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Risk factors for insufficient perioperative oral nutrition after hip fracture surgery within a multi-modal rehabilitation programme

Nicolai B. Foss[1,2], Pia S. Jensen[2], Henrik Kehlet[3]

[1]Departments of Anaesthesia, Hvidovre University Hospital, Denmark
[2]Department of Orthopaedic Surgery, Hvidovre University Hospital, Denmark
[3]Section of Surgical pathophysiology, and the Juliane Marie Centre 4074, Rigshospitalet, Denmark

Address correspondence to: Nicolai B. Foss. Email: nbf@comxnet.dk

Abstract

Objective To examine oral nutritional intake in the perioperative phase in elderly hip fracture patients treated according to a well-defined multi-modal rehabilitation program, including unselected oral nutritional supplementation, and to identify independent risk factors for insufficient nutritional intake.
Design Prospective, descriptive.
Setting A specialised hip fracture unit at the department of orthopaedic surgery in a university hospital.
Subjects Two hundred and sixty-two consecutive, unselected elderly hip fracture patients.
Intervention Patients were treated according to a well-defined multi-modal care and nutrition plan comprising early surgery, short fasting period, supplementary protein drinks, epidural anaesthesia and analgesia, standardised fluid and transfusion protocols and aggressive mobilisation and physiotherapy. All nutritional intake during the first three post-operative days was recorded, as well as post-operative morbidity and mortality.
Results Nutritional energy intake during the first three post-operative days was median 90% of BMR and 86% of recommended protein intake. The independent risk factors for an insufficient energy intake were perioperative medical complications, and no association between low nutritional intake in the perioperative phase and the commonly used predictors of low BMI or albumin on admission was found.
Conclusion Perioperative medical complications and dementia restricted nutritional intake in the perioperative phase. These factors help identify hip fracture patients in whom increased nutritional support is necessary.

Keywords: *hip fracture, elderly, nutrition, perioperative, complications*

Introduction

The number of patients with hip fractures is increasing worldwide, and the patients presenting are increasingly frail and elderly [1, 2]. Patients often suffer from malnutrition both before the fracture and in the post-operative phase [3, 4]. Malnutrition combined with the catabolic response to surgery leads to muscle wasting which impairs post-operative rehabilitation [5, 6]. Oral nutritional protein and energy supplementation has been investigated as a means of improving post-operative outcome, but the overall results and a meta-analysis are inconclusive [7]. Furthermore, compliance may be a major limiting factor in achieving optimal oral nutrition in the post-operative phase [8–10]. Oral nutrition in the early perioperative phase has only been examined in a few studies, and risk factors for decreased nutritional intake in this phase have not been identified. Previous studies of risk factors for insufficient nutritional intake have primarily focused on the later post-operative phase.

The purpose of the present study was to investigate perioperative nutritional intake in a consecutive series of hip fracture patients receiving multi-modal rehabilitation including oral nutritional supplementation, in order to identify clinical risk factors for impaired nutritional intake.

Material and Methods

Between May 2003 and July 2004, 262 consecutive patients >65 years of age referred to the department of orthopaedics at Hvidovre University Hospital with a primary hip fracture, were studied prospectively. All patients were admitted to the special hip fracture unit. Perioperative care was standardised and well-defined, including surgery within 24 h from admittance, epidural analgesia with local anaesthetics and low dose morphine (Bupivacaine 0.125% + morphine 50 mcg/ml—4 ml/h) initiated immediately after admittance and continued for 96 h post-operatively, epidural anaesthesia, standardised perioperative fluid and transfusion protocol, supplemental oxygen, when supine in the entire perioperative period, indwelling urinary catheter until day 4, prophylactic intraoperative antibiotics and perioperative low-molecular weight heparin (enoxaparin 40 mg^{-1} s.c. once daily) [11]. The patients were mobilised on the day of operation, and received an intensive physiotherapy programme with two daily 30-min sessions starting on the first post-operative day. Patients were primarily rehabilitated in the orthopaedic ward until they fulfilled the standardised discharge criteria, or, if this was deemed unobtainable, until transfer was arranged to definitive nursing home residence.

