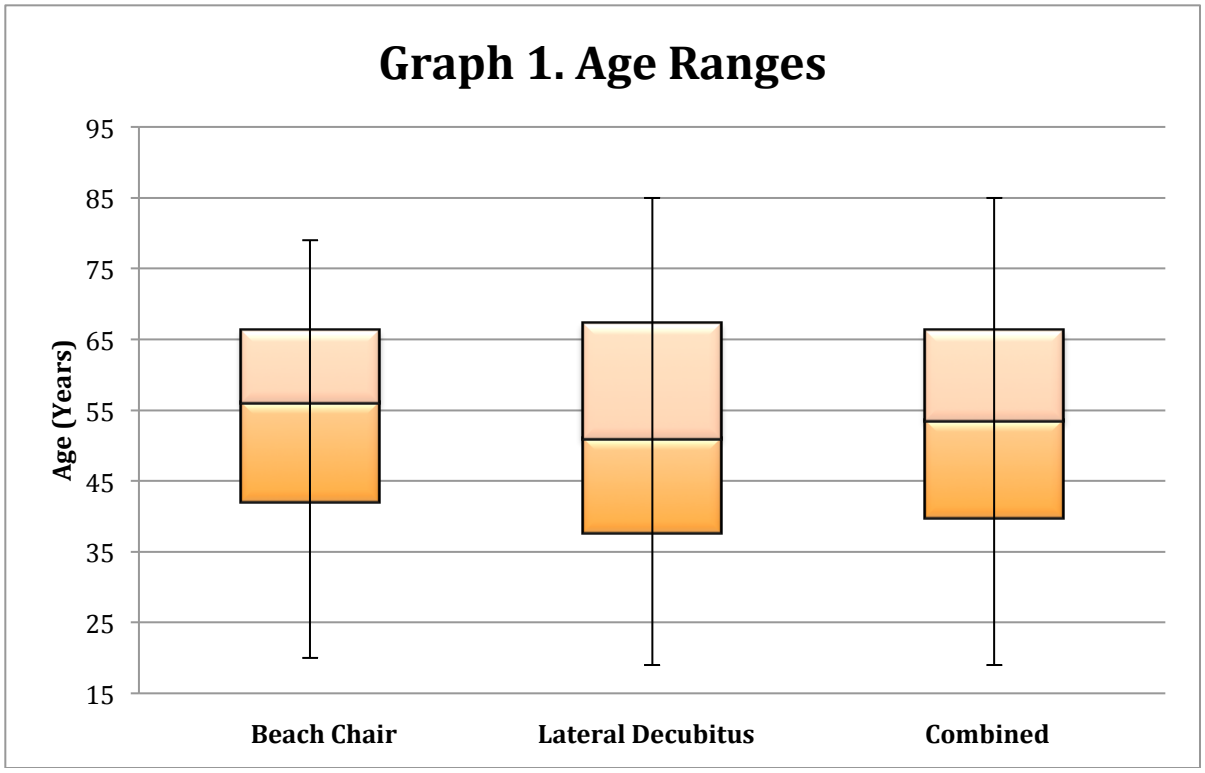
Table 1 provides a comprehensive summary of the advantages and disadvantages between the beach chair and lateral decubitus positions.

Table 2. Beach Chair Versus Lateral Decubitus: Patient Age, Height, Weight, and Time Under Anesthesia Minimums, Maximums, Averages, and Standard Deviations			
		Beach Chair	***Lateral Decubitus***
Age (years)	**Minimum**	**20**	**19**
	Average ± Standard Deviation	**54.4 ± 16.0**	**51.5 ± 21.2**
	Maximum	**79**	**85**
Height (inches)	**Minimum**	**62**	**62**
	Average ± Standard Deviation	**67.6 ± 3.5**	**68.8 ± 4.4**
	Maximum	**72**	**75**
Weight (lbs)	**Minimum**	**125**	**117**
	Average ± Standard Deviation	**163.3 ± 25.4**	**173.4 ± 47.4**
	Maximum	**210**	**290**
Time Under Anesthesia (mins)	**Minimum**	**35**	**41**
	Average ± Standard Deviation	**55.6 ± 10.7**	**62.1 ± 16.4**
	Maximum	**75**	**109**

