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THE LOCAL SKIN BLOOD FLOW IN AREAS AT RISK FOR PRESSURE SORES TREATED WITH MASSAGE

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ABSTRACT. In order to evaluate methods to prevent pressure sores the effect of massage on the local skin blood flow was studied in normal skin and in skin with discolouration (red or reddish blue). In this study massage is defined as small circular movements with the fingertips using liniment. The cutaneous blood flow was measured with a laser Doppler flowmeter. To study the long term effect of massage on normal skin ten patients were measured over a twenty day period with five days before and after a ten day period with massage. Twenty-nine patients with cerebral haemorrhage were measured for two days each to examine the effect immediately after the massage on normal skin. Fifteen patients with discolouration were measured for one day each both on normal skin and injured skin. The difference in blood flow before and after the ten day period of massage was inconsistent and insignificant. The effect of massage which appeared one to two minutes after the stimulus was implemented varies between individuals and within individuals; significantly more women than men increased their skin blood flow bilaterally after massage. In the centre of the injured skin the basal blood flow was higher than in normal skin and it decreased after the massage was implemented. The results stress the importance of continued research to provide an opportunity for individualization in the selection of methods to prevent and treat pressure sores.

Key words: Massage, skin blood flow, pressure sore, laser Doppler flowmeter, nursing care

The purpose of massage is to prevent and treat pressure sores. The massage method is deeply rooted in practice and 45 of 66 wards used the liniment massage method in 1980 (2). Massage is supposed to stimulate local skin blood flow and is used in areas at risk for pressure sores (1, 7).

Ryan (8) describes the aged skin as atrophic due to less vascularization in the papillae and a decreased total vascularization in the dermis. The results of the previous study on skin blood flow indicated an impaired ability of older in-patients to increase skin blood flow in response to thermal stimulus. The ability to increase blood flow in response to thermal stimulus seems to weaken with age and inactivity (3). The aged skin can grow new capillaries when it is stimulated, for example after an injury during the process of healing (8). Does massage give a temporary effect with increased skin blood flow? Does massage stimulate enough to give a long-term effect with an increased capability of responding to thermal stimuli? Does the skin with symptoms of ischaemic injury react in the same way after massage as normal skin?

The purpose of this investigation was to study the effect of massage on the local skin blood flow in normal skin and in skin with discolouration in areas at risk for pressure sores.

MATERIALS AND METHODS

In this study massage of the skin means small circular movements with the fingertips from the periphery to the centre for 3 min with liniment in an area of 10 cm^2. In this study skin discolouration means red or reddish blue coloured skin after prolonged pressure causing ischaemia remaining 30 min after relief of pressure.

Group A

Ten patients, 7 women and 3 men older than 60 years of age, with normal skin over the lateral part of the left hip (treatment area) and over the ventral part of the left thigh (control area) were measured for 20 days each. The 20 day period was divided into 5 days before and 5 days after a 10 day period of massage implemented twice a day, in the morning and in the evening. The measurement before and after were done at ambient temperature (20–24°C) and at increased temperature (40°C) on treatment area and control area. For the 10 day period of massage on treatment area the measurements were made before and after the massage was implemented in the morning. The patients suffered from cerebral haemorrhage, senile dementia, rheumatoid arthritis, arteriosclerosis, diabetes mellitus and Parkinson's disease.

Group B

Twenty-nine patients, 15 women and 14 men, with cerebral haemorrhage and with normal skin over the lateral part of the hip on both sides had blood flow measurements on two successive days. Blood flow was measured bilaterally first in the basal and then after a thermal stimulus. After a 30 min pause the "basal" measurement was repeated. Following this massage was carried out and the

Table I. *The distribution of age, body temperature, skin temperature, ambient temperature and blood pressure*

Mean ± SD. A=the group of ten patients measured for 20 days each. B=the group of 29 patients measured for two days each. C=the group of 15 patients with skin discolouration measured for one day each

		Temperature			Blood pressure	
Group	Age	Body	Skin	Ambient	Systolic	Diastolic
A (n=10)	84.7±5.5	36.6±0.2		23.0±0.6	140±25	70±10
Treatment area			31.5±0.6			
Control area			32.0±0.6			
B (n=29)	76.1±8.5	36.9±0.3		22.9±0.9	140±20	65±10
			left right			
Before thermal stimulus			31.2±1.0 31.9±1.2			
Before massage			31.9±0.9 32.2±1.0			
C (n=15)	77.1±10.2	36.7±0.6		22.6±1.2	130±20	60±10
Normal skin			31.7±1.3			
Skin with discolouration			32.3±1.5			

blood flow measurements began immediately after the completion of massage and continued for 5 min. Seventeen patients had hemiplegia on the left and 12 on the right. Nineteen patients had total hemiplegia and 10 had partial. Eleven of the patients had had their hemiplegia less than one year. Twenty patients were measured in the morning and 9 one hour after lunch with at least 30 min bedrest before any measurements were made.