Pre-operative fasting was restricted to 6 h for solids and 2 h for fluids. All the patients received a standardised house diet prepared in the hospital kitchen consisting of three meals and three snacks with a total daily energy content of 9,500 KJ and 95 g of protein. This diet was supplemented by three nutritional supplementation drinks of 200 ml containing 1100–1270 KJ and 8–20 g of protein; patients were free to choose their preferred type. The patients were encouraged by the nursing staff members to eat and drink in the entire perioperative period including the pre-operative period. The unit had 14 beds with a daytime attendance of five staff members (nurses and assistants). Tube or intravenous feeding was not part of the standardised nutrition plan.

Nutritional intake during the pre-operative period and the first three post-operative days was recorded by the staff members at all times, and meals, where assessed, as being ingested 100, 75, 50, 25 or 0%. Nutritional intake was compared to an estimated Basic Metabolic Rate (BMR) of 100 KJ/kg/day [12] and a recommended protein intake of 0.8 g/kg/day [13].

Data were gathered prospectively. Pre-operative functional level was expressed by the new mobility score (NMS) [14], and cognitive function was assessed by a Danish version of the abbreviated mental status test taken upon admission [15], medical conditions, medications, American Society of Anesthesiologists (ASA) classification [16], type of anaesthesia and surgery as well as length of stay and 30-day mortality were all registered. Weight and BMI were assessed upon admission. Since the patients by the nature of their disease could not be weighed, the weight of the individual patients were estimated by the admitting orthopaedic surgeon supported by the patient's own information [17].

A major medical complication was defined as being present in any patient that developed any of the following: cerebrovascular accident, acute myocardial infarction or unstable angina, acute congestive heart failure, new onset arrhythmia, pneumonia, respiratory insufficiency, gastric or duodenal ulceration, renal dysfunction (defined as creatinine >200 mmol/l), septicaemia, pulmonary embolus or deep venous thrombosis. All these complications were grouped into those occurring before the fourth post-operative day—defined as the perioperative period—and those occurring later on. Decubitus and wound infections (both deep and superficial) were analysed separately. The presence of perioperative delirium was evaluated daily by both nursing staff and attending physicians according to the criteria set forth in DSM-IV [18].

The study is part of Hvidovre University Hospitals Hip Fracture Project, which was evaluated by the local ethical committee, who had no objections to the project, and concluded that no patient's written consent was obtained. The study was approved by the Danish data protection agency.

The chi-square test was used for testing the significance of categorical data and Students *t*-test was used for continuous numerical data. Logistic regression was used to identify factors independently associated with decreased nutritional intake. All data analyses were performed with SPSS version 10.1.

Results

During the inclusion period, 291 patients >65 years of age (range 66–101 years) were admitted to the hospital and treated at the hip fracture unit. Of these, 29 were excluded from the analysis; four because of death in the early post-operative phase, 11 due to early transfer to other wards, and 14 due to insufficient nutritional registration, leaving 262 patients available for analysis. There were a high proportion of patients suffering from dementia (28%), and patients from nursing homes (21%) in the cohort, and 55% had a NMS of 5 or less indicating a poor rehabilitation potential. The multi-modal regimen had a high compliance as only 3% of all patients did not receive the planned epidural analgesia, 92% had surgery no later than the day after admission, and only two patients waited beyond 48 h for surgery. The majority (76%) of major medical complications occurred within the first four days after surgery, while all wound infections and decubitus occurred in the later post-operative phase. Median hospital stay from admission to discharge was 13 days. Patient characteristics, perioperative data and outcomes are summarised in Table 1.