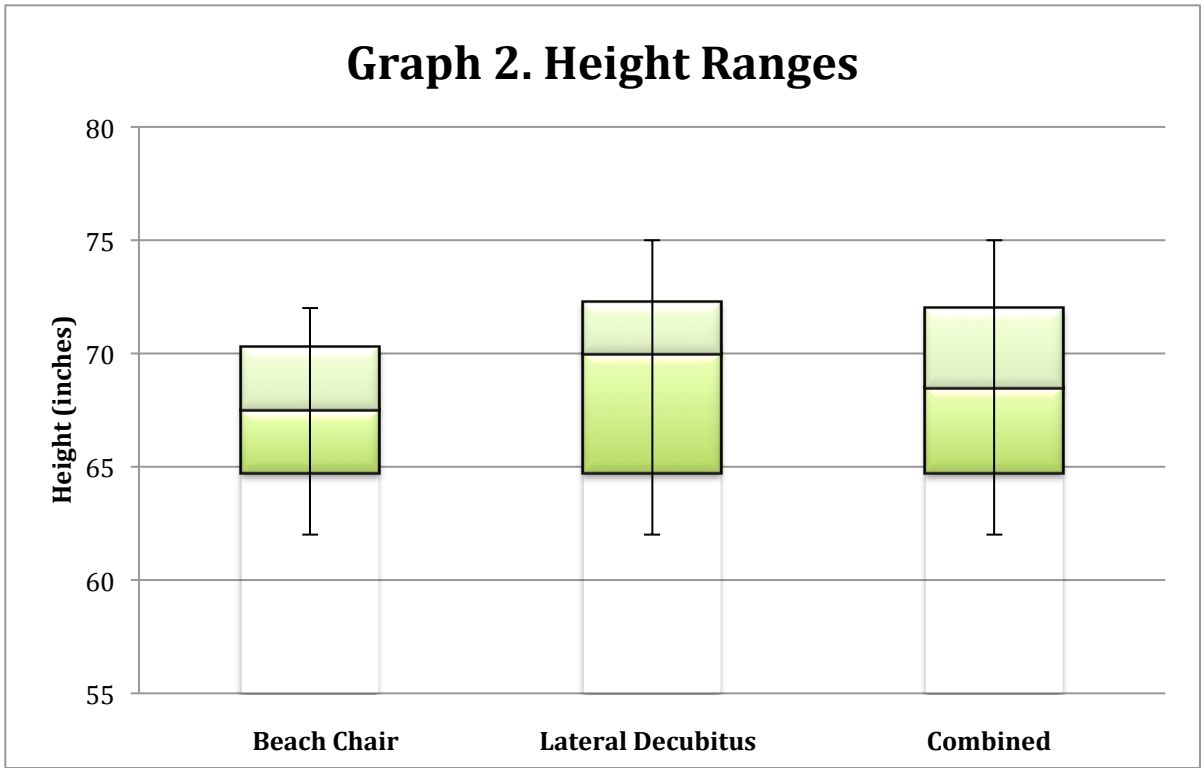
Table 2 provides the minimums, maximums, and averages with standard deviations of the patients' ages, heights, weights, and times under anesthesia between the beach chair and lateral decubitus positions.

Figure 1 depicts the lateral decubitus position of the right shoulder (right side up, view from behind with head to the left) shown with right operative arm suspended with use of a traction device.

