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Face Tissue Pressure in Prone Positioning

A Comparison of Three Face Pillows While in the Prone Position for Spinal Surgery

Margaret Grisell, MD, MBA, and Howard M. Place, MD

Study Design. This is a prospective, randomized study.

Objective. The purpose was to compare the tissue-pillow interface pressures at the forehead and chin in patients positioned in the prone fashion for spinal surgery on each of 3 facial positioners.

Summary of Background Data. Facial pressure ulcers have been infrequently observed after spinal surgery requiring prone positioning. This requires the use of a specially designed head positioner to maintain spinal alignment and to allow space for the endotracheal tube.

Methods. We enrolled 66 consecutive elective thoracic and/or lumbar surgery patients from 18 to 65 years of age. Patients were randomized on entry into the study to 1 of 3 positioners. Facial tissue pressures were measured at the patient's forehead and chin at times 0, 5, 15, and 60 minutes of positioning. The integrity of the patient's skin was recorded and classified at the end of surgery.

Results. The pressures measured for the Dupaco positioner were lower at all time points at both the forehead and the chin in comparison with the other 2 positioners ($P < 0.05$). The ROHO and the OSI positioners created similar chin pressures at all time points ($P > 0.05$). The pressures at the forehead for the ROHO positioner were significantly less than those for the OSI positioner at all time points ($P < 0.05$). Ten patients on the OSI positioner had pressure ulcers at the end of the procedure.

Conclusion. The Dupaco ProneView Protective Helmet System is superior to both the OSI and the ROHO positioners in decreasing forehead and chin tissue interface pressures during prone position surgery.

Key words: pressure ulcers, facial complications, prone positioning, thoracolumbar spinal surgery. **Spine 2008;33:2938–2941**

Facial pressure ulcers have been observed after prolonged spinal surgery requiring prone positioning (Figure 1, an example of the pressure ulcers seen after prone positioning for spinal surgery). Recent data examining facial (forehead and chin) pressures obtained from awake, healthy volunteers using the 3 facial pillow devices available for use at our facility show that the lowest pressures seem to be obtained using a polyurethane foam-mirrored positioner.[1] However, this data were obtained on awake, healthy volunteers who were able to reposition and to relieve pressure as it created foci of irritation. Patients are not able to adjust their positioning to relieve pressure during general anesthesia.

The purpose of this study was to measure and compare the tissue-pillow interface pressures at the forehead and chin in patients who are positioned in the prone fashion for spinal surgery on each of 3 different facial pillows. Each of these pillows is currently in use at our facility for this purpose. The hypothesis was that the dry floatation device would produce equal or lower tissue interface pressures than either of the 2 polyurethane prone head positioners.

Materials and Methods

This study was a prospective, randomized study designed to evaluate the facial tissue interface pressures that result from the use of each of 3 different face pillows that have been used for prone positioning in the operating room (Figure 2). The 3 pillows are as follows: (1) the OSI (Orthopedic Systems Inc., Union City, CA) disposable polyurethane foam prone head positioner, (2) the Prone View Protective Helmet System that uses a disposable polyurethane foam head positioner (Dupaco Inc., Oceanside, CA), and (3) a neoprene air filled bladder "dry flotation" device by ROHO (The ROHO Group, Belleville, IL). This study was approved by our Institutional Review Board.

From November 2005 to May 2006, 66 consecutive patients between the ages of 18 and 65 years (inclusive) presenting to the operating room for elective thoracic, lumbar, or thoracolumbar spinal surgery that required prone positioning were included. Patients presenting with any facial skin ailment or lesion (rash, abrasion, infection, redness, inflammation, bruising) were not included. Patients were also excluded if they had a history of increased intraocular pressure or glaucoma. Patients who presented for emergent spinal surgery were not included. Patients presenting for surgery that included any cervical level were excluded. Patients whose major language was not English were not included. We did not stratify by gender, age, or ethnicity.

The patients were consented for participation in the study before surgery. After consent was obtained, the randomization list was consulted for assignment of positioner, the positioner was obtained, and the patient positioned before the start of the procedure. The patient was unaware of their assigned positioner type at all times. The randomized list of the 3 pillow types was generated using the web site www.randomization.com on November 1, 2005. This web site uses the method of randomly permutated blocks to assign each subject to a pillow.

