

Evaluation of the Effectiveness of Two Support Surfaces Following Myocutaneous Flap Surgery

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Abstract:

Recurrence of pressure ulcers is a serious problem following myocutaneous flap surgery and can lead to prolonged and expensive hospitalization. One of the most important aspects of patient care after surgery is the monitoring of reduced pressure in the area of the flap. Usually reducing pressure requires an expensive high-tech support surface. The purpose of this study was to evaluate the effectiveness of a less expensive support surface. There were 12 patients involved in a clinical trial that lasted 14 days and compared the effectiveness of the ROHO dry-floatation mattress to that of the Clinitron bed. Findings indicated that post-operative patients were effectively treated on either support surface.

The cost of treating and healing pressure ulcers, with emphasis on cost-effectiveness while not compromising quality patient care, is an ongoing concern in today's healthcare environment. The cost of treating and healing pressure ulcers has been reported to range from \$4,000 to \$40,000 per patient (Hibbs, 1988; Frantz, 1989). This cost is considerably increased among spinal-cord-injured patients who frequently require myocutaneous flap surgery to close Stage IV ulcers. For these patients, the increased costs are primarily related to the operative procedures and the high-tech support surfaces upon which they are placed post surgery. Reducing the cost of treatment for these patients involves an investigation and use of alternative treatment methods and support surfaces.

The standard treatments of pressure ulcers include wound cleansing, debriding, covering with appropriate dressings, and providing pressure reduc-

tion. Although these treatments effect healing for many pressure ulcers, often for Stage IV ulcers in paraplegia or quadriplegia, the definitive treatment is flap surgery (Ger & Levine, 1979; Colen, 1990; Daniel, Terzis, & Cunningham, 1987). Such flaps have the advantage of a predictable blood supply, an adequate padding over the pressure point, a limited loss of blood, and a better cosmetic effect without major functional disability (Stevenson, 1983). As a result, the use of myocutaneous flap surgery has been widely accepted for the treatment of Stage IV pressure ulcers (Anthony, Huntsman, & Mathes, 1992).

Such procedures, however, may fail if patients are not placed on proper support surfaces in the immediate post-

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operative period. Complications such as recurrent flap breakdowns in 69% of patients, sepsis, and high mortality have been reported in the literature (Disa, Carlton, & Goldberg, 1992). The use of high-tech beds has been a great adjunct to surgery and has served as a protection from such complications (Dolezal, Mimis, & Schultz, 1985). However, the question arises about the possibility of decreasing costs by using less expensive support surfaces after surgery. The purpose of this study was to evaluate the cost effectiveness of using the ROHO dry floatation mattress (hereafter referred to as dry-floatation mattress) as compared to the high-tech, air-fluidized Clinitron bed (hereafter referred to as high-tech bed) while not compromising the quality of patient care.

The dry-floatation mattress is a bed-overlay support system (ROHO, Inc., Belleville, Ill.) consisting of 720 individual air cells that conform to the body to provide a maximum support area that evenly and comfortably distributes the patient's weight. The air cells create a floatation environment, lowering the peak

interface pressures applied to the skin. This also minimizes tissue deformation and reduces interstitial edema.

The high-tech bed is an air-fluidized bed (Hill-Rom—formerly Support Systems International—Charleston, S.C.) that contains millions of ceramic microspheres within a 12-inch layer and is covered with a monofilament polyester sheet. Warm pressurized air causes the microspheres to be lifted to the undersurface of the filter sheet, creating a dry-fluid environment on which the patient floats. Even distribution of body weight and low interface pressures are achieved with this method of floatation.

Methodology

This was a prospective, randomized, controlled clinical trial using 12 patients who had Stage IV ulcers and were scheduled for myocutaneous flap surgery between November 1989 and April 1991.

Patients who met the following criteria were involved in the study:

- patients 18 years of age or older
- presence of Stage IV pressure ulcer needing my-

- ocutaneous flap closure
- hospitalization planned for 14 days post surgery
- life expectancy greater than or equal to 30 days
- signed informed consent and surgeon approval of patient participation.

The patients were assigned to a support surface by using a table of random numbers. The names of the two support surfaces were placed in envelopes that were sealed and numbered sequentially. After the eligibility of each patient was established, an investigator opened the envelope and assigned the patient to the support surface indicated on the enclosed card. There were 6 patients assigned to the dry-floatation mattress treatment and 6 patients assigned to the high-tech, air-fluidized bed therapy. In order to establish comparability of the two groups, extensive baseline data were collected. These included patient demographic characteristics, underlying medical conditions, level of consciousness, level of activity and mobility, urinary and fecal continence status, nutritional assessment, and pressure ulcer characteristics. Other data obtained were the patient's history and physical examination, EKG, chest x-ray, routine hematology, biochemistry, urinalysis, nitrogen balance, laser-Doppler blood flow measurements, interstitial fluid of ulcer for biochemical analysis, and culture sensitivities.