Group C

Fifteen patients, 7 women and 8 men, with skin discolouration were measured once before and after the massage was implemented. The measurements were made at the centre of the area of the injured skin 30 min after relief from pressure and on normal skin about 10 cm from the edge of the discolouration. The discolourations were situated on the lateral part of the hip, ischial tuberosity, sacrum, or on the calcaneal tuberosity. The patients suffered from cerebral haemorrhage, senile dementia, arteriosclerosis, diabetes mellitus, rheumatoid arthritis, Parkinson's disease, fracture or tetraplegia.

The skin blood flow was measured with the laser Doppler flowmeter equipped with a thermostatic probe holder (Ø 3 cm) to permit measurement during thermal stimulus (26 to 40°C). In group A a prototype Mk V IMT 058 Serial: 07 with full scale 5 V was used. In groups B and C a Periflux 1d with full scale 10 V was used (Perimed, Stockholm, Sweden). Laser Doppler flowmetry is a noninvasive technique that measures the velocity of moving red cells to a depth of approximately 1 mm. This technique gives a measure in millivolts which is linearly related to blood flow (10). The skin temperature and the ambient temperature were measured with a thermistor temperature probe (Yellow Springs Instrument Co., Yellow Springs, Ohio). Additional measurements were body temperature and blood pressure. In group A, blood pressure and body temperature were measured in the 5 day periods before and after the massage period. The massage was given within each group by one and the same individual who was trained in the massage technique.

The characteristic of the patients in groups A, B and C are shown in Table I.

The effect of the stimuli on the skin blood flow was calculated from the maximum blood flow. Statistical methods used in this study are arithmetic mean, standard deviation, regression analysis, Student's t-test, Wilcoxon test and chi-square test. When more than one measurement has been made per variable the mean obtained from the measures is the basis for the calculations.

RESULT

Regression analysis indicates a significant positive correlation between skin temperature and basal skin blood flow in the treatment area ($p<0.01$), a negative correlation between mean arterial pressure and basal blood flow in the treatment area ($p<0.05$) and the control area ($p<0.01$) in group A (Table I). A significant positive correlation between the variables body temperature ($p<0.05$), mean arterial pressure (<0.01) and the changes in skin blood flow in response to thermal stimulus and between skin temperature before the massage and the changes in skin blood flow in response to the massage ($p<0.05$) were found in group A (Table I). A significant negative correlation was found between mean arterial pressure and the changes in skin blood flow in response to massage in subgroup 3 in group B on the left side of the body ($p<0.05$) (Table I, Fig. 4).

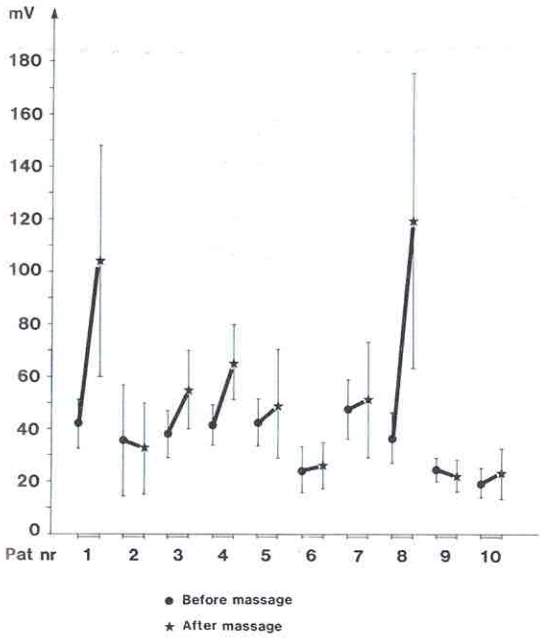

Fig. 1. The recorded blood flow values in millivolts in normal skin over the lateral part of the hip before and after the massage measured with a laser Doppler flowmeter in group A ($M \pm SD$). The values are calculated from ten measurements each except patient number 6 which are based on 9.

