Nutrition as a prognostic indicator in amputations

A prospective study of 47 cases

Niels Wisbech Pedersen and Dina Pedersen

The nutritional status was evaluated prospectively in 47 consecutive patients who were amputated for lower extremity ischemia. It was good in 13 patients, reduced in 18, and poor in 16. Malnourished patients had a higher frequency of impaired wound healing, and an increased risk of postoperative cardiopulmonary and septic complications; all 6 deaths occurred in these groups.

Department of Orthopedics, Odense University Hospital, DK-5000 Odense C, Denmark
Correspondence: Niels Wisbech Pedersen, Registrar, Princess Margaret Rose Orthopaedic Hospital, Fairmilehead,Edinburgh EH10 7ED, Scotland. Tel +44–31 445 4123
Submitted 91-10-05. Accepted 92-04-20

Patients with poor nutritional status appear to have an increased postoperative mortality, morbidity and rehabilitation time due to increased risk of infection, impaired wound-healing and muscle function following surgery (Law et al. 1974, Buzby et al. 1980, Chandra 1980, Bastow et al. 1983a, Russell et al. 1983, Haydock and Hill 1986, Katelaris at al. 1986). Malnutrition has been shown to be of major importance in failure of wound healing after Symes amputation in diabetic patients (Dickhaut et al. 1984) and in lower extremity amputations proximal to the ankle (Kay et al. 1987).

We have evaluated the nutritional status among patients prior to lower extremity amputation and its importance regarding wound healing, mortality, morbidity and the duration of the hospital stay.

Patients and methods

Patients who underwent a lower extremity amputation proximal to the ankle from April 1987 to May 1988 were included prospectively. Preoperative evaluation of nutritional status was performed using a nutritional index which divides the patients into normal, reduced or poor nutritional status based on the following parameters: weight loss, skinfold thickness over the triceps, circumference of upper arm muscles, serum albumin, and serum prealbumin (Jensen et al. 1983). Concomitant medical diseases recorded were diabetes mellitus, ischemic heart disease, cardiac, pulmonary, or renal insufficiency, hepatic disease, and malignant disease.

The selection of amputation level was based on a clinical examination supplemented by measurement of skin blood flow by the Xenon washout technique (Sejrsen 1971). All below-knee amputations were sagittal (Persson 1974), whereas the through-knee amputations, as described by Kjølbye (1970), and all the above-knee amputations, were performed with myoplastic technique. Methicillin and streptomycin were given for three days. Two suction drains were used, and the sutures were removed on day 14.

Primary healing was defined as complete healing on day 21, secondary healing as spontaneous healing after day 21 or healing at the same level after further surgery. Reamputation was defined as further surgery at a higher level.

Duration of the operation, peroperative blood loss, and per- and postoperative blood transfusions were recorded. Postoperative complications, including death, sepsis, pneumonia, myocardial infarction, pulmonary edema, pulmonary thromboembolism, cystitis and decubiti, were recorded. The duration of the hospital stay for patients discharged to their own home was also recorded.

During the period of observation 52 patients had a major lower extremity amputation performed because of ischemia. 3 patients were operated on acutely, and a nutritional index could therefore not be determined. Another 2 patients were excluded because of deficient blood samples.

The remaining 47 patients had a female/male ratio of 24/23, and a mean age of 68 (38–86) years; 34 had one or more concomitant medical diseases (diabetes mellitus 16, heart disease 15, renal insufficiency 6, hepatic disease 3, cancer 3, and pulmonary insufficiency 1).

21 patients had a below-knee amputation, 16 had a through-knee, 9 an above-knee amputation and 1 had a hip exarticulation. All but three healed at the initial

Table 1. Relationship between nutritional status, and impaired wound healing, postoperative medical complications, death, and duration of hospital stay

Nutritional status	Number of patients	Impaired healing	Medical complications	Death	Days in hospital Mean	range
Normal	13	1	1	0	32	21–56
Malnourished	34	15	15	6	45	27–96
Total	47	16	16	6		

level. Two of the failures were above-knee amputations, one a through knee amputation. Another 13 patients had secondary healing; none of them needed further surgery.

16 patients suffered from various postoperative medical complications (myocardial infarction 3, pulmonary thromboembolism 2, pulmonary edema 3, sepsis 2, pneumonia 1, decubitus 2, and cystitis 3); 6 of these patients died postoperatively.

The data were analyzed using logistic regression. Impaired wound healing and postoperative medical complications were the dependent variables, and nutritional index, sex, age, concomitant medical diseases, skin blood flow, amputation level, operation time and number of blood transfusions were the independent variables. The relationship between duration of hospital stay and the independent variables was analyzed using a linear regression model for normally distributed observations; the logarithm of duration of hospital stay could be considered normally distributed. The number of patients was insufficient to allow stratification into three nutritional groups, therefore patients with reduced or poor nutritional status were assembled in a malnourished group for the statistical analysis. The relationship between nutritional index and death was tested by the Fischer's test.