Energy intake was 2,497 (SD 1,680), 5,426 (SD 2,640), 5,358 (SD 2,413) and 5,440 (SD 2,654) KJ during the day

Table 1. Perioperative characteristics of 262 consecutive elderly patients admitted with hip fracture and treated according to a multi-modal rehabilitation regimen

Age (years)	83 (77–89)
Sex (M/F)	210/52 (80/20%)
Pre-fracture New mobility score (0–9)	5 (3–9)
Mental test score (0–9)	8 (5–9)
Dementia	72 (28%)
Pre-fracture nursing home residence	54 (21%)
ASA classification (I/II/III/IV)	5/123/118/16 (2/47/45/6%)
Weight (kg)	60 (52–70)
BMI	22.5 (20.0–24.8)
Albumin on admission (g/l)	36.3 (33.3–39.3)
Pre-operative haemoglobin (mmol/l)	8.0 (7.2–8.6)
Fracture type	
Medial	126 (48%)
Pertrochanteric	104 (40%)
Subtrochanteric	32 (12%)
Delay to surgery (h)	19 (14–23)
Blood loss during surgery (ml)	200 (100–300)
Epidural blockade	255 (97%)
Perioperative (early) medical complications	51 (19%)
Medical complications *after* 4th post-operative day	16 (6%)
Delirium	51 (19%)
Decubitus	8 (3%)
Wound infection (deep + superficial)	12 (4%)
Length of stay (days)	13 (7–23)
In-hospital mortality	26 (10%)
30-day mortality	30 (12%)

Values are presented as number of patients (percentage) for nominal data and as median (interquartile range) for data in scales.

of surgery, the first, second and third post-operative days respectively, whereas protein intake was an average of 18 (SD 13), 42 (SD 21), 42 (20) and 42 (SD 20) g respectively.

The energy intakes relative to BMR on the respective days constituted 43% (SD 31), 91% (SD 47), 90% (SD 43) and 90% (SD 45) of the required energy intake, whereas the protein intake relative to the recommended daily intake constituted 40% (SD 30), 88% (SD 47), 89% (SD 45) and 88% (47) respectively.

Patients were discharged back to their original place of residence in 169 (72%) cases. Discharge was to independent residences in 121 cases, nursing homes in 61 cases and to further rehabilitation units in 56 cases. Patients discharged to further rehabilitation had an initial stay in the hip fracture unit of median 22 days.

In Table 2 the association between potential risk factors for decreased nutritional intake, morbidity and mortality, and the average energy intake on the first three post-operative days as a percentage of BMR is presented. All the pre-fracture risk fractures analysed were significantly associated with a decreased nutritional energy intake in the post-operative period, except a BMI <20 that was associated with a relatively increased nutritional intake compared to BMR. There was significant association between both perioperative medical complications and mortality at 30 days and nutritional intake in the perioperative phase, but no significant association could be demonstrated between the perioperative nutritional intake and later complications.

Table 3 presents the results of multi-variate analysis of associations between an average nutritional energy intake of less than 100% of BMR in the first three post-operative days and patient risk factors. A medical complication in the perioperative phase and dementia were significant independent risk factors for an energy intake less than 100% of BMR. Neither advanced age, ASA score III/IV, low admission albumin or a poor pre-fracture functional level was found to be independent risk factors for reduced energy intake in the early post-operative period.

Discussion

This study shows that insufficient energy and protein intake is prevalent after hip fracture surgery despite the implementation of a multi-modal rehabilitation care plan. The major independent risk factors for inadequate post-operative nutritional intake were early medical complications and dementia.

Elderly patients with hip fractures are often malnourished upon admission [3, 4] and this situation is usually aggravated by perioperative semi-starvation due to pre-operative fasting, long delays to surgery, moderate to severe pain, post-operative ileus and gastric retention as well as nausea and vomiting due to both anaesthesia and perioperative opioid administration [19, 20]. The catabolic response to surgery is enhanced by this semi-starvation contributing to loss of muscle mass and function, and potentially to impaired

Table 2. Energy intake according to perioperative risk factors for insufficient nutrition and post-operative morbidity in 262 consecutive elderly hip fracture patients treated according to a multi-modal rehabilitation regimen

