International Orthopaedics (SICOT) (1997) 21: 104–108

International
Orthopaedics

Improved wound healing in transtibial amputees receiving supplementary nutrition

M. Eneroth[1], **J. Apelqvist**[2], **J. Larsson**[1], **B. M. Persson**[3]

[1] Department of Orthopaedic Surgery, University Hospital, Lund, Sweden
[2] Department of Internal Medicine, University Hospital, Lund, Sweden
[3] Department of Orthopaedic Surgery, Helsingborg Hospital, Helsingborg, Sweden

Accepted: 12 July 1996

Summary. *The objective of this prospective study of matched controls was to find out whether supplementary nutrition would improve wound healing and decrease mortality in patients undergoing transtibial amputation for occlusive arterial disease. The nutritional status of 32 consecutive transtibial amputees was assessed and 28 were classified as malnourished. Supplementary nutrition was given reaching an average intake of 2098 kcal/day for a total of 11 days. In 24 patients, at least 5 days of preoperative supplementary nutrition were given, followed by postoperative treatment for a total of 11 days. Four patients who had an immediate operation were given only postoperative treatment, and 4 were excluded. The controls were 32 amputees in another hospital and matching procedures were carried out with corrections for diabetes, sex, age, smoking habits, previous vascular surgery and living conditions before amputation. Healing, including those healed before death in both groups, occurred in 26 of the nutrition group compared to 13 in the control group, which was statistically significant. Nine patients died within 6 months in the nutrition group compared to 14 of the controls (not significant). Malnutrition was present in nearly 90% of transtibial amputees and supplementary nutrition improved healing, but not mortality.*

Résumé. *L'objectif de cette étude prospective a été d'étudier si une augmentation de l'apport nutritionnel peut ameliorer la cicatrisation et réduire la mortalité chez les malades ayant subi une amputation de jambe en raison d'une maladie vasculaire. L'état nutritionnel de trente-deux patients consécutifs ayant subi une amputation de jambe a été évalué. Vingt-huit ont été considérés comme malnutris. Une nutrition additionnelle leur a été donnée avec un apport moyen de 2098 kcal par jour pendant 11 jours. Chez 24 malades une nutrition additionnelle, de cinq jours au moins en préopératoire, a été suivie par un traitement postopératoire pour atteindre un total de 11 jours. Quatre malades necessitant une amputation en urgence n'ont reçu le traitement que postopératoire et quatre malades ont été exclus. Trente deux amputés de jambe venant d'un hopital universitaire voisin ont été utilisés comme contrôle, après associations des cas tenant compte de l'age, le sexe, du diabète, de la consommation de tabac, des opérations vasculaires précédentes et des conditions de vie antérieure à l'amputation. L'étude de la cicatrisation a montré que 26 amputés étaient cicatrisés dans le groupe ayant bénéficié d'un apport nutritionnel contre 13 dans le groupe de controle, P = 0.001. Neuf patients sont morts dans les premier six mois dans le groupe ayant bénéficié d'un apport nutritionnel contre 14 dans le groupe de controle, (n.s.). Cette étude montre clairement que près de 90% des amputés de jambe étaient malnutris et qu'un apport nutritionnel a amelioré la cicatrisation du moignon sans pour autant augmenter la survie.*

Reprint requests to: M. Eneroth, Department of Orthopaedic Surgery, University Hospital, S-221 85 Lund, Sweden

Introduction

Transtibial amputation for vascular disease carries a serious risk of delayed or failed healing, ream-

putation and a high mortality [5, 10]. There is interest in the occurrence and effects of malnutrition in hospital patients [6, 27], and it is common in those with osteoporotic hip fractures [8, 16, 20] and major amputees [9, 17, 22]. Malnourished patients have a greater risk of delayed healing, decubitus, infection, congestive heart failure, progressive weakness, apathy and death [11, 15, 16, 22, 28]. Supplementary nutrition improved the clinical outcome after hip fracture, with significantly fewer complications, deaths and shorter hospital stays [2, 8, 26].

The main objective of the present study was to assess the presence of malnutrition in patients undergoing transtibial amputation for vascular disease and to evaluate whether supplementary nutrition before and after amputation would improve healing and decrease mortality.