Each patient was positioned prone on a Jackson table using standard positioning with the subject's face resting on 1 of the 3 facial pillows. A low profile pressure sensor was positioned between the subject's forehead and the pillow and between the

From the Department of Orthopaedic Surgery, Saint Louis University, Saint Louis, MO.
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Address correspondence and reprint requests to Howard M. Place, MD, Department of Orthopaedic Surgery, Saint Louis University, 7th Floor Desloge Tower, 3635 Vista @ Grand Avenue, Saint Louis, MO 63110; E-mail: place@slu.edu

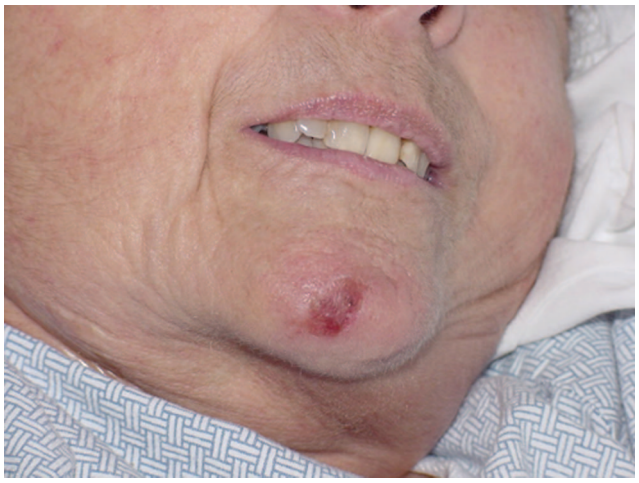

Figure 1. An example of the pressure ulcers seen after prone positioning for spinal surgery.

subject's chin and the pillow. Pressure readings were recorded at time 0, 5, 15, and 60 minutes. At the conclusion of the procedure, any skin changes such as pillow impression marks or redness were documented. Any pressure ulcers seen at this time were staged according to the National Pressure Ulcer Advisory Panel staging system:

Stage I: Nonblanchable erythema of intact skin.

Stage II: Partial thickness skin loss involving epidermis and/or dermis.

Stage III: Full thickness skin loss involving damage or necrosis of subcutaneous tissue that may extend down to, but not through, underlying fascia.

Stage IV: Full thickness skin loss with extensive destruction, tissue necrosis or damage to muscle, bone, or supporting structures.[2]

Statistical Analysis

Sample size estimates were generated using data obtained in a pilot study on awake volunteers.[1] Based on our power estimates, we required 20 patients in each group to determine statistical significance with 80% power. To accommodate for possible patient drop-out, we collected data on 66 consecutive patients presenting for elective spine surgery.

Nonparametric statistical methods were used to analyze the data because of the small sample sizes. Mann-Whitney *U* (the nonparametric equivalent of the independent sample *t* test) was used to analyze measures of central tendency (mean, median) and variability (standard deviation, range, minima, and maxima) of the tissue pressures measured. The Friedman analysis (the nonparametric equivalent of the repeated measures ANOVA) was used to evaluate and assess differences across time at each of the time variables measured. All statistical analyses were completed using SPSS version 11.5 (Chicago, IL).

■ Results

All patients enrolled in the study completed the study. Data were collected on 66 patients, 22 on each pillow. No data points were missed. No patients dropped out of the study. There were no complications requiring early termination of any procedure. Procedures lasted from 1 to 12 hours. Although statistics were not used to evaluate the lengths of the procedures, the average time for the procedures on each of the positioners was similar.