	Energy intake as % of BMR		
	Factor present	Factor not present	*P*
>85 years old	81 (53–107)	96 (66–119)	0.006
Female sex	89 (61–117)	92 (61–107)	0.70
Pre-fracture New mobility score <5	81 (56–108)	96 (72–119)	0.005
Dementia	51 (33–65)	96 (71–119)	<0.001
Pre-fracture nursing home residence	65 (51–91)	96 (66–119)	<0.001
ASA classification III/IV	56 (41–85)	95 (71–123)	0.002
BMI <20	107 (74–136)	83 (59–107)	<0.001
Admission albumin <35 g/l	80 (56–107)	94 (64–119)	0.03
Perioperative medical complications	71 (49–93)	95 (65–119)	<0.001
Medical complications *after* 4th post-operative day	81 (64–113)	90 (61–115)	0.90
Delirium	76 (49–110)	93 (64–116)	0.23
Decubitus	77 (61–86)	91 (61–115)	0.48
Wound infection	82 (63–116)	90 (61–114)	0.65
Death within 30 days	61 (45–94)	93 (64–117)	<0.001

Values are presented as percentage of BMR (median (interquartile range)) ingested on average for the first three post-operative days.

Table 3. Relationship between average nutritional intake for the first three post-operative days of <100% of basic metabolic rate (BMR) and categorised perioperative patient characteristics in 262 consecutive elderly hip fracture patients treated according to a multi-modal rehabilitation regimen

Average energy intake (day 1–3 after surgery)	<100 % of BMR univariate analysis				<100 % of BMR multivariate analysis			
	Odds ratio	95% CI Upper	95% CI Lower	*P*	Odds ratio	95% CI Upper	95% CI Lower	*P*
>85 years	1.82	1.07	3.08	0.03	1.70	0.91	3.18	0.09
Female sex	0.76	0.41	1.44	0.40	0.89	0.46	1.95	0.89
ASA score III/IV	1.39	0.85	2.29	0.19	0.82	0.44	1.54	0.54
Dementia	3.31	1.75	6.26	<0.01	2.64	1.10	6.35	0.03
Pre-fracture NMS 0–5	1.83	1.11	3.02	0.02	1.12	0.57	2.20	0.75
BMI <20	0.34	0.19	0.61	<0.01	0.21	0.10	0.42	<0.01
Nursing home residence	4.20	1.95	9.04	<0.01	2.62	0.97	7.06	0.06
Perioperative medical complication	2.39	1.29	4.45	0.003	3.19	1.40	7.26	<0.01
Delirium	1.44	0.84	2.46	0.18	1.56	0.74	3.29	0.24
Albumin <35 g/l	0.70	0.41	1.19	0.19	1.04	0.55	1.95	0.91

<100% of BMR indicates an average energy consumption less than the patients calculated basic metabolic rate for the first three postoperative days.

immune function and delayed healing [5, 6]. The concept of multi-modal perioperative care with optimised anaesthesia, analgesia, surgery and perioperative care principles can potentially reduce complications and time to restoration of physical status [11, 21]. In the present study, patients received early surgical intervention, fasting time was short and patients received epidural analgesia both in the pre- and post-operative phase, reducing the pain level, sparing opioids and thereby potentially improving appetite [11]. Anaesthesia was almost uniformly epidural in order to reduce post-operative nausea and vomiting [22] as well as, neuroaxial anaesthesia attenuates the catabolic response to surgery [23]. Therefore, the present regimen should provide optimal possibilities for adequate oral nutritional support compared to more traditional regimens with long delays to surgery, insufficient pain management [7] and general anaesthesia. Supplementation of normal hospital diets with protein enriched energy drinks has in most trials led to an increased energy and protein intake, but a definitive effect on outcome has not been proven [7, 24]. The limiting factor in many studies of oral supplementation effectiveness has been patient compliance [8, 10], which also may be further reduced by the above mentioned perioperative factors.

The present study has clinical relevance since it does not exclude patients with severe pre-fracture disease or cognitive dysfunction, which constitute the weakest groups among hip fracture patients. Previously, these patients had been excluded from most studies of nutritional supplementation hindering interpretation of the possibilities for sufficient oral nutritional supplementation in the hip fracture group as a whole [7]. In the present study, all patients admitted with a primary hip fracture were included, and exclusion was only due to logistics in the data gathering process.