Results

The nutritional status of the 47 patients was normal in 13, reduced in 18, and poor in 16.

The malnourished group (nutritional status reduced or poor) had increased frequency of impaired wound healing ($P < 0.05$), and medical complications ($P < 0.05$), while none of the other independent variables was significant (Table 1). The malnourished group had a prolonged hospital stay ($P < 0.05$). High age was also related to prolonged hospital stay ($P < 0.01$), while none of the other independent variables were of significance. All 6 patients who died were malnourished, but there was no significant relation between death and malnutrition.

Discussion

In our study almost three quarters of the patients were in a not so good or poor nutritional state. This is in agreement with the work of Kay et al. (1987) where 61 percent of the patients undergoing lower extremity amputation proximal to the ankle were malnourished when lowered albumin level or total lymphocyte count was used to evaluate nutritional status. Based on skinfold thickness and circumference of upper arm muscle measurements in 744 elderly women with fractured neck of the femur, 53 percent were found to be thin or very thin (Bastow et al. 1983b). The incidence of malnutrition in general surgical patients ranges between 20 and 50 percent (Bistrian et al. 1974, Hill et al. 1977, Mullen et al. 1979, Jensen and Møller-Petersen 1982, Warnold and Lundholm 1984, Pettigrew and Hill 1986). This confirms that amputation patients are at an extremely high risk of being malnourished compared to other surgical patients. One explanation could be the high incidence of concomitant medical diseases in these patients.

Wound healing response, assessed by measuring hydroxyproline over a 7-day period in fine thin-walled Gore-Tex tubes placed in the subcutaneous layers of the arm, was less in malnourished patients than in normally nourished patients (Haydock and Hill 1986). In several studies malnutrition has been correlated to impaired wound healing (Hill et al. 1977, Warnold and Lundholm 1984, Katelaris et al. 1986). In the study by Kay et al. (1987) patients with compromised nutritional status who needed lower extremity amputation had a failure rate of 16 percent and delayed wound healing occurred in an additional 16 percent. This may be compared to a lower wound healing complication rate of 7 percent in the nourished group. Correspondingly, in 86 percent of the nourished diabetic patients the amputation healed after Symes amputation in contrast to in only 18 percent in the malnourished group (Dickhaut 1984). In the present study an increased frequency of impaired wound healing was found in patients with lowered or poor nutritional status. However, only three patients needed reamputation or further surgery at the same level. One reamputation was performed in a patient in good nutritional status who had developed necrosis in a previously healed through-knee amputation.

16 of our patients developed postoperative complications which were lethal in 6 cases. Myocardial infarction and pulmonary edema were the most frequent complications. 6 patients suffered from various septic conditions. The frequency of medical complications was increased among patients with reduced or poor nutritional status, but was not correlated to age or concomitant physical diseases. The relationship between nutritional status and immunological competence has been recognized with indices such as low lymphocyte count, decreased response to recall antigens and delayed hypersensitivity (Chandra 1980, Dowd and Heatley 1984). This might explain the increased risk of septic conditions which was found among the malnourished patients in our study. All 6 patients who died were malnourished, but the number was too small to be significantly related to impaired nutritional status. Buzby et al. (1980) found a highly significant increase in postoperative mortality and all classes of complications in patients with poor nutrition. This has been validated by other studies (Harvey et al. 1981, Katelaris et al. 1986, Pettigrew and Hill 1986, von Meyenfeldt and Soeters 1988).

Domestic and social factors are major determinants for the duration of the hospital stay. Nevertheless we found that impaired nutritional status and high age correlated to a prolonged hospital stay for patients discharged to their own home. This could be expected from the increased frequency of impaired wound healing and medical complications in our malnourished patients. Another factor of significance could be increased rehabilitation time due to impaired muscle function. Rehabilitation time, defined as the time needed to achieve independent mobility, was prolonged among the very thin patients recovering from a fractured neck of the femur (Bastow et al. 1983a). Studies have shown, that muscle strength is decreased, fatiguability is increased, and there are deficits of muscle fiber types and enzymes which may account for these functional changes (Russell et al. 1983, Church et al. 1984, Jeejeebhoy 1986). Klidjian et al. (1982) showed hand-grip dynamometry to be a useful screening test of patients at surgical risk, and a valuable additional test for nutritional assessment.

Several studies, including the present, provide evidence, that malnutrition is associated with a high incidence of complications and deaths. From these studies, however, it cannot be stated with certainty whether malnutrition is a cause of complications in surgical patients or whether increased complications and malnutrition merely occur concurrently. The final evidence that malnutrition increases postoperative morbidity and mortality would be to show that effective treatment of malnutrition before surgery could decrease operative morbidity and mortality. Such a study has yet to be performed in patients with lower extremity amputations.

Acknowledgement

The study was supported by the Danish Medical Research Council. The authors would like to thank the nursing staff, secretaries and the dietitians at ward O4, Odense University Hospital.