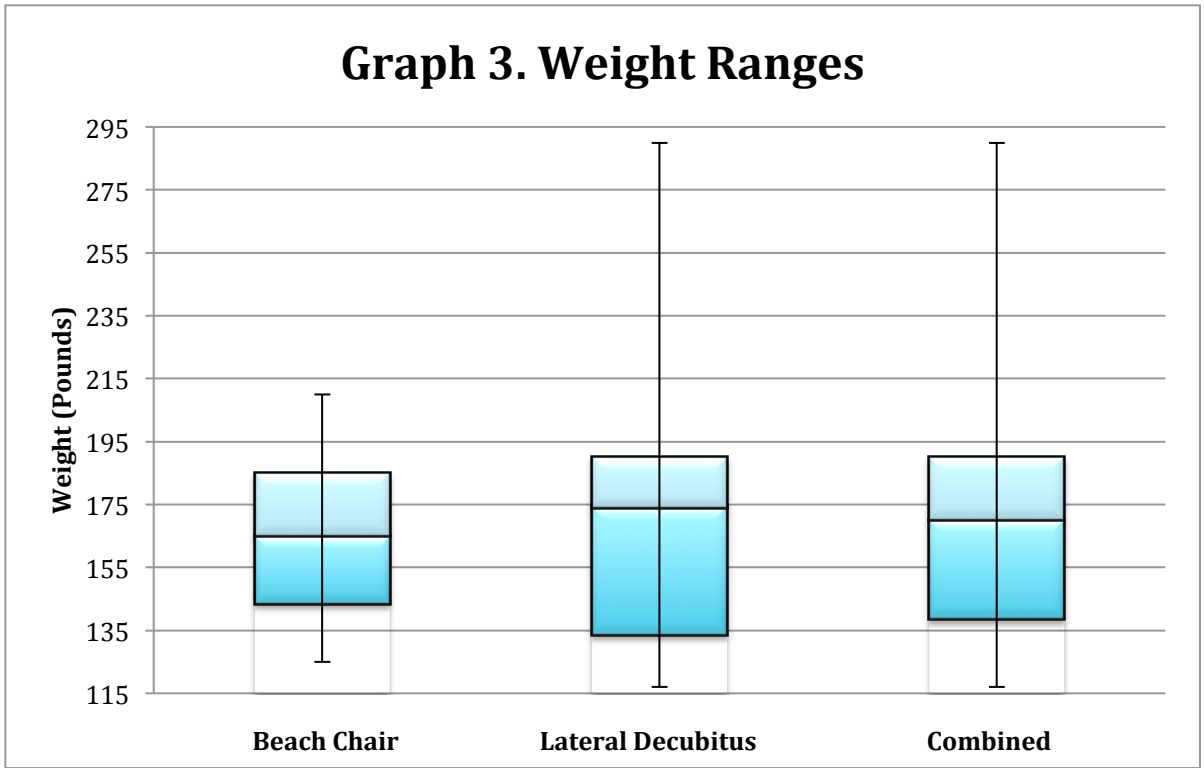
Figure 2 depicts the beach chair position of the right shoulder (view from the right side) with the left arm tucked with a mechanical support strap and the right operative arm free (to be positioned and retracted by scrubbed assistant).



