

Sitting Pressure-Time Patterns In Patients with Quadriplegia

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ABSTRACT. Patterson RP, Fisher SV: Sitting pressure-time patterns in patients with quadriplegia. *Arch Phys Med Rehabil* 67:812-814, 1986.

• Continuous pressure under each ischial tuberosity was measured on five ulcer-free patients with quadriplegia for four days as they completed their normal daily activities. Results showed many multihour periods without pressure relief. More than 50% of the time the pressure-time periods were outside of previously reported acceptable limits. The results indicate that quadriplegic patients can sit with ischial tuberosity pressures above the previously reported capillary pressure of 32mmHg for long periods of time without getting an ulcer. This study suggests that other factors beside pressure must be studied in order to develop a better resting surface.

KEY WORDS: Behavior; Decubitus ulcer; Spinal cord injury; Tissue survival

Decubitus ulcers continue to be a major medical problem for individuals with spinal cord injury. The common cause of the problem is thought to be inadequate pressure relief. Uninterrupted pressure on the skin^{7,8,15} that causes tissue pressure above the capillary pressure of 32mmHg reported by Landis⁹ produces local ischemia that if prolonged will cause an ulcer.

This theory ignores the work of many researchers who have shown that blood flow in the tissue occurs above this pressure value. Holstein and colleagues⁶ reported that skin blood flow did not cease until the applied pressure was above diastolic pressure. Holloway's group⁵ showed that skin blood flow is reduced but continues to flow with a value of approximately 33% of control up to a pressure of 60mmHg. Newson and Rolfe¹⁰ demonstrated the surface PO_2 decreased less than 20% when up to 200mmHg pressure was applied to the skin surface.

The work by Daniel and colleagues³ gave even stronger evidence to not use the 32mmHg pressure criteria exclusively. They demonstrated that pressure greater than 200mmHg applied for longer than 15 hours was needed to produce the skin breakdown and pressures of 100mmHg for 10 hours caused muscle damage. In that study 30mmHg for one hour caused no damage in either the muscle or the skin. However, they did point out that their experiment was a one-time insult of pressure and that repetitive pressure insults needed to be considered.

Coupled with this scientific information are anecdotal reports from patients who repeatedly sit for many hours without getting an ulcer. This has been documented by our work with paraplegic and quadriplegic patients.^{4,12} The purpose of this paper is to report the pressure time periods observed in a full day with a group of subjects who have quadriplegia.

METHOD

Five patients with quadriplegia (four men and one woman) were studied for four days. The subjects had a complete C6 or higher spinal cord injury and could not perform a push-up

because of lacking tricep function. They could, however, partially weight shift to reduce pressure on the ischial tuberosity. None of the subjects had a decubitus ulcer up to the time of the study and one year following.

The pressure over each ischial tuberosity was recorded using small flat (1mm thick by 5mm in diameter) pressure transducers.⁴ The transducers were applied over the ischial tuberosities with double-sided tape while the subject lay on the side with knees and hips bent to 90°. Zero pressure was recorded with the subjects in this position. The transducers connected to a small portable tape recorder^b capable of recording for 24 hours and were calibrated as reported previously.¹²

The subjects received the recording instruments in the morning and were encouraged to go about their normal daily routines, returning in late afternoon for removal of the equipment. A zero pressure reading was recorded at the start and end of each experiment. The average experimental time was five hours and 30 minutes. Each subject was studied for four days; two days using a foam cushion and two days on a Roho cushion.

Data were played back on a high-speed tape deck.^c Analog signals were converted to digital form and analyzed by a digital computer. A push-up was defined as a pressure drop below 10mmHg with a duration either greater than one second or five seconds. If the push-up time was less than the selected duration, relief for pressure was not recorded and sitting time continued to increase in duration.¹² The average pressure on each ischial tuberosity was calculated for each time period between a push-up.