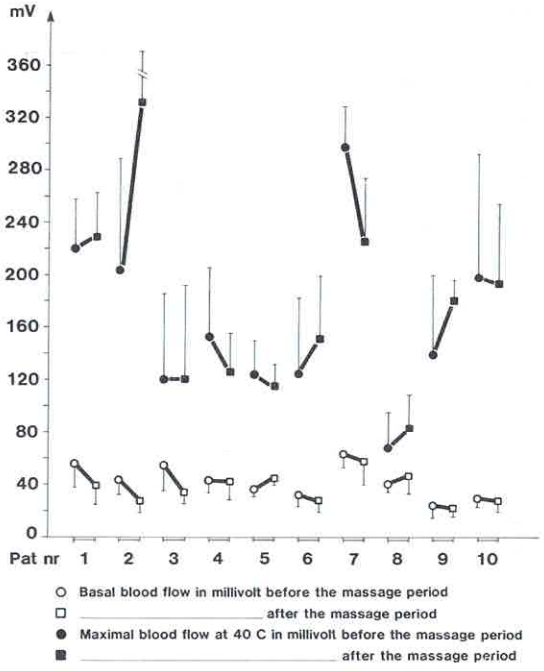

Fig. 2. The recorded blood flow values in millivolts in normal skin over the lateral part of the hip (treatment area). Basal and maximum blood flow at 40°C five days before and after a ten day period of massage in group A ($M \pm SD$).

Group A

For four of the patients there was an increase in the skin blood flow recorded 1.3±0.4 min after the massage was implemented; the mean of the differences was 46.2±31.4 mV (Fig. 1). The six patients had either unchanged blood flow or slightly increased or decreased changes recorded after 0.9±0.4 min. These six patients suffered from cerebral haemorrhage and senile dementia. The patients with senile dementia were on no medications while the other patients were. One women with senile dementia had no recorded increase in her skin blood flow nine days of ten with massage but day number two in the massage period an increase in the skin blood flow of 860% was recorded.

To investigate the long-term effect of the massage, the measurements at ambient temperature and with thermal stimulus five days before and five days after a ten day period of massage were compared both on the treatment area and on the control area. The results indicated no changes in the skin blood flow at ambient temperature and no changes in the ability to increase the skin blood flow at 40°C after a ten day period of massage two times a day (Fig. 2). The maximum effect in skin blood flow appeared after 3.5±0.3 min. Within the ten day period of massage no increased effect from the massage could be observed at the end of the period.

The skin blood flow at ambient temperature recorded on the ventral part of the thigh was greater than that recorded on the lateral part of the hip in all the patients (Fig. 3). The mean differences 15±5 are statistically significant ($p<0.01$). The differences in skin temperature are not statistically significant.

Group B

In group B the measurements were made on twenty patients in the morning and on nine patients after lunch. The differences in the skin blood flow between the two groups are not statistically significant. In the further analysis, they are therefore combined.

The recorded skin blood flow at ambient temperature varied between the left and the right side and between the two measurements before the ther-

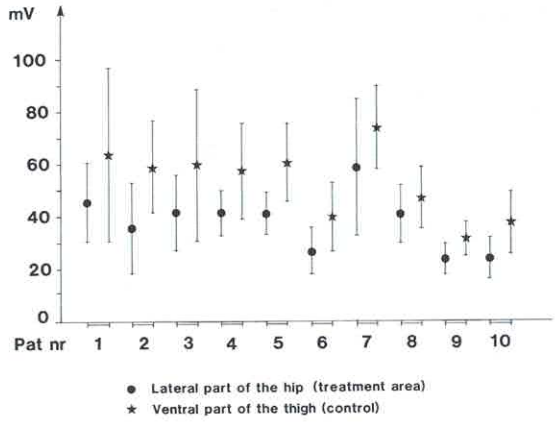

Fig. 3. The recorded blood flow values in millivolts at ambient temperature in normal skin over the lateral part of the hip and over the ventral part of the thigh measured with a laser Doppler flowmeter in group A ($M \pm SD$).

mal stimulus and the massage. The differences are however not statistically significant (Fig. 4). The differences between the basal skin blood flow and maximum blood flow at 40°C and after the massage in the whole group ($n=29$) are statistically significant ($p<0.01$). The effect of massage appeared after 1.8±0.8 min and remained in 14 cases in 3.9±1.1 min and in 14 cases more than 5 min on the left side. On the right the effect appeared after 1.6±0.7 min and remained in 18 cases in 3.9±1.1 min and in 10 cases more than 5 min. The maximum effect of thermal stimulus appeared in both sides after 3.4±0.6 min.