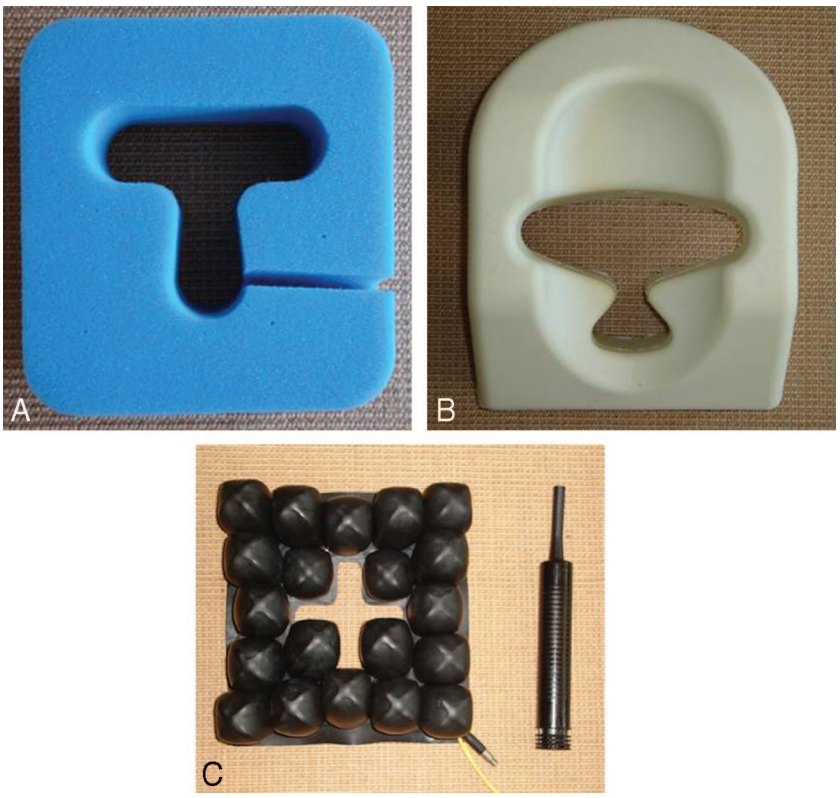

Figure 2. **A,** OSI foam positioner, **B,** ProneView Protective Helmet System, **C,** ROHO dry floatation device.

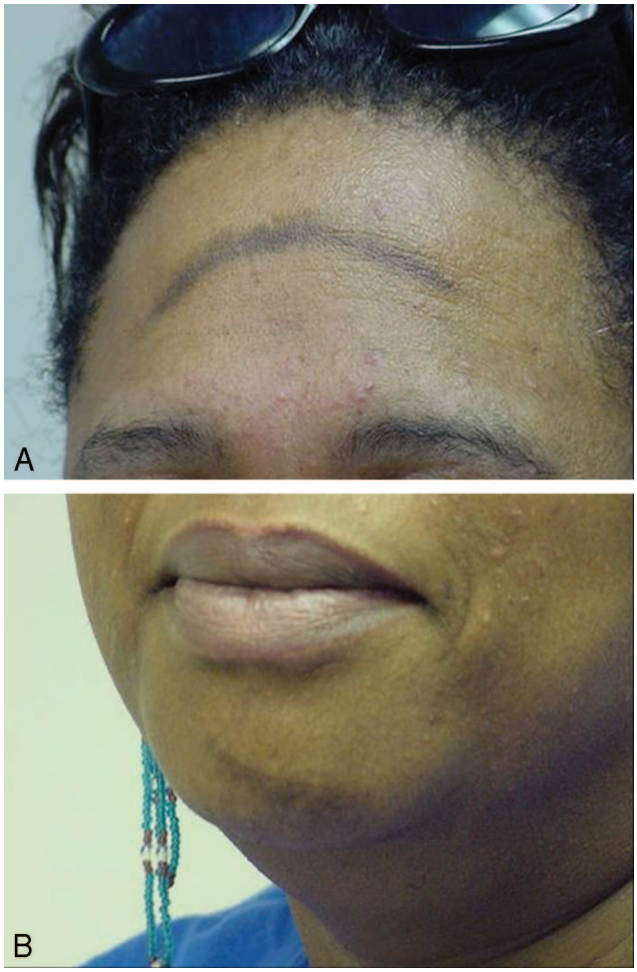

Figure 3. Forehead (**A**) and chin (**B**) pressure ulcers appearing at the resting sites of the face on the OSI positioner.

Pressure Ulcers

Eight patients positioned on the OSI positioner had Stage I pressure ulcers at the termination of the procedure. Each of the procedures lasted greater than 2 hours. These patients had a total of 6 forehead pressure ulcers and 8 chin pressure ulcers. Two patients who were positioned on the OSI positioner had Stage II pressure ulcers, on the forehead and on the chin in both patients. The forehead pressure ulcers seemed to occur at the edge of the positioner's T-shaped cut-out for the eyes, nose, and endotracheal tube. Chin ulcers seemed to be where the chin prominence rested on the positioner (Figure 3).

No patients from either the ROHO or the Dupaco groups showed any evidence of pressure ulcers or skin discoloration.

Tissue Pressures

Tissue pressures for all positioners seemed to equilibrate over the first 15 minutes and then remain fairly constant. The pressures measured for the Dupaco positioner were lower at all time points for both the forehead and the chin in comparison with the OSI and the ROHO positioners ($P < 0.05$). The ROHO and the OSI positioners created similar chin pressures at all time points ($P > 0.05$). The pressures at the forehead for the ROHO positioner were significantly less than those for the OSI positioner at all time points ($P < 0.05$). Stated another way, the OSI positioner had higher tissue pressures at the forehead than either the Dupaco positioner or the ROHO positioner at all time points.