References

Bastow M D, Rawlings J, Allison S P. Benefits of supplementary tube feeding after fractured neck of femur: a randomised controlled trial. Br Med J (Clin Res Ed) 1983a; 287 (6405): 1589–92.

Bastow M D, Rawlings J, Allison S P. Undernutrition, hypothermia, and injury in elderly women with fractured femur: an injury response to altered metabolism? Lancet 1983b; 1 (8317): 143–6.

Bistrian B R, Blackburn G L, Hallowell E, Heddle R. Protein status of general surgical patients. JAMA 1974; 230 (6): 858–60.

Buzby G P, Mullen J L, Matthews D C, Hobbs C L, Rosato E F. Prognostic nutritional index in gastrointestinal surgery. Am J Surg 1980; 139 (1): 160–7.

Chandra R K. Immunology in nutritional disorders. Edward Arnold Ltd, London 1980.

Church J M, Choong S Y, Hill G L. Abnormalities of muscle metabolism and histology in malnourished patients awaiting surgery: effects of a course of intravenous nutrition. Br J Surg 1984; 71 (7): 563–9.

Dickhaut S C, DeLee J C, Page C P. Nutritional status: importance in predicting wound healing after amputation. J Bone Joint Surg (Am) 1984; 66 (1): 71–5.

Dowd P S, Heatley R V. The influence of undernutrition on immunity. Clin Sci 1984; 66 (3): 241–8.

Harvey K B, Moldawer L L, Bistrian B R, Blackburn G L. Biological measures for the formulation of a hospital prognostic index. Am J Clin Nutr 1981; 34 (10): 2013–22.

Haydock D A, Hill G L. Impaired wound healing in surgical patients with varying degrees of malnutrition. JPEN J Parenter Enteral Nutr 1986; 10 (6): 550–4.

Hill G L, Blackett R L, Pickford I, Burkinshaw L, Young G A, Warren J V, Schorah C J, Morgan D B. Malnutrition in surgical patients. An unrecognised problem. Lancet 1977; 1 (8013): 689–92.

Jeejeebhoy K N. Muscle function and nutrition. Gut (Suppl 1) 1986; 27: 25–39.

Jensen S, Møller-Petersen J. Protein kalorisk ernaeringstilstand hos kirurgiske patienter. Bedømt ved antropometriske målinger og serum proteiner. Ugeskr Laeger 1982; 144 (7): 463–6.

Jensen S, Møller-Petersen J, Madsen P. Prognostisk ernaeringsindeks. Sammenhaeng mellem den praeoperative ernaeringstilstand og det postoperative forløb. Ugeskr Laeger 1983; 145 (20): 1531–3.

Katelaris P H, Bennett G B, Smith R C. Prediction of postoperative complications by clinical and nutritional assessment. Aust N Z J Surg 1986; 56 (10): 743–7.

Kay S P, Moreland J R, Schmitter E. Nutritional status and wound healing in lower extremity amputations. Clin Orthop 1987; 217: 253–6.

Kjølbye J. The surgery of the through knee amputation. In: Prosthetic and Orthotic Practice (Ed. Murdoch, G.) Edward Arnold Ltd, London 1970: 255–7.

Klidjian A M, Archer T J, Foster K J, Karran S J. Detection of dangerous malnutrition. JPEN J Parenter Enteral Nutr 1982; 6 (2): 119–21.

Law D K, Dudrick S J, Abdou N I. The effects of protein calorie malnutrition on immune competence of the surgical patient. Surg Gynecol Obstet 1974; 139 (2): 257–66.

von Meyenfeldt M F, Soeters P B. Risk factors for postoperative complications. Br J Clin Pract (Symp Suppl) 1988; 63: 49–52.

Mullen J L, Gertner M H, Buzby G P, Goodhart G L, Rosato E F. Implications of malnutrition in the surgical patient. Arch Surg 1979; 114 (2): 121–5.

Persson B M. Sagittal incision for below knee amputation in ischaemic gangrene. J Bone Joint Surg (Br) 1974; 56 (1): 110–4.

Pettigrew R A, Hill G L. Indicators of surgical risk and clinical judgement. Br J Surg 1986; 73 (1): 47–51.

Russell D M, Leiter L A, Whitwell J, Marliss E B, Jeejeebhoy K N. Skeletal muscle function during hypocaloric diets and fasting: a comparison with standard nutritional assessment parameters. Am J Clin Nutr 1983; 37 (1): 133–8.

Sejrsen P. Measurement of cutaneous blood flow by freely diffusible radioactive isotopes. Methodological studies on the washout of krypton 85 and xenon 133 from the cutaneous tissue in man. Dan Med Bull (Suppl 3) 1971; 18: 9–38.

Warnold I, Lundholm K. Clinical significance of preoperative nutritional status in 215 non-cancer patients. Ann Surg 1984; 199 (3): 299–305.