Patients and methods

From March 1993 to August 1994, 38 consecutive patients in Helsingborg County Hospital had major amputations for occlusive arterial disease; their nutrition was assessed and they were given supplementary nutrition. The amputation was transtibial in 32.

The control group was selected from 88 consecutive major amputations at the University Hospital in Lund during 1990–1992; 54 had a primary transtibial amputation [19]. Thirty-two controls were chosen after a matching procedure with corrections for diabetes, sex, age (± 5 years), smoking habits, previous vascular surgery and living conditions before amputation. Selection was carried out by a surgeon without knowledge of the results in the nutrition group. There was no difference in the major characteristics between the two groups after correction (Table 1). Both hospitals were the only institutions in their areas which carried out amputations. Stay in hospital was recorded from the first admission for the relevant event until discharge to their preoperative residence or a nursing home.

Table 1. Clinical characteristics in both groups prior to amputation. *n* = patients

Matching factors	Nutrition group (*n* = 32)	Control group (*n* = 32)
Median age (range)	80 (54–88)	81 (47–90)
Male sex	15	13
Diabetes (insulin)	15 (11)	14 (8)
Smoker	4	5
Vascular surgery		
– *angiography, no intervention*	*13*	*13*
– *vascular intervention*	*14*	*14*
– *no angiography*	*5*	*5*
Living conditions		
– *own home*	*22*	*21*
– *old peoples home*	*7*	*7*
– *nursing home*	*3*	*4*

Nutritional assessment

This was carried out on the day of inclusion in the study and was based on 4 categories including 7 parameters. The categories were clinical assessment, anthropometric measurements, serum protein (albumin, peralbumin) and total lymphocyte count. Those who had a combination of 3 or more subnormal nutritional parameters, including at least 3 categories, were classified as malnourished. The weight loss during the preceding 3 months [23] and the nutritional intake in the preceding 2 weeks [30] were used for clinical assessment. To evaluate weight loss, we compared measurements from medical records and the patients' weight at inclusion. In 6 patients, their recollection of their normal weight was used.

Arm muscle circumference (AMC) and triceps skin fold thickness (TSF) were used as anthropometric measurements [1]. TSF, measured with Harpenden callipers, is a measure of subcutaneous fat stores, and AMC of the skeletal muscle mass calculated from midarm circumference measured with a tape and TSF. The mean of 3 measurements made either by one of us (ME) or a research dietitian were recorded. Reference data for the anthropometric variables were matched for age and sex [25]. The level for abnormal values for TSF and AMC was defined as below the 10th percentile [4].

Laboratory measurements were made one week before amputation, on the day of operation, one week and one month postoperatively. Serum protein depletion and a total lymphocyte count below 1500 cells/cmm were used as markers of malnutrition [3]. Neither nutritional assessment nor supplementary nutrition were systematically carried out in the control group.

Food intake and supplements

Food was provided by the hospital kitchen, and the daily food and beverage intake were recorded on charts by the nursing staff. All meals had a known energy content (kcal). The approximate energy intake was calculated in the evening of each day. Supplementary nutrition was given to reach a minimum daily intake of 2000 kcal for 11 days.

The aim was to achieve at least 5 days of preoperative treatment. We used Fortimel® (Nutricia AB, Netherlands), a nutritional supplement with 1 kcal/ml orally, Nutrodrip Intensiv® (Sandoz AB, Switzerland) for enteral nutrition via a nasogastric tube), and Vitrimix® (Kabi Pharmacia AB, Sweden) for parenteral intravenous infusion according to a structured protocol. Nutrodrip Intensiv® is an enteral nutriment based on a mixture of meat, milk, vegetables and fruit, and consists of recommended amounts of protein, fat, carbohydrates, vitamins, minerals and trace elements. Vitrimix® consists of aminoacids, fat, carbohydrates and electrolytes which can be given into peripheral veins. Trace elements (Tracel®, Kabi Pharmacia AB), water and fat soluble vitamins (Soluvit Novum® and Vitalipid Novum®, Kabi Pharmacia AB) were added to the Vitrimix infusion according to the structured protocol and the manufacturer's instructions.

Definitions

Malnutrition: protein and energy malnutrition. Healing: complete healing with intact skin. Gangrene: a continuous necrosis of skin and underlying structures. Major amputation: amputation through or proximal to the ankle. Diabetes: previously known diabetes [29].