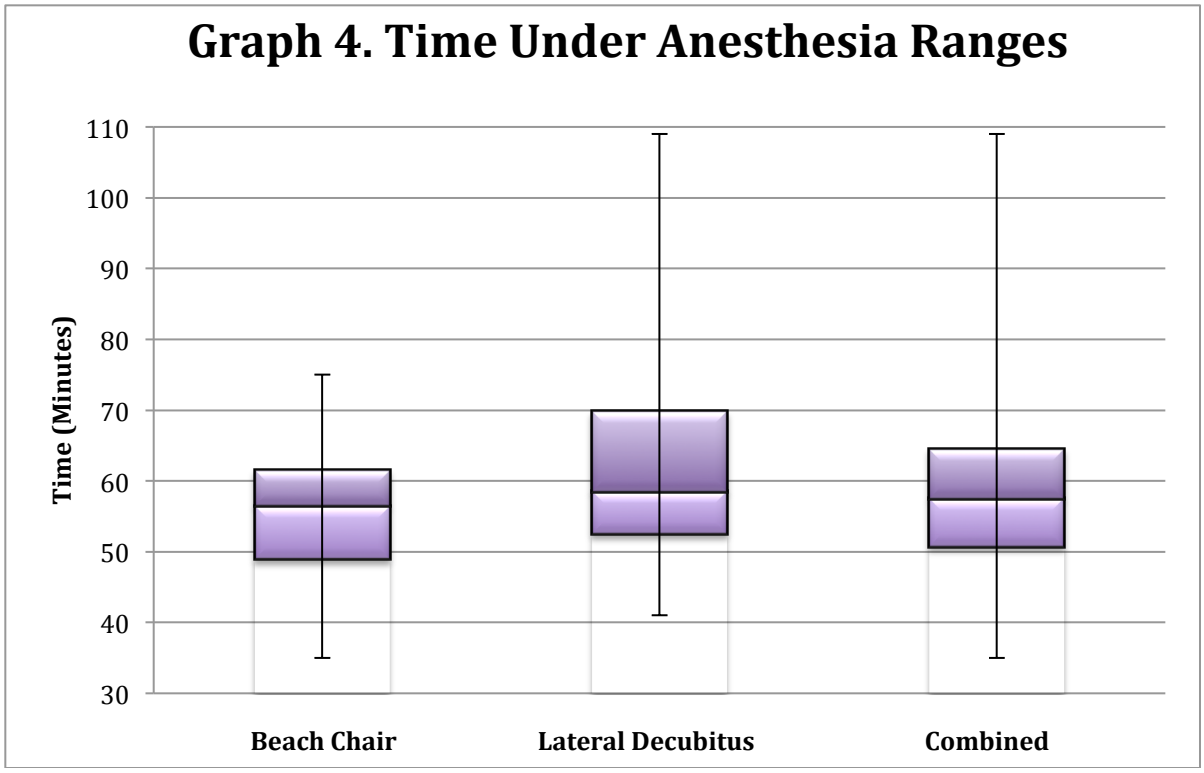
Graph 1 is an assortment of box plots depicting the range of patient age among the 32 de-identified shoulder arthroscopic patients analyzed in this article. Each position, beach chair and lateral decubitus, is graphed separately and a combined box plot is shown as well. The smallest point marked on each box plot is the sample minimum, the next up represents the lower quartile, the middle is the sample mean, the next up represents the upper quartile, and the highest is the sample maximum.



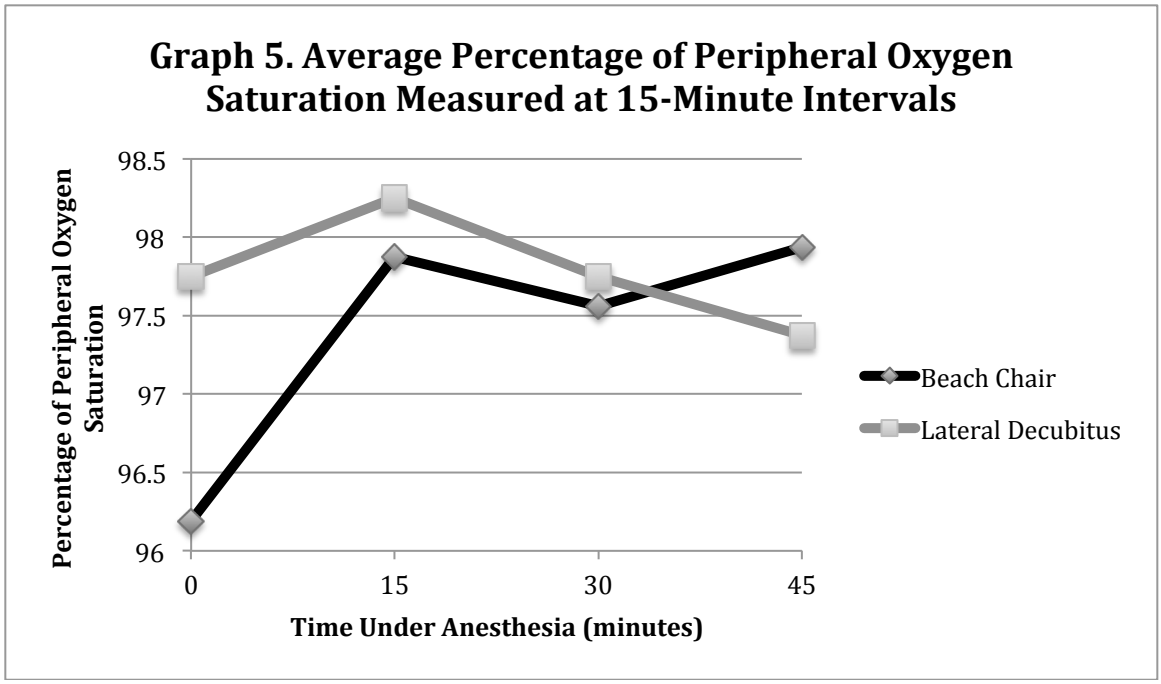
Graph 2 is an assortment of box plots depicting the range of patient height among the 32 de-identified shoulder arthroscopic patients analyzed in this article. Each position, beach chair and lateral decubitus, is graphed separately and a combined box plot is shown as well. The smallest point marked on each box plot is the sample minimum, the next up represents the lower quartile, the middle is the sample mean, the next up represents the upper quartile, and the highest is the sample maximum.



