SACRAL SKIN BLOOD PERFUSION IN RELATION TO OTHER POSTERIOR AND REMOTE SITES

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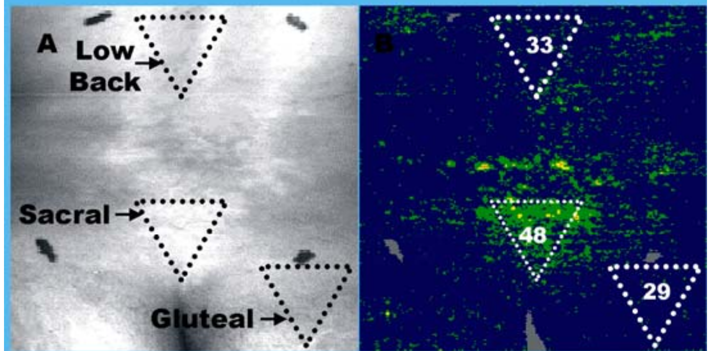
INTRODUCTION

BACKGROUND: It is known that sites of bony prominence are at risk of skin breakdown and pressure ulcer development as compared to soft tissues under similar loading conditions. Pressure sores occur over the sacrum but are rare over the gluteus maximus[1]. This predilection is in part explainable by pressure concentration and other mechanical effects on tissue overlying bone. However, differences in response to short term pressure loading of skin overlying sacrum and gluteus regions, have been reported[2]. A possible reason is that tissues with greater resting BF might be at greater breakdown risk if loaded to levels that significantly decrease BF. This hypothesis is based on the concept that for equal loading durations, tissue "flow-debt" and thus injury potential, would be greater in more highly perfused tissue. The validity of this hypothesis depends in part on whether breakdown prone regions do in fact tend to have greater resting flow than in nearby surrounding regions. Data that describes resting BF in the breakdown prone sacral region is scarce and is based on single point laser-Doppler[3-5]. The combination of a small sample size and small tissue sampling area of single point laser-Doppler (~ 1 mm^2) used in these studies, may obscure true differences in SBF between these sites. So, to investigate the relative resting BF levels in ulcer prone vs. nearby less -at-risk tissue, we employed laser Doppler imaging (LDI)[6-13] to measure skin BF (SBF) within the ulcer prone sacral region, nearby less at -risk-tissue and remote sites for comparison.

PROTOCOL: Thirty subjects (15) male (21-56 yrs) participated. None reported cardiac or vascular disease or had diabetes mellitus. The lower back, sacrum and gluteus maximus were scanned with LDI, which yields an image and quantitative data on SBF. All LDI scans were obtained with subjects prone on an exam table using a 633 nanometer wavelength device (Moor Instruments, LDI -VR), positioned 50 cm above the sacral area. The scan pattern was rectangular (19 cm x 24 cm) with a scan area of 456 cm^2. Scans began after about 15 minutes rest; each scan took about 4 minutes to complete. Skin temperatures were recorded at the mid-sacrum, gluteus maximus and lower back on the midline at the level of L2 using a small thermocouple thermometer. In addition to the single baseline back scans, a second scan was done in 13 subjects after heating the mid-sacral area with a 1.9 cm diameter contact heater raised to a temperature of 44ºC for 5 minutes. In 8 others, the dorsal surface of the dominant hand was scanned immediately after the back scan. Six subjects were re-scanned six weeks after initial back scans.

RESULTS

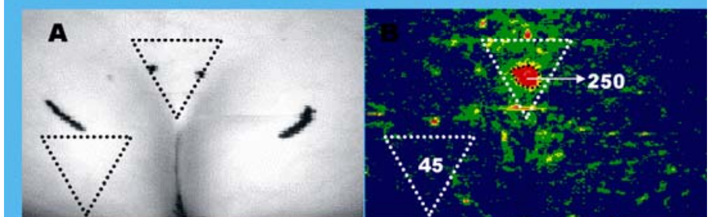
Scan Sites and Sample Perfusion Images



Standardized posterior regions were used

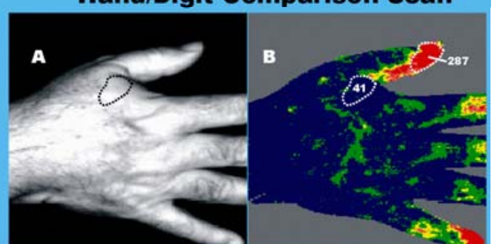
Numbers are mean blood perfusion in target areas