Table 2. Nutritional parameters, criteria for abnormal values and signs of malnutrition at inclusion. Values are given as means (±SD)

Nutritional parameters	Male (n = 15)	Female (n = 17)	Criteria for abnormal values[a]	Signs of malnutrition (%)
Weight loss (%)	11 ±6	9 ±5	>5% previous 3 months	27 (84%)
Low food intake (yes/no)	12/3	15/2	previous 2 weeks	27 (84%)
TSF (mm)	9.9 ±4.1	11.1 ±4.6	<10th percentile[b]	8 (37%)
AMC (cm)	24.7 ±4.2	23.5 ±4.2	<10th percentile[b]	3 (10%)
Serum albumin (g/l)	24 ±4	26 ±5	<36	31 (97%)
Serum prealbumin (g/l)	0.12±0.08	0.14±0.05	<0.18	29 (91%)
TLC ($\times 10^9$/l)	1.2 ±0.5	1.3 ±0.7	<1.5	26 (81%)

[a] (Blackburn 1977, Pettigrew 1988, Campbell 1990, Peck 1990, Windsor 1991, Cederholm 1994)
[b] Compared to sex and age related reference values (Symreng 1983)

Per- and postoperative management

Indications for amputation were progressive gangrene or intractable pain not responding to conservative treatment or vascular surgery. The level of primary amputation was chosen by the attending orthopaedic surgeon and made on the basis of clinical symptoms and signs. In one patient, the initial choice of level was changed from transfemoral to transtibial during 6 days of preoperative supplementary nutrition. In the others, no changes were made after the original decision.

The sagittal flap technique, circular plaster on web-roll and intravenous antibiotics were standard methods in both groups. Two patients in the nutrition group did not have prophylactic antibiotics. One patient in the nutrition group had an amputation with a long posterior flap because of an infected wound after a vascular operation on the medial side of the lower leg; this was the only patient in whom a part of the wound was left open. No surgeon carried out the majority of operations in either group.

Postoperative management was similar in the two groups with plaster for 2 or 3 weeks, removal of sutures after 3 weeks and weightbearing when the wound was healed.

Statistical methods

Values are given as mean (SD) or, if appropriate, as median and range. Differences between groups were calculated by the Mann-Whitney's U-test and the chi-square test when applicable.

Results

Nutritional status and supplementary nutrition

The nutritional parameters at inclusion are shown in Table 2. Twenty-eight patients were malnourished. All 32 in the nutrition group were intended to have the supplements but one patient refused to participate and 3 patients had a mental disturbance that made participation impossible. In 28 transtibial amputees a median of 2056 (1873–2595) kcal/day was given for 11 days (6–12). In 24, supplementary nutrition was given for 5 to 7 days preoperatively, and then postoperatively for 11 a total of days. In the 4 who had immediate amputation, nutrition was given for 11 days after operation.

Table 3. Descriptive statistics of intake of nutriments in kcal/day

Nutrition	Mean (kcal)	SD (kcal)	% of total
Food+beverage	1142	563	55
Fortimel®	151	132	7
Nutrodrip Intensiv®	403	562	19
Vitrimix®	401	456	19
Kcal total	2098	176	100
Kcal/kg bodyweight	34	9	

Table 4. Clinical outcome at six months postoperatively

Outcome	Nutrition group (n = 32)	Control group (n = 32)
Healed	21	10
Unhealed	1	2
Reamputated	1	6
Deceased	9	14
– *healed*	*5*	*3*
– *unhealed*	*4*	*9*
– *reamputated*	*0*	*2*

Most patients had a combination of different nutriments each day. Food and beverage accounted for half the energy intake, and Nutrodrip Intensiv® and Vitrimix® accounted for one-fifth each (Table 3); the former was used preferably before and the latter after amputation.

Adverse reactions

One patient receiving Vitrimix® 1000 ml/day developed pulmonary oedema on the 11th day. One having Nutrodrip Intensiv® stopped for 3 days because of haematemesis. Of the 15 having Nutrodrip Intensiv®, 5 had adverse reactions, probably caused by the enteral nutriment: all 5 had nausea for 1–3 days; 3 vomited for 1–3 days, and 2 had diarrhoea for 2 days. An unstable blood glucose level was common in diabetics on starting

nutrition; insulin was increased and in 3 had to be given intravenously to maintain control.