RESULTS

Figures 1 and 2 show the average pressure for various sitting periods for a push-up duration greater than one second and

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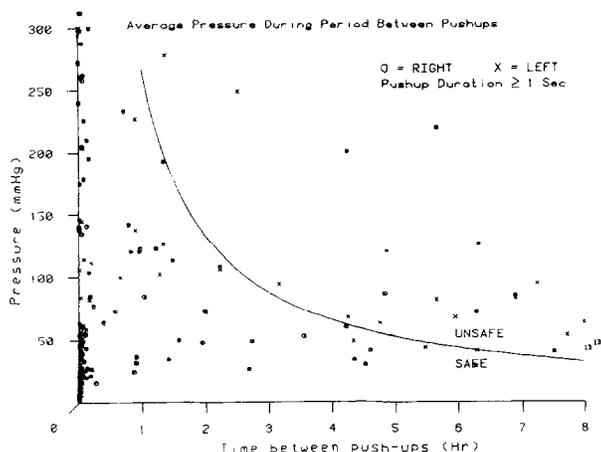


Fig 1—Average pressure occurring under ischial tuberosities between push-ups versus time between push-ups. Push-up duration greater than 1sec.

greater than five seconds, respectively. Superimposed on the figures is a curve which represents the middle of the uncertainty region between acceptable and unacceptable time pressure periods.¹⁴ The % time in the unsafe pressure-time region for push-ups with a duration <1sec was 50% and 69% respectively for the right and left buttocks. The % time in the unsafe pressure-time region for push-ups with a duration of <5sec was 66% and 73% respectively for the right and left buttocks. The overall average pressure under the ischial tuberosities was 88mmHG.

DISCUSSION

The results of this study clearly show that individuals with spinal cord injury can sit for long periods beyond the previously reported critical capillary pressure of 32mmHg⁹ without developing an ulcer. Our past studies suggest that errors in pressure measurement of 20 to 30mmHg could occur.¹¹ If 20 or 30mmHg is subtracted from the measurements there are still many multihour periods above 32mmHg. Laboratory measurements have shown that the average sitting pressure on

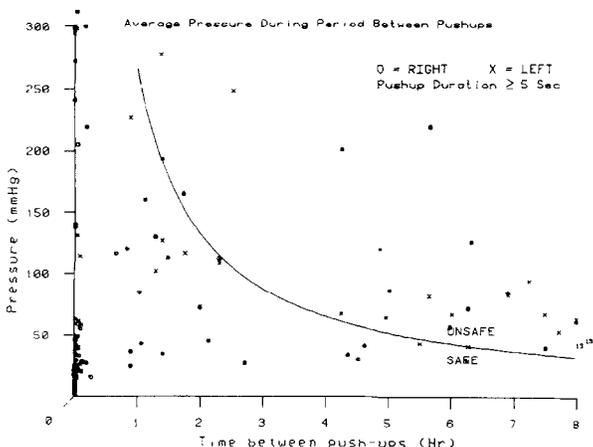


Fig 2—Average pressure occurring under ischial tuberosities between push-ups versus time between push-ups. Push-up duration greater than 5sec.

various cushions ranges from 75 to 90mmHg.¹⁵ The average pressure of 88mmHg measured in this study is in the same range, suggesting no large error occurred with the pressure measurement.

High-pressure periods that lasted more than 30 minutes usually occurred on only one buttock, suggesting the subject was leaning to that side. The lower pressure value seen in the laboratory measurements were usually made with the subjects balanced on both buttocks. This variation suggests that subject position may be very important for reducing high pressures on ischial tuberosity.

Clinical experience has shown periodic pressure relief to be effective in preventing decubitus ulcers. Results from this study should not change this practice. These results suggest that other factors in addition to pressure are very important also. Such factors may include shear forces,¹ high-impulse forces, temperature, humidity, nutrition,^{2,13} and the lack of protection given a slight bruise or injury. Future research should focus on these factors to determine their relative importance in pressure ulcer etiology. To date, research concentrates on studying pressure and designing resting surfaces that reduce resting pressures. If these other factors prove important, patient information and education could be improved along with better designed resting surfaces. Both efforts may significantly reduce the incidence of decubitus ulcers.

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