Overall, absolute nutritional intake was relatively high compared to other studies of nutritional supplementation despite these studies not including the weakest and demented patients [24, 25]. The median energy intake compared to BMR was slightly less than 100%, although BMR should only be considered a minimum requirement for nutritional intake. These findings should be compared with previous findings, where three out of four hip fracture patients had insufficient estimated daily energy consumption *before* their fracture, 60% suffered from reduced appetite [3], and that 40% of healthy, independent, cognitively intact elderly did not meet the recommended daily intake [26]. As such, our study supports the hypothesis that the multi-modal care regimen and oral nutritional supplementation had a synergistic effect on perioperative nutritional intake. We found an association between low perioperative nutritional intake and mortality at 30 days, but we could not demonstrate an association with later medical complications, wound infections or decubitus, the latter possibly due to the very low incidence with the present regimen.

Screening for patients at risk of malnutrition post-operatively includes BMI and hypoalbuminaemia [27, 28]. We found no association between a low albumin level on admission and low perioperative nutritional intake, and an inverse relation between BMI and energy intake as a percentage of BMR. This association is potentially confounded by the fact that a low BMI potentially leads to an underestimation of the required energy intake as estimated by BMR. So, whereas malnutrition has been shown to be associated with a poor outcome *per se*, we found no definite association between pre-admission malnutrition and decreased nutritional intake, within a regimen with a multi-modal approach to oral nutrition intake.

The only independent risk factor identifiable on admission was dementia, but any major medical complication occurring before the fourth post-operative day was also independently associated with a low energy intake. It is most likely that the complications are the cause of the low food intake and not vice versa, since the detrimental effect of a low intake most likely would develop over several days. Most patients without risk factors had a sufficient/minimum required nutritional intake on a regular hospital diet combined with supplementation with energy/protein drinks, calling for a stratified approach to nutritional supplementation in hip fracture patients. Patients suffering from dementia, and those developing medical complications in the perioperative period should receive further intensification of nutritional support. Whether the supplementation in these high-risk patients should be intravenous supplementary nutrition, or tube feeding, or a combination, needs further investigation.

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Key points

- Insufficient nutritional intake after hip fracture surgery potentially leads to increased morbidity and delayed recovery.
- Nutritional intake has not previously been assessed within a multi-modal rehabilitation programme.
- Nutritional intake within a multi-modal rehabilitation programme was primarily dependent on dementia and the occurrence of post-operative medical complications.
- Optimisation of nutritional intake should, besides pre-operative risk assessment, involve close post-operative monitoring of nutritional intake.
- Future research should investigate optimal methods for nutrition in those patients where adequate oral nutrition is not possible.

Conflict of interest

None declared

References

1. Kannus P, Parkkari J, Sievanen H, Heinonen A, Vuori I, Jarvinen M. Epidemiology of hip fractures. Bone 1996; 18: 57S–63S.
2. Foss NB, Kehlet H. Mortality analysis in hip fracture patients: Implications for the design of future outcome trials. Br J Anaesth 2005; 94: 24–9.
3. Carlsson P, Tidermark J, Ponzer S, Soderqvist A, Cederholm T. Food habits and appetite of elderly women at the time of a femoral neck fracture and after nutritional and anabolic support. J Hum Nutr Diet 2005; 18: 117–20.
4. Lumbers M, New SA, Gibson S, Murphy MC. Nutritional status in elderly female hip fracture patients: comparison with an age-matched home living group attending day centres. Br J Nutr Res 2001; 85: 733–40.
5. Bisgaard T, Kehlet H. Early oral feeding after elective abdominal surgery-what are the issues? Nutrition 2002; 18: 944–8.
6. Wilmore DW. Metabolic response to severe surgical illness: overview. World J Surg 2000; 24: 705–11.
7. Avenell A, Handoll HHG. A systematic review of protein and energy supplementation for hip fracture aftercare in older people. Eur J Clin Nutr 2003; 57: 895–903.
8. Bruce D, Laurance I, McGuiness M, Ridley M, Goldswain P. Nutritional supplements after hip fracture: poor compliance limits effectiveness. Clin Nutr 2003; 22: 497–500.
9. Houwing RH, Rozendaal M, Wouters-Wesseling W, Beulens JW, Buskens E, Haalboom JR. A randomised, double-blind assessment of the effect of nutritional supplementation on the prevention of pressure ulcers in hip-fracture patients. Clin Nutr 2003; 22: 401–5.