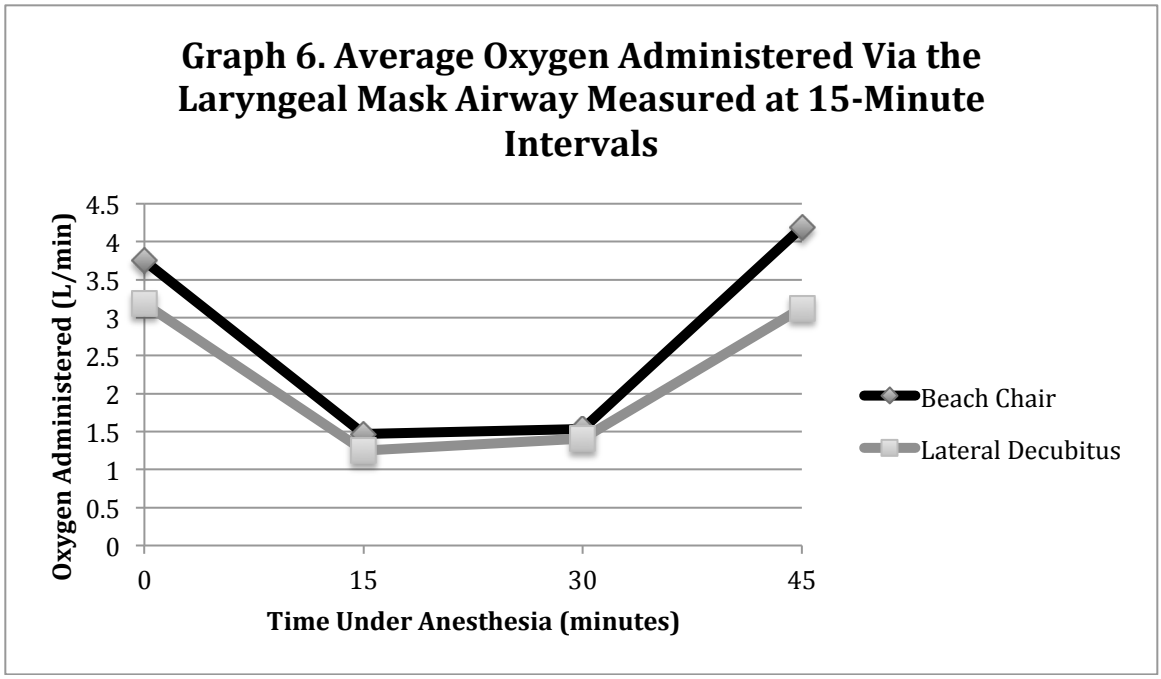
Graph 3 is an assortment of box plots depicting the range of patient weight among the 32 de-identified shoulder arthroscopic patients analyzed in this article. Each position, beach chair and lateral decubitus, is graphed separately and a combined box plot is shown as well. The smallest point marked on each box plot is the sample minimum, the next up represents the lower quartile, the middle is the sample mean, the next up represents the upper quartile, and the highest is the sample maximum.