Further analysis indicated that the whole group of the patients could be divided into three subgroups on the basis of their reaction of the skin blood flow after the massage: patients with recorded increase in the blood flow bilaterally more than 100% ($p<0.01$), patients with recorded increase in the blood flow unilaterally more than 100% ($p<0.01$) and patients with no recorded increase in the blood flow bilaterally after massage (Fig. 4).

The first subgroup consisted of eleven women and three men and as many patients with the hemiplegia on the left as on the right. The second subgroup consisted of two women and five men of whom six had their hemiplegia on the left. These patients had less of an increase in blood flow after massage on the right ($p<0.05$). This difference between the left and the right could not be seen in response to thermal stimuli. The third subgroup consisted of two women and six men and as many patients with the hemiplegia on the left as on the right. The recorded increases in skin blood flow in response to thermal stimulus were statistically significant ($p<0.01$) in this subgroup as in the others.

Significantly more women than men had a re-

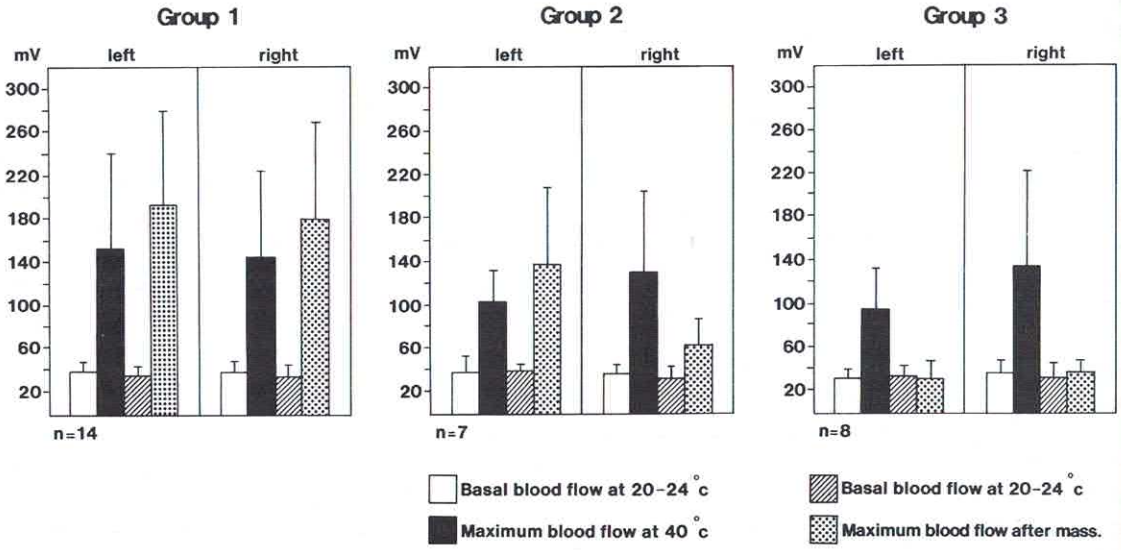

Fig. 4. The recorded blood flow values in millivolts measured with a laser Doppler flowmeter in normal skin over the lateral part of the left and right hip. Basal blood flow before thermal stimulus and massage. Maximum blood flow at 40°C and after massage for 3 min with liniment. $M \pm SD$ for group B divided into subgroups 1, 2 and 3 on the basis of their recorded reaction to massage.

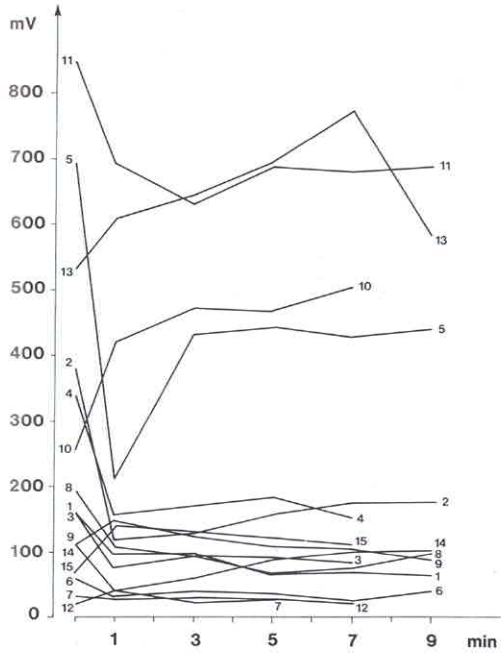

Fig. 5. The recorded blood flow values in millivolts at ambient temperature and at 1, 3, 5, 7 and 9 min after the massage was implemented in skin with discolouration (red or reddish blue). The numbers represent individual patients in group C.

corded increase in the skin blood flow after the massage ($p<0.05$). The differences in age and period of disease between the groups are not statistically significant.