10. Lawson RM, Doshi MK, Ingoe LE, Colligan JM, Barton JR, Cobden I. Compliance of orthopaedic patients with postoperative oral nutritional supplementation. Clin Nutr 2000; 19: 171–5.
11. Foss NB, Kristensen MT, Kristensen BB, Jensen PS, Kehlet H. Effect of postoperative epidural analgesia on rehabilitation and pain after hip fracture surgery: a randomized, double-blind, placebo-controlled trial. Anesthesiology 2005; 102: 1197–204.
12. Luhrmann PM, Neuhaeuser Berthold M. Are the equations published in literature for predicting resting metabolic rate accurate for use in the elderly? J Nutr Health Aging 2004; 8: 144–9.
13. Walrand S, Boirie Y. Optimizing protein intake in aging. Curr Opin Clin Nutr Metab Care 2005; 8: 89–94.
14. Parker MJ, Palmer CR. A new mobility score for predicting mortality after hip fracture. J Bone Joint Surg Br 1993; 75: 797–8.
15. Quereshi KN, Hodkinson HM. Evaluation of a ten-question mental test in the institutionalised elderly. Age Ageing 1974; 3: 152–7.
16. ASA Physical Classification System. Available at: http://www.frca.co.uk/article.aspx?articleid=100184. Accessed January 10, 2007.
17. Menon S, Kelly AM. How accurate is weight estimation in the emergency department. Emerg Med Australas 2005; 17: 113–6.
18. Bitsch M, Foss N, Kristensen B, Kehlet H. Pathogenesis of and management strategies for postoperative delirium after hip fracture: a review. Acta Orthop Scand 2004; 75: 378–89.
19. Kehlet H, Wilmore DW. Multimodal strategies to improve surgical outcome. Am J Surg 2002; 183: 630–41.
20. Kehlet H, Dahl JB. Anaesthesia, surgery and challenges in postoperative recovery. Lancet 2003; 362: 1921–8.
21. Basse L, Thorbol JE, Lossl K, Kehlet H. Colonic surgery with accelerated rehabilitation or conventional care. Dis Colon Rectum 2004; 47: 271–7.
22. Gan TJ, Meyer T, Apfel CC *et al.* Consensus guidelines for managing postoperative nausea and vomiting. Anesth Analg 2003; 97: 62–71.
23. Holte K, Kehlet H. Epidural anaesthesia and analgesia–effects on surgical stress responses and implications for postoperative nutrition. Clin Nutr 2003; 21: 199–206.
24. Eneroth M, Olsson UB, Thorngren KG. Insufficient fluid and energy intake in hospitalised patients with hip fracture. A prospective randomised study of 80 patients. Clin Nutr 2005; 24: 297–303.
25. Delmi M, Rapin CH, Bengoa JM, Delmas PD, Vasey H, Bonjour JP. Dietary supplementation in elderly patients with fractured neck of the femur. Lancet 1990; 335: 1013–6.
26. Volkert D, Kreuel H, Heseker H, Stehle P. Energy and nutrient intake of young-old, old-old and very-old elderly in Germany. Eur J Clin Nutr 2004; 58: 1190–200.
27. Bouillanne O, Morineau G, Dupont C *et al.* Geriatric nutritional risk index: a new index for evaluating at-risk elderly medical patients. Am J Clin Nutr 2005; 82: 777–83.
28. Stratton RJ, King CL, Stroud MA, Jackson AA, Elia M. Malnutrition universal screening tool predicts mortality and length of hospital stay in acutely ill elderly. Br J Nutr 2006; 95: 325–30.

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