Graph 4 is an assortment of box plots depicting the range of time each patient spent under anesthesia among the 32 de-identified shoulder arthroscopic patients analyzed in this article. Each position, beach chair and lateral decubitus, is graphed separately and a combined box plot is shown as well. The smallest point marked on each box plot is the sample minimum, the next up represents the lower quartile, the middle is the sample mean, the next up represents the upper quartile, and the highest is the sample maximum.



Graph 5 depicts the average percentage of peripheral oxygen saturation measured from the start of surgery in 15-minute intervals through 45 minutes between lateral decubitus and beach chair-positioned patients.



Graph 6 depicts the average oxygen administered in liters per minute via the laryngeal mask airway measured from the start of surgery in 15-minute intervals through 45 minutes between lateral decubitus and beach chair-positioned patients.

IX. Certifications and Approvals

Summary Statement

In order to perform this retrospective chart review, extensive steps were taken to obtain certification and approval. Yearly, I obtain HIPAA Privacy and Security certification for the protection of patients and their health information. On March 8, 2011, I successfully completed two courses through Oakland University's CITI training module: Basic Course Completion and Course in Basic Human Subject Research. April 4, 2011 I received written approval from the executive director, Amie Starkey, and medical directors, Dr. Bruce Evans M.D. and Dr. Christopher Chaput M.D., of UnaSource Surgery Center to conduct this retrospective chart review. May 13, 2011 I received exempt approval from Oakland University's Institutional Review Board (IRB). August 8, 2011 my thesis proposal earned approval from Oakland University's Honors College.

In order to support my written description of the two operative positions, I provided pictures of the positions in the operating room. UnaSource Surgery Center approved pictures to be taken of the primary investigator, myself, to demonstrate the lateral decubitus and beach chair positions in formal operating presentations. With these photographs, I am able to more effectively explain the operative orientations. Also, with myself as the only person photographed, no further consents were required aside from the Surgery Center's main consent approving the conduction of my research.

CITI Collaborative Institutional Training Initiative

Students conducting no more than minimal risk research Curriculum Completion Report
Printed on 3/8/2011

Learner: Kayla Schmitt (username: krschmitt)
Institution: Oakland University
Contact Information Department: Biological Sciences
Email: krschmit@oakland.edu

Students - Class projects: This course is appropriate for students doing class projects that qualify as "No More Than Minimal Risk" human subjects research.

Stage 1. Basic Course Passed on 01/29/11 (Ref # 5542465)

Required Modules	Date Completed	Score
Belmont Report and CITI Course Introduction	01/29/11	3/3 (100%)
Students in Research	01/29/11	10/10 (100%)
History and Ethical Principles - SBR	01/29/11	4/4 (100%)
Defining Research with Human Subjects - SBR	01/29/11	5/5 (100%)
The Regulations and The Social and Behavioral Sciences - SBR	01/29/11	5/5 (100%)
Assessing Risk in Social and Behavioral Sciences - SBR	01/29/11	5/5 (100%)
Informed Consent - SBR	01/29/11	5/5 (100%)
Privacy and Confidentiality - SBR	01/29/11	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBR	01/29/11	4/4 (100%)
Oakland University	01/29/11	no quiz

For this Completion Report to be valid, the learner listed above must be affiliated with a CITI participating institution. Falsified information and unauthorized use of the CITI course site is unethical, and may be considered scientific misconduct by your institution.