Comparisons of blood flow and interface pressures were used to ascertain safety and quality of support surfaces. Laser-Doppler blood flow measurements were used to assess circulation and how it was affected by pressure or vasoconstriction (Fagrell, 1989). Normal laser-Doppler

Table 1

DEMOGRAPHICS OF PATIENTS WITH MYOCUTANEOUS FLAP SURGERY

Parameters/ Characteristics	Treatment Groups													
	df* (N=6)						Mean (SD)	ht** (N=6)						Mean (SD)
Age	25	25	77	18	48	29	37 (20.1)	45	58	33	39	56	33	44 (10.1)
Gender	M	M	F	M	M	M		M	M	M	M	M	M	
Race	B	W	W	B	W	W		B	W	B	W	B	B	
Weight (lbs)	127	173	120	155	131	200	151 (28.4)	130	220	113	145	158	130	149.3 (34.5)
Height (in)	62	75	66	72	68	75	69.7 (4.78)	68.5	75	64	66	69	68	68.4 (3.39)

*dry-floatation **high-tech

Table 2

SELECTED PRE- AND POST-OPERATIVE VARIABLES FOR MYOCUTANEOUS FLAP SURGERY PATIENTS

Parameters	Results of treatment groups													
	df* group (N=6)						Mean (SD)	ht** groups (N=6)						Mean (SD)
Post-surgery daily calorie count	2379	1475	2330	1518	2514	2570	2131 (455.8)	2192	1550	1978	2346	2599	390	1842 (725.0)
Post-surgery daily protein intake	104	45	97.3	52	103	110	85.21 (26.29)	90	55	98	84	83	15	70.8 (28.2)
Pre-surgery T. protein	7.9	6.2	5.8	6.6	6.8	8.5	6.96 (0.94)	7.1	7.2	8.0	7.1	6.4	7.0	7.13 (0.47)
Post-surgery T. protein	7.2	6.4	4.6	6.1	5.4	6.8	6.08 (0.87)	7.1	6.9	5.8	6.3	6.9	5.3	6.38 (0.65)
Pre-surgery albumin	4.2	3.2	3.0	3.6	3.3	4.0	3.55 (0.43)	3.2	3.9	3.7	3.4	2.9	2.9	3.33 (0.38)
Post-surgery albumin	3.9	3.3	2.4	3.1	2.7	3.3	3.12 (0.48)	3.5	3.9	2.6	3.4	4.3	2.3	3.33 (0.69)
Pre-surgery HCT	40.7	38.9	29.8	31.3	33.7	37.7	35.35 (4.01)	33.3	40.8	24.9	39.1	29.9	38.0	34.33 (5.59)
Post-surgery HCT	36.2	29.9	28.7	32.1	24.7	31.4	30.5 (3.49)	33.0	37.0	30.6	32.5	26.3	29.8	31.53 (3.27)
Pre-surgery HGB	3.9	12.8	10.2	10.1	11.2	12.4	11.76 (1.39)	11.3	13.1	8.0	13.1	10.0	12.8	11.38 (1.88)
Post-surgery HGB	12.6	10.2	9.6	10.6	8.2	10.5	10.28 (1.31)	10.9	11.9	10.4	11.0	8.4	10.2	10.46 (1.07)
Post-surgery average daily measured pressures	13.6	22.9	21.5	28.9	25.0	29.4	23.54 (5.29)	10.9	11.2	19.6	21.9	9.6	21.4	17.43 (4.59)
Post-surgery average daily measured blood flow	2.02	2.02	4.06	0.88	1.35	2.40	2.12 (0.99)	2.58	2.43	0.48	1.49	3.69	1.46	2.02 (1.02)

*dry-floatation **high-tech

flow measurements are reported in the literature as a basis for post-surgical flap viability (Reichert, 1986). Interface pressure measurements were obtained using a Talley-Scimed Pressure Evaluator (TSI Laser Flow Model BPM 403 A). The blood perfusion monitor was used to determine capillary blood flow. During surgery, laser-Doppler measurements of the flap were obtained before the rotation, prior to suturing, and when the flap was set in. Each measurement site was marked in such a way that it was readily recognizable as the location for daily measurements. Photos were taken of the pressure ulcer prior to incision and of

the surgical flap after surgery. The patients were assessed daily by the same person for two weeks following surgery. The daily assessments included:

- vital signs
- healing of surgical site
- caloric count and protein intake
- pain and comfort status
- study compliance and evaluation of adverse experiences
- interface pressures and laser-Doppler flow measurement.

Laboratory assessments (e.g., hematology, biochemistry, urinalysis, nitrogen balance, and interstitial fluid of the ulcer obtained from the

surgical drain) were obtained on post-operative days 3, 7, 11, and 14. To document healing of the surgical wound, photographs of the surgical site were made on days 3, 7, 11, and 14. Photographs were taken at a fixed distance with a camera lens designed for medical photography (Canon AI, 100 mm lens).

Findings

The demographics of the patients are presented in Table 1. Various other parameters and values before and after myocutaneous flap surgery are presented in Tables 2 and 3. The patients all underwent primary excision of the ulcer and had an immediate recon-

struction with myocutaneous or muscle flap surgery. The mean daily interface pressures in the dry-floatation group were 23.54 mmHg/patient; for those in the high-tech bed group mean daily measured pressures were 17.43

mmHg/patient. The laser-Doppler flow of the dry-floatation group was 2.12 ml/sec; the laser flow of the high-tech bed group was 2.02 ml/sec.

