A comparison of shoulder pressure among different patient stabilization techniques

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OBJECTIVE: The purpose of this study was to evaluate the pressure placed on the shoulders as a function of varying degrees of head-down tilt (the Trendelenburg position) and to compare these pressures among 3 different patient-positioning systems.

STUDY DESIGN: Participants were placed in the dorsal-lithotomy position with arms tucked and tilted at 5, 10, 15, 20, 25, and 30 degrees of head-down tilt. Using a manometer, we measured the pressure (centimeters of water) on the shoulders at each angle for 3 support devices: the Skytron shoulder support (Skytron, Grand Rapids, MI), the Allen shoulder support (Allen Medical Systems, Acton, MA), and the Allen Hug-u-Vac.

RESULTS: Among 23 participants, body mass index (mean $\pm$ SD) was 24.5 ± 4.3 kg/m^2. As the tilt angle increased, so did the shoulder pressure for all support systems. At a 30-degree Trendelenburg position, the Allen Hug-u-Vac transmitted less pressure to the shoulders than the Skytron (right and left, $P < .001$) and the Allen shoulder supports system (right, $P < .001$; left, $P = .434$). Each participant was asked, "Which system was most comfortable?" Seventy-four percent of the participants reported that they preferred the Hug-u-Vac ($P < .001$).

CONCLUSION: Shoulder pressure increases as tilt angle increases. Of the 3 support systems that were tested, the Allen Hug-u-Vac transmitted less pressure to the shoulders at a 30-degree Trendelenburg position than the Skytron and the Allen shoulder support systems.

Key words: brachial plexus injury, dorsal lithotomy, patient positioning device, shoulder pressure, Trendelenburg position

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For most laparoscopic, pelvic surgeries, the surgeon places the patient in dorsal lithotomy with the Trendelenburg position (head-down tilt). In this position, a patient is on his/her back with the hips and knees slightly flexed, the thighs open, and the operating-room table at an incline with the head below the rest of the body (Figure 1). This position is used frequently to perform hysterectomies, which is one of the most common procedures performed in the United States (>600,000 performed annually).[1] Many surgeons increase the degree of head-down tilt to 30 degrees (steep Trendelenburg position) to optimize exposure. Shoulder braces provide a rigid backstop to prevent the body from sliding down as gravity exerts force on the patient.

Improper patient positioning while in the Trendelenburg position can result in position-related injuries.[2] The incidence of position-related brachial plexus injuries during laparoscopy is 0.16%.[3] The mechanism of action is presumed to be compression of the acromion or soft tissues 4-6 cm medial to the acromion by the shoulder braces. This compression increases the pressure over the clavicle and the stretch on the brachial plexus.[3,4] These injuries can result in a variety of motor and sensory deficits in the shoulders, arms, forearms, and hands. Additionally, these injuries can lead to medico-legal risk.[5] The incidence and prevalence of these injuries may increase as more patients undergo robotic surgery and are placed in steep Trendelenburg position for long durations.[4,6,7]

It is intuitive that, when a patient is placed in steeper Trendelenburg position, there is greater pressure placed on the shoulders and that this pressure may increase the incidence of nerve injuries. However, this qualitative deduction is not backed by quantitative data. The first step towards understanding the nature of these injuries is to quantify how much pressure is being placed on the shoulders and to evaluate how that pressure changes as the degree of the Trendelenburg position increases. Furthermore, there are many different shoulder braces/patient-positioning systems, and one system may exert more pressure on the shoulders than another and thus be more likely to cause injury.

The objective of this study was to measure the pressure placed on the shoulders as a function of varying degrees of head-down tilt and to compare these pressures among 3 different patient-positioning systems. We hypothesized that shoulder pressure would increase as the degree of the Trendelenburg position increased and that shoulder pressure would vary among the different patient-positioning systems.