Paul Braunschweiger Ph.D.
Professor, University of Miami
Director Office of Research Education
CITI Course Coordinator

CITI Collaborative Institutional Training Initiative

CITI Course in Basic Human Subject Research - Student Curriculum Completion Report
Printed on 3/8/2011

Learner: Kayla Schmitt (username: krschmitt)
Institution: Oakland University
Contact Information Department: Biological Sciences
Email: krschmit@oakland.edu

CITI Course in Basic Human Subject Research - Student: This is group is for student researchers not engaged in Masters-level final projects or theses, or Doctoral-level dissertations.

Stage 1. Stage 1 Passed on 01/29/11 (Ref # 5542334)

Required Modules	Date Completed	Score
Oakland University	01/29/11	no quiz
Students in Research	01/29/11	10/10 (100%)
Research Misconduct 1-1215	01/29/11	5/5 (100%)

For this Completion Report to be valid, the learner listed above must be affiliated with a CITI participating institution. Falsified information and unauthorized use of the CITI course site is unethical, and may be considered scientific misconduct by your institution.

Paul Braunschweiger Ph.D.
Professor, University of Miami
Director Office of Research Education
CITI Course Coordinator

Certificate of Completion

This certifies that

Kayla Renee Schmitt

Has successfully completed

2011 HIPAA Privacy & Security Training Groups 2 & 3

Completed On 2/22/2011 08:17 AM America/New York

UnaSource Surgery Center Research Consent Approval: April 4, 2011

RESEARCH CONSENT FORM
For Retrospective Collection of De-Identified Medical Information/Data

Description: The proposed study is a retrospective chart review of de-identified patient records from UnaSource Surgery Center. The purpose of this study is to compare oxygen saturation levels during shoulder arthroscopies in two operative approaches: lateral decubitus and beach chair.

Procedures: The data that will be collected includes: gender, age, weight, presence of cardiovascular diseases and/or diabetes, operative position, and oxygen saturation during surgery. The information will be collected from data sheets that are used during surgical procedures, which will be de-identified. The proposed process for de-identification is as follows: Kathy Heniff, UnaSource Surgery Center Patient Care Team Leader, will select charts of 30 patients who have had shoulder arthroscopic procedures: 15 from each operative position: lateral decubitus and beach chair. The 15 selected for each position will contain approximately 50% male and 50% female, with an assortment of ages. Confidentiality of the data will be maintained as follows: Kathy will make a paper copy of the "History and Physical" and "Anesthesia Record" data sheets per patient, black out personal identifiers, and make a new copy from which the data will be gathered for analysis. The primary investigator will gather and store the data on a password-protected laptop computer outside of work time. The original de-identified data sheets will remain in the locked medical records facility at UnaSource Surgery Center. Once the data has been collected the data sheets will be shredded at UnaSource Surgery Center.

Risks and Benefits: There are no anticipated risks associated with this study. Although the data is de-identified, the electronic data files will be stored on a password-protected computer for additional security. You and your patients will not receive any direct benefit from participation. However, future benefit may be discovered from the outcome of this research. The results of this study will be shared with you.

Time Involvement: The time involved with this study will only include the initial random subject selection and de-identification of the data. The primary investigator will collect the data outside of scheduled work hours.

Authorization to Use Patient Health Information for Research Purposes
Because information about you and your patients is personal and private, it cannot be used in this research study without your written authorization. Your signature below provides that authorization.

If We Sign, Can We Revoke It or Withdraw from the Research Later?
If you agree to participate, you are free to withdraw your authorization at any time. After any revocation, the de-identified data will no longer be used or disclosed in the study. If you wish to revoke your authorization for the research use or disclosure of your patients' de-

identified health information in this study, you must do so in writing. Please provide the written withdrawal to *Kayla Schmitt at 2651 Sylvan Shores Drive, Waterford, MI 48328.*

How Will the Data Be Used?
The data collected will be used for the primary investigator's academic senior thesis research requirements for the Oakland University Honors College and as partial fulfillment of the degree of Bachelor of Science-Biology. The primary investigator will also present the results of this study at the Honors College Research and Scholarship Day Event.