Follow-up

Twenty-six patients in the nutrition group had healed stumps at 6 months, compared to 13 in the controls ($P = 0.001$) (Table 4). If the 4 amputees who did not have supplementary nutrition are excluded, 24 out of 28 healed ($P = 0.0004$). When those who died are excluded, 2/23 of the nutrition group were not healed, compared to 8/18 in the controls ($P = 0.01$). Four out of 5 classified as not healed died within 2 weeks of amputation. The only patient alive in the nutrition group who were not healed after 6 months did not have supplementary nutrition and subsequently he required a revision of the stump. The only reamputation in the nutrition group was carried out 10 days after the primary amputation; a very short stump was left because of extensive gangrene and she had diarrhoea while in hospital; gluten intolerance was diagnosed 8 months later.

There was no significant difference in mortality in the 9 patients who died within 6 months in the nutrition group compared to 14 in the controls. The median total stay in hospital was 36 (12–256) days in the nutrition group compared to 30 (4–269) days in the controls ($P = 0.08$).

Discussion

This is the first study to evaluate the benefits to major amputees of supplementary nutrition. We had technical and ethical difficulties with performing a randomised trial. Some patients had an immediate amputation and so could not be randomised for preoperative nutrition; others were confused due to pain, analgesia or medical conditions which made it difficult to obtain information from them or their consent to participate. We therefore decided to do a comparative study using a matched control group. No major differences were found between the two groups except for the percentage of primary transtibial amputations.

We found that the rate of wound healing 6 months after transtibial amputation was better among those receiving supplementary nutrition than in the controls. In the nutrition group, there were 88% primary transtibial amputees with a median age of 80 years, and only one out of 32 had to be reamputated within 6 months. No study has been published with equally good results.

The clinical outcome in the control group did not differ from our 136 consecutive transtibial amputees from 1987 [12], or from the largest prospective study of this amputation for vascular disease in which 713 patients from 51 hospitals in 6 European countries were included [10]. Dormandy et al. described 19% reamputations at a higher level within 3 months, 11% not healed and 11% dead (patients with a myocardial infarction or cerebrovascular accident during the previous 3 months were excluded) [10].

Although a definitive test for nutritional status is not available and many methods of assessment have disadvantages [7, 13, 14, 24], malnourished individuals can be identified by using a combination of different tests [6, 18, 25], including recent loss of weight and nutritional intake. Major amputees are at special risk to become malnourished because of a decreased intake of food due to pain, nausea and confusion, increased loss of nutrients from the wounds, diarrhoea and vomiting and the increased requirements because of major surgery or infection. Normal values of serum albumin and of the total lymphocyte count indicate a well nourished patient and predict a successful outcome after Syme's amputation [9], and in a study of 41 major lower limb amputations patients with a normal serum albumin and lymphocyte count had a decreased risk of healing complications [17]. The only previous study with an extensive nutritional assessment among amputees found that 72% of patients were malnourished [22], similar to our study. Pedersen reported that malnourished amputees had a higher frequency of impaired healing and an increased risk of postoperative cardiopulmonary or septic complications [22].

There are no guidelines describing when, or for how long, malnourished patients need supplementary nutrition, so we used 5 to 7 days preoperatively and a total of 11 days for all patients. We also decided for practical reasons to give the same energy-protein intake to all patients regardless of their body weight. Although gastro-intestinal symptoms are common in major amputees, 28 out of 32 had their major intake by mouth so that parenteral nutrition by central venous catheters was not needed. Oral intake should be supplemented by nutrition given through peripheral veins.

Although a minimum of 5 days preoperative supplementary nutrition was given to 24 out of 32 patients in the nutrition group, the median stay in hospital was not different compared to the controls.

This study demonstrates that nearly 90% of transtibial amputees were malnourished and that pre- and postoperative supplementary nutrition improved wound healing without increasing the stay in hospital.

Acknowledgements. This study was supported by grants from Stifelsen för bistånd åt vanföra i Skåne, Thelma Zoégas för medicinsk forskning and The Swedish Diabetic Association.

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