Heat Procedure and Example Scan



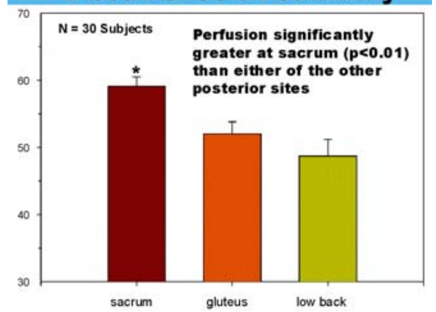
Central region of sacrum is heated to 44ºC and scanned

Hand/Digit Comparison Scan



Hands were scanned immediately after posterior scans

Blood Perfusion Summary



MAIN FINDINGS

The findings demonstrate several features of sacral skin blood flow in comparison to other nearby tissue regions and with respect to other skin areas. In contrast to previous data[3-5] obtained with single point laser Doppler methods, the laser Doppler imaging method has revealed that resting sacral SBF is greater than SBF overlying the gluteus maximus and is also greater than nearby lower back skin SBF. Average sacral SBF (59.1± 1.4 a.u.) was significantly ($p<0.001$) larger than other posterior sites (48.7 ± 2.5 a.u.) and was greater in females (63.0±1.6 vs. 55.2±1.8, $p<0.01$).

On average, sacral SBF was found to be 13.7% greater than gluteal SBF and 21.3% greater than low back SBF. These differences are not explainable on the basis of skin temperature differences, as the low back site had significantly higher temperature than either of the other two sites. Further, for subjects undergoing the heat response protocol (N=8), average SBF within the heated area (1.1 ± 0.1 cm^2) increased from its baseline of 54.5± 3.6 a.u. to 186.6±21.8 a.u. This is a heat induced SBF increase by 3.5 ± 0.5.

Remote hand measurements show that average perfusion within the sacral region of the present group was close to, but somewhat greater than that in the hand web but was, as expected, significantly less than the high flow normally found in the finger tips. These comparisons help place the resting sacral skin perfusion levels in perspective and combined with the large heat induced responses at the sacrum, show a hyperemia potential at the sacrum near to that of resting digit perfusion.

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CONCLUSIONS/IMPLICATIONS

The higher SBF over the sacrum we found using the LDI method, is consistent with the hypothesis that regions of higher resting blood flow (BF) may be at greater risk of injury when exposed to external forces that cause a substantial reduction in this resting BF. The relative importance of this finding, compared to other factors that predispose to sacral pressure ulcers has not been investigated, but it is useful to speculate. The average resting sacral SBF among persons we studied varied by about 1.7 times. It is likely that patients, who have varying superimposed conditions that affect skin BF, would also have such person-to-person differences in sacral SBF.

A relevant question is whether resting flow variations among patients represents a factor that influences sacral ulcer predilection. For similar sacral loading conditions, it almost seems counter-intuitive to expect that a person with a higher resting BF would be more at risk for a sacral ulcer than one who has a lower BF.

But, it may be argued that if resting BF is reduced to near zero for a sufficient duration, then the relative deficit is greater in a person with higher resting flow. If BF is then restored by offloading the sacral forces, either mechanically, as with pressure relief surfaces, or by turning the patient, the deficit needs to be repaid via the normal hyperemic response. For persons with higher resting BF, this response needs to be more vigorous and sustained. A differentiating factor, as to ulcer risk, may then be whether a suitable amount of hyperemia can occur.

The findings indicate that a substantial flow reserve is normally present in the sacrum. Based on the localized heat responses, a peak hyperemia that was about 3.5 times the resting SBF was observed. But, there are at least two broad categories to consider. One is a category in which vasodilation capacity is blunted due to vascular deficits. This includes persons with diabetes, the aged and those with systemic hypotension. The other category includes persons who have had an abnormal increase in resting BF due to prior bed lying, skin heating or other skin conditions such as localized irritation. These persons may have a vasodilatory BF capacity that is adequate to meet their normal resting repayment needs following intervals of SBF deprivation, but it may not be adequate to meet the imposed increased BF demands. Based on these considerations, it seems to be prudent to consider the role of resting SBF as an added risk component and to consider factoring this concept in to patient care strategies. More investigative work is needed to provide direct evidence.