Contact Information:
Questions, Concerns, or Complaints: If you have any questions, concerns or complaints about this research study, its procedures, risks and benefits, or alternatives, contact the primary investigator, Kayla Schmitt, (248) 709-1974.

Independent Contact: If you have any additional questions related to this study you may also contact the Oakland University Institutional Review Board, at (248) 370-3098.

I give permission for the proposed research study to be carried out at UnaSource Surgery Center. This authorization for the use and/or disclosure of patients' de-identified health information will expire on *December 31, 2012*.

Amie Starkey, R.N.
Executive Director - UnaSource Surgery Center
4/1/11
Date

MD
Dr. Christopher Chaput, M.D.
Medical Director - UnaSource Surgery Center
4-4-11
Date

Dr. Bruce Evans, M.D.
Medical Director - UnaSource Surgery Center
4-4-11
Date

Institutional Review Board Exempt Approval: May 13, 2011

Institutional Review Board for the Protection of Human Subjects

Office of Grants, Contracts & Sponsored Research
Rochester, Michigan 48309-4401
(248) 370-4898 Fax: (248) 370-2973

May 13, 2011

Professor Melodie Kondratek
School of Health Sciences

Reference: IRB application #4725, "Oxygen Saturation during Shoulder Arthroscopies in Lateral Decubitis and Beach Chair Positions: A Retrospective Chart Review" (Kayla Schmitt)

Dear Professor Kondratek:

The Institutional Review Board (IRB) responsible for the review of research involving human participants has reviewed your application referenced above and determined that **the project, as currently described, is exempt from federal regulation as defined in 45CFR46.101(b)(4). Your application will be kept in our active file for three years.** Prior to the end of the third year, you will be receiving an Exempt Application Status Update Form to complete and return back to us.

The exemption is made with the understanding that NO changes may be made in the procedures to be followed until after such modifications have been submitted to the IRB for review and approval. Do not collect data while the modified application is being reviewed. Data collected during this time can not be used.

If a consent form is required for the project, researchers must retain a copy of the informed consent form in their files for three years and must provide a copy of the consent form to the subject.

Any unanticipated problems involving risks to human subjects or serious adverse effects must be promptly reported to the IRB.

When project is completed, please down load the **IRB Exempt Application Completion Form** from the Human Subjects site at the Research webpage, complete and email it to me so that I can change the status of the application. Thank you.

Sincerely,

Judette Haddad

Judette Haddad, PhD, CIP
Regulatory Compliance Coordinator

Oakland University's Honors College Thesis Proposal Approval: August 8, 2011

OAKLAND UNIVERSITY
Powered by Google

Kayla Schmitt <krschmit@oakland.edu>

HC Thesis

Karen Conn <conn@oakland.edu> **Mon, Aug 8, 2011 at 9:20 AM**
To: "krschmit@oakland.edu" <krschmit@oakland.edu>

Kayla,
The council liked your proposal and voted to accept it. They said it was "very carefully thought out and eminently do-able".
There were just a few small suggestions that we would like to pass on and have you incorporate in your final thesis.

- If Kayla studies a sample of 32 instead of 30, 16 to each group, she'll have even numbers, and can divide each group exactly, rather than approximately, into 50% males and 50% females.
- I would suggest that subject assignments adhere to experimental design specifications
- Grammar correction…it's "lying," not "laying.

If you have any questions let us know. Enjoy the rest of your summer.
Karen

Karen Conn
Administrative Assistant
Honors College
112 E. Vandenberg Hall
Oakland University
Rochester, MI 48309
Phone: 248-370-4419
Fax: 248-370-4479

Photograph Consent: January 11, 2012

Name of Person to Be Filmed: Kayla Schmitt

Place of Filming: UnaSource Surgery Center, Troy MI

1. I consent to the use of photographs of me for demonstration of the lateral decubitus and beach chair positions in formal operating presentations. Doing so enables a more effective method to explain the operative orientations.

2. I have read and understand this consent.

Kayla R. Schmitt — Signature of person to be filmed

1-11-12 — (Date)