■ Discussion

Intraoperatively acquired pressure ulcers are reported to occur 5% to 66% of the time[3–5] and are estimated to increase the cost of care by $5000 to $40,000.[3,5] This cost not only includes treatment for the ulcer itself but also represents an increase in length of hospital stay, estimated to be 6.7 days longer than patients without pressure ulcers.[6] There are several factors that contribute to the development of pressure sores in the operating room. These include, but are not limited to, positioning, the type of material placed under bony prominences, shear, friction, and the effects of anesthesia and paralysis.[3,7,8] Moisture macerates and injures skin, making it more easily eroded by friction, more permeable to irritants, and more readily colonized by microorganisms than normally hydrated skin.[6]

Pressure ulcers are most likely to occur at bony prominences because of the high interface pressures, shearing forces that occur at these sites, and the decreased muscle tone associated with anesthesia, leading to perturbation of local blood flow.[7] The head and face have little muscle mass to provide blood supply to surrounding skin and subcutaneous tissues, creating an opportunity for pressure ulcer formation within the time period required for most spine surgeries.

One major complication of prone positioning not addressed by our study is vision loss. This is a rare but devastating complication of prone positioning in spine surgery. The incidence has been reported to be 0% to 0.12% in various reports.[9] We did not have any cases of vision loss in this study. With a study population of 66 patients and a reported incidence (at the high end) of 0.12%, the fact that we did not have any cases does not statistically add to knowledge of the complication. We did have 1 patient who suffered a corneal abrasion; the patient was wearing mascara, and she rubbed her eyes immediately on wakening. Ophthalmology was consulted and the patient was treated with antibiotic ointment. The abrasion resolved without further sequelae.

Recent data examining facial (forehead and chin) pressures obtained from awake, healthy volunteers using these 3 facial pillow devices show that the lowest pressures seem to be obtained using Dupaco's mirrored positioner.[1] However, these data were obtained on awake, healthy volunteers who were able to reposition and to relieve pressure foci.

This study was done to evaluate positioner tissue pressures on actual, anesthetized patients who were unable to adjust for local pressure and perturbance of local me-

tabolism. Patients undergoing cervical spine surgery were excluded secondary to changes in facial tissue pressures that may not be related to the positioner, *i.e.*, the use of tong traction, motion of the head because of local dissection, and placement of instrumentation in the cervical spine. Patients in this study were not stratified by age or gender as we felt that neither of these factors would significantly change the outcome of the tissue pressures measured.

We noted that 2 of 22 patients positioned on the OSI positioner had the complication of a facial pressure ulcer, Stage I. This represents a 9% incidence in our study. This is consistent with our experience, and is what prompted us to evaluate our options for head positioner use. This complication and its repercussions (scar formation, permanent discoloration of facial skin, risk of infection) should be discussed with all patients positioned prone for surgery.

Limitations of this study include that we did not stratify by age, gender, surgery type, surgery location, or surgery length (other than the requirement that surgery last at least 1 hour). We also did not include cervical spine surgeries, surgery on patients younger than 18 years old, or patients with facial abrasions. Age and gender may be issues based on head weight and/or size. However, we did not have any grouping of the data obtained that would indicate that other variables could account for lower or higher tissue pressures. Because of the fact that the tissue pressures seemed to even out after 15 minutes, the expected return for gathering data points past 1 hour (60 minutes) would likely be slim. Though possible, this was felt to be of low yield.

Patients with any facial abrasion or rash were not included in this study because of the possibility of confusing an abrasion extending from an already existing skin lesion or occurring because of skin that was already sensitive and friable.

■ Conclusion

This prospective randomized study shows that the Dupaco positioner created the lowest tissue pressures at both the forehead and the chin in an anesthetized, prone patient population undergoing spinal surgery. In addition, no patient placed on either the ROHO or the Dupaco positioner had postoperative skin changes.

■ Key Points

- Facial pressure ulcers are observed in patients who have been positioned in the prone position for spinal surgery.
- Tissue-positioner interface pressures are measured at the forehead and at the chin for 3 positioners during the first hour of prone positioning for spinal surgery.
- Positioner type is shown to have an effect on tissue interface pressures during the first hour of prone positioning for spinal surgery.

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