In the whole group ($n=29$) there were 19 patients with total and 10 with partial hemiplegia. Comparison between those two groups indicates that the group with partial hemiplegia had a significantly greater increase in the skin blood flow after the massage on the paretic side of the body ($p<0.05$) but not on the non-paretic side. The differences in response to thermal stimulus are not statistically significant.

The most common medications in the whole group were diuretics, hypnotics, analgetics, digitalis and laxatives.

Group C

The injuries on the patients with skin discolouration were very heterogeneous. The period between the injury and the measurement, the size, the site and the ischaemic period are variables difficult to standardize. The patients were those who had a skin discolouration at the time of measurement.

Recorded mean skin blood flow in the normal skin at ambient temperature before the massage was implemented was 43.5±21.3 mV. One minunte after the massage was implemented 10 of 15 patients had a skin blood flow that was lower than before. The skin blood flow at ambient temperature recorded on injured skin varied from 20 mV to 860 mV (Fig. 5). Eleven of the patients had a higher skin blood flow in the injured skin before the massage was implemented compared with their normal skin. After the massage 10 of 15 patients showed a decrease in the skin blood flow and 7 of those patients did not increase the blood flow to the same level as before within 9 min (Fig. 5). Three of the five patients who showed an increase in the skin blood flow after the massage had had a sore at the site of the discolouration. All the patients decreased their skin temperature significantly after the massage ($p<0.01$). Application of liniment without any massage gave significantly decreased skin temperature after 3 min ($p<0.01$).

DISCUSSION

In the present investigation the effect of massage on the local skin blood flow was studied. Some patients increased their skin blood flow significantly after the massage was implemented, while other did not. The long-term effect as measured by the response to thermal stimulus could not be demonstrated in this study, depending either upon no effect from the massage or too short a period of massage to give a long-term effect. The patients with discolouration (red or reddish-blue) reacted principally with a reduced skin blood flow after the massage was implemented, either in the normal skin or in the injured skin, seven patients in both sites. Hovind et al. (4) found that kneading (foulage) gave no net increase in skeletal muscle blood flow in healthy young individuals, but emptied the venous reserves during the treatment and Paaske et al. (6) found no significant increase in cutaneous blood flow after ultrasonation was administered.

The massage method used was based on the result of a pilot study and on theoretical descriptions (1.7). The massage was given by one individual who was trained in the massage method. The technique was tested during the studies on the same patient as in the pilot study. The method used in the study to measure the skin blood flow was the laser Doppler flowmetry. The laser light which penetrates the

skin 1 mm is reflected by the cells in the skin and is linearly related to the blood flow (10). The method does not give a measure in ml/min/tissue weight but rather in millivolts. The technique permits non-invasive continuous measurement during stimulus or can easily be applied to the tissue immediately after the stimulus has been implemented. The method can be used repeatedly without any trauma on the same region and is therefore useful in studies such as this.

Massage is supposed to stimulate the local skin blood flow to avoid and reduce ischaemic injury (1, 7). In some patients the local skin blood flow increased, but in other patients it did not. Huber (5) describes different massage methods for different purposes. The massage given to stimulate the skin blood flow is supposed to release histamine in the tissue which in turn causes vasodilatation. Release of histamine gives itching, redness and edema (5). In some cases diffuse redness could be observed, but in most cases it was not. Sejrsen et al. (9) suggest in a model factors which can either give vasodilatation or vasoconstriction in the skin vessels. Factors which give vasodilatation are, for example histamine, bradykinin and prostaglandins. Locally decreased skin temperature and myogenic stretching are factors which cause vasoconstriction. All patients reacted with a decreased skin temperature due to the liniment, even though some of the patients increased their skin blood flow recorded after the massage was implemented. If the skin is thin the massage could penetrate and give effect in deeper layers. The method used to measure the blood flow does not give the opportunity to record such deep reaction.

In group B no significant differences could be seen due to the medications, age or period of disease. However, more women than men increased their skin blood flow after massage. Women are supposed to develop pressure sores more frequently than men (2). What factor or factors cause the vasodilatation after massage?

This investigation shows that the effect of massage on the local skin blood flow varies between individuals, within individuals and between normal skin and injured skin. The mechanism behind the effect of massage is an important field for research to provide an opportunity to individualize the prevention and treatment of pressure sores.

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