One patient in the high-tech group developed arterial thrombosis of the flap and had

to have disarticulation of his hip. This occurrence was unrelated to the support surface. There was one minor wound breakdown at the donor site in the dry-floatation group and two minor wound breakdowns at the donor sites in the high-

Table 3

COMPARISON OF SELECTED VARIABLES FOR TWO GROUPS OF PATIENTS HAVING MYOCUTANEOUS FLAP SURGERY

Parameters	df** (N=6)						ht*** (N=6)					
	Paraplegia	Paraplegia	Parkinson's Multiple Inf. Dementia Sepsis	Paraplegia	Quadriplegia	Paraplegia	Paraplegia	Quadriplegia	Quadriplegia	Paraplegia	Paraplegia	Multiple Sclerosis
Contributing Medical Condition												
Location of Ulcer	Right Ischium	Right Ischium	Sacral	Sacral	Right Ischium	Sacral, Right Ischium	Left Ischium	Sacral	Right Ischium	Left Ischium	Left Ischium	Sacral, Right & Left Ischium
Ulcer Stage	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV
Pre-op Measurements of Ulcer	4cm x 4cm	6cm x 8cm	6cm x 6cm	12cm x 14cm	5cm x 4cm	7cm x 4.5cm	4cm x 6cm	3cm x 4cm	40cm x 50cm	Draining Sinus Tract	6cm x 6cm	12cm x 10cm
Post-op Measurements of Flap	10cm x 15cm	8cm x 27cm	15cm x 15cm	5cm x 18cm	8cm x 8cm	8cm x 8cm	8cm x 15cm	6cm x 6cm	Not Measured	12cm x 10cm	10cm x 15cm	25cm x 15cm
Previous Surgical Treatment	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Development of Atelectasis	No	Yes	Yes	No	No	No	No	Yes	No	No	No	Yes
Wound Breakdown	No	No	No	Yes	No	Yes	Yes	Yes	*	No	No	No
Wound Infection	No	Yes	No	No	Groin Abscess	Yes	No	No	*	No	No	Yes
Diarrhea	No	No	Yes	Yes	Yes	No	No	No	*	Yes	No	No
Urinary Incontinence	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	*	Yes	No	Yes
Urinary Tract Infection	No	No	No	Yes	Yes	No	No	Yes	*	No	No	Yes
Temperature above 102° F	No	Yes	Yes	Yes	Yes	No	No	No	*	No	No	Yes

*Patient developed an arterial clot to the myocutaneous flap and it was necessary to disarticulate his hip.

**dry-floatation

***high-tech

tech bed group. All patients except the one with intravascular complications were discharged on post-operative day 14.

Discussion

Table 1 reflects the similarities of both groups in terms of age, gender, race, weight, and height. The mean age in the high-tech group was higher than in the dry-floatation group, but had no statistical significance.

As depicted in Table 2, all patients were in positive nitrogen balance on entering the study and maintained adequate caloric intake throughout their hospitalization. All patients had adequate hemoglobin prior to surgery with a minimum drop post-operatively. The data reveal that wound healing of the grafts occurred with adequate levels of protein, albumin, hemoglobin, and caloric intake. Values were comparable in both groups. Measured pressures and blood flow were slightly less in the high-tech group, but were not statistically significant. Table 3 summarizes the known adverse effects following surgery and demonstrates that the variables measured post-operatively were comparable for patients on the dry-floatation and high-tech support systems. The two groups were similar in terms of contributing medical conditions, locations, size, stage of ulcers, and size of the myocutaneous flaps used for the closure. In both groups, the reduction of pressure was adequate as evidenced by the minimal interference of blood flow (2.02 - 2.12 ml/sec), which was virtually unchanged as indicated by the similar measurements obtained during the surgical procedure.

The average hospital charge where this study was done was \$165/day for the high-tech support surface and \$49/day for the dry-floatation mattress. This represents savings of \$1,624/patient in this study alone. Based on these costs, there are significant savings related to the use of the dry-floatation support surface.

This research reiterates the long-term question of how to continue to prevent recurrences of pressure ulcers after flap surgery. Based on this short-term trial, it might be assumed that if patients continued to use these support surfaces, prevention of pressure ulcers could be prolonged for indefinite periods. This should be the subject of further research. It seems, at present, that most investigators are finding recurrent pressure ulcers regardless of support surfaces (Disa et al., 1992; Ferrell, Osterweil, & Christenson, 1993). Variables such as the ones measured in this study should be standardized for future studies in order to assess the long-term efficacy of support surfaces. It may be possible to identify combinations of variables that are just as important as support surfaces in preventing recurrence of pressure ulcers. Such research will, of necessity, be long-term because of the paucity of suitable subjects.

Conclusions

This study showed that either dry-floatation or high-tech, air-fluidized support surfaces were adequate to prevent flap breakdown in the immediate post-operative period. Further studies with larger numbers of patients and longer study periods are needed to determine statistical significance. **A**

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