Materials and Methods

This prospective, unfunded, descriptive study examined how shoulder pressure

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FIGURE 1
Dorsal-lithotomy position with a 30-degree head-down tilt

Suozzi. Shoulder pressure by stabilization method. Am J Obstet Gynecol 2013.

measurements changed as a person was placed in increasing degrees of head-down tilt and how these pressures compared among 3 different patient-positioning systems: the Skytron shoulder support (Skytron, Grand Rapids, MI), the Allen shoulder support (Allen Medical Systems, Acton, MA), and the Allen Hug-u-Vac (Allen Medical Systems). The Skytron shoulder support and the Allen shoulder support are padded braces that provide a backstop for the torso as a patient is placed in the Trendelenburg position. The Hug-u-Vac is a large beanbag from which air is removed to form a rigid cast around the patient. All 3 devices are used currently at Hartford Hospital for laparoscopic pelvic surgery; the choice to use 1 patient-stabilization system over another is based largely on surgeon preference.

Hospital employees participated in our study from Sept. 10, 2012, through Sept. 13, 2012, inclusive. The Hartford Hospital Institutional Review Board approved this study. Male and female patients who were at least 18 years old were included. Participants were excluded if they were pregnant or had current neck or shoulder pain, cardiac issues, or a history of major trauma or surgery to the neck or shoulders. After obtaining informed consent, we collected data pertaining to age, height, and weight.

Each participant was placed in the dorsal-lithotomy position with arms tucked to the sides and was asked to relax completely (Figure 1). The shoulders were padded with gel pads. A manometer was placed over each acromion between the participant's shoulders and the padding/support brace. The manometers were zeroed (with 0 degrees as the reference point [ie, parallel to the floor]).

We tilted each participant on the same standard operating table at 5, 10, 15, 20, 25, and 30 degrees of head-down tilt and measured the pressure on the shoulders in centimeters of water at each angle. The tilt angle was measured by placing a Pro 360 Digital Protractor (Mitutoyo America Corporation, Aurora, IL) on the metal rail on the side of the operating-room table, and the pressure was measured with a simple manometer.

Participants were repositioned, and we repeated the measurements in a similar fashion with the remaining 2 patient-positioning systems. For logistical reasons, we did not randomize the order of the patient-positioning systems, nor did we have participants follow the same order.

A sample size of 20 was needed to show a 10 cm H_2O difference between patient-positioning systems with 80% power, assuming that pressures were distributed normally with a standard deviation of 15 cm H_2O. Pressure readings between the right and left shoulders, with the same positioning system, were performed with a paired *t* test. Comparisons of the same shoulder between devices used analysis of variance at each tilt angle, with a post hoc Scheffé's test used to determine whether there was a significant difference in mean pressure transmitted to the shoulders between individual pairings of support systems.

All statistical analyses were conducted with SPSS software (version, 19.0, 2010; IBM/SPSS Inc, Armonk, NY), with an a priori alpha level of .05.

Results

Thirty people were contacted; 25 of them (83%) agreed to participate. Of these, we analyzed data from 23 participants. One participant was excluded because of pregnancy, and 1 participant was unavailable during the study period. Of the 23 participants, 4 were men; 19 were women, and all of them had complete data for each angle with each patient-positioning system. Body mass index (BMI; mean ± SD) was 24.5 ± 4.3 kg/m^2, with a median of 23.4 kg/m^2 and a range of 19.1−32.9 kg/m^2.

For all 3 support systems, as the tilt angle increased, so did the pressure on each shoulder (Figure 2). As expected, the highest pressures were observed at a 30-degree head-down tilt. On the right shoulder at 30 degrees, the Skytron shoulder support had a pressure of 34.5 ± 11.9 cm H_2O (median, 32.0 [minimum, 15.0; maximum, 62.5]); the Allen shoulder support had a mean of 29.8 ± 12.2 cm H_2O (median, 29.5 [minimum, 7.0; maximum, 51.0]); and the Allen Hug-u-Vac had a mean of