The Journal of Laryngology & Otology (2015), ***129***, *706–709*.

doi:10.1017/S0022215115001486

MAIN ARTICLE

Hand-grip strength does not correlate with treatment-related weight loss in patients with head and neck cancer

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Abstract

Background: Hand-grip strength has been shown to be a reliable predictor of health outcomes. However, evidence supporting its use as an indicator of nutritional status is inconsistent. This study investigated its use in monitoring nutritional status in patients with head and neck cancer.

Methods: A prospective audit of patients treated for head and neck cancer was undertaken at four centres over a three-month period in 2009. Nutritional outcomes were collected at 3, 6 and 12 months, and the data were statistically analysed.

Results: Data from 114 patients showed that mean weight, but not hand-grip strength, fell significantly at 3, 6 and 12 months post-treatment ($p < 0.003$ *vs* $p < 0.126$).

Conclusion: A fall in weight does not coincide with a drop in hand-grip strength in patients receiving treatment for head and neck cancer. Hand-grip strength may therefore not be of benefit in the nutritional assessment of these patients and should not be part of routine assessment.

Key words: Head And Neck Neoplasms; Hand Strength; Nutritional Status; Weight Loss

Introduction

Patients with head and neck cancer are known to be at risk of nutritional deficiencies as the result of a variety of factors, including mechanical obstruction to swallowing caused by the tumour, treatment side effects, cancer cachexia and pre-existing malnourishment. Whilst many measures of nutritional status are available, including weight, body mass index (BMI), skinfold thickness and upper arm circumference,[1] hand-grip strength has increasingly been investigated as a simple and non-invasive anthropometric marker of nutritional status.[2]

In states of malnourishment, protein is lost preferentially from muscle mass, to compensate for the reduced nutritional input.[3,4] As muscle function is known to be associated with whole body protein,[5,6] body-cell mass[7] and BMI,[7–9] loss of weight and muscle mass results in weakness and deteriorating function which hand-grip strength may be able to approximate.

The use of hand-grip strength may not only be limited to approximating nutritional status. It has been shown to be strongly correlated with post-operative complications,[10–12] length of hospital stay,[13,14] functional status,[14,15] short-term[16] and medium-term[17] survival, and dependency for activities of daily living.[18]

Previous research has investigated hand-grip strength as a predictor of post-operative complications and hospital stay in patients with head and neck cancer.[10] However, to our knowledge, no previous study has investigated its use in the routine monitoring of head and neck cancer patients' nutritional state, despite its inclusion in national guidelines for nutritional assessment.[19] As there is a correlation between weight and hand-grip strength in healthy individuals,[20] we aimed to prospectively compare the weight loss and hand-grip strength of patients with head and neck cancer at baseline and 3, 6 and 12 months post-treatment to see if changes in weight correspond with changes in hand-grip strength.

Materials and methods

A prospective study of nutritional and swallowing support in patients receiving treatment for head and neck cancer was undertaken at four independent sites in the North of England Cancer Network (Cumberland Infirmary,

On behalf of the North of England Cancer Network Audit group.
Accepted for publication 8 January 2015

Carlisle; James Cook Hospital, Middlesbrough; Freeman Hospital, Newcastle upon Tyne; and Sunderland Royal Hospital, Sunderland). Consecutive patients were recruited over a three-month period between June and September 2009.

Patients received nutritional assessments and had appropriate interventions at baseline and during treatment and follow up, as recommended by national guidelines.[19] Data on nutritional status, including weight and hand-grip strength, were collected at baseline, and 3, 6 and 12 months after treatment. Other patient details, including tumour and treatment demographics and World Health Organization performance status classification data,[21] were obtained from the data submitted to the National Head and Neck Cancer Audit ('DAHNO'). Hand-grip strength was measured in the non-dominant arm, with the patient standing and their elbow extended. The best of three measurements was recorded.[22] Weights were recorded on approved scales in follow-up clinics.

Ethical considerations

Weight is recorded in all patients undergoing treatment and is thus an integral part of practice. Hand-grip strength is measured in two centres in the region and was rolled out to other centres for the purpose of the audit. The current study involved analysis of the existing data obtained at routine follow-up visits. Ethical approval was therefore not required.

Statistical analysis

Descriptive statistics were used for the following variables: age, gender, tumour site, tumour stage and treatment modality. Data on weight loss and hand-grip strength were analysed using repeated measures analysis of variance (ANOVA) (with Mauchly's sphericity test) and Bonferroni correction for pairwise comparisons. A p-value of 0.05 was considered significant (two-tailed test) unless post-hoc analyses were performed. Bonferroni adjusted alpha was used in post-hoc analysis. Statistical analysis was performed using the IBM® SPSS® Statistics software package, version 20.

Results

A total of 114 patients were recruited for the audit. The demographics for these patients are shown in Table I.

Data on pre- and post-treatment weights and hand-grip strengths are shown in Tables II and III. Repeated measures ANOVA showed that weight loss was statistically significant ($p < 0.003$, with Mauchly's sphericity <0.05). However, changes in hand-grip strength were not statistically significant over the time period ($p < 0.126$, with Mauchly's sphericity <0.05).

Further pairwise comparisons (Bonferroni correction applied) showed that weight loss was significant at both 3 and 6 month intervals, but not at 12 months. However, hand-grip strength was not significantly different at any of the time intervals (Table IV).

TABLE I
PATIENT DEMOGRAPHICS

Variable	Value(s)
Age (years)	
– Mean	61.7
– Range	19–90
Gender (*n* (%))	
– Male	79 (69)
– Female	35 (31)
Tumour site (*n* (%))	
– Nasopharynx	4 (3.5)
– Oropharynx	45 (39.5)
– Hypopharynx	10 (8.8)
– Oral cavity	27 (23.7)
– Larynx	24 (21.1)
– Unknown primary	4 (3.5)
Tumour stage (*n* (%))	
– I	16 (14)
– II	15 (13.2)
– III	15 (13.2)
– IV	63 (55.3)
– Unknown	05 (4.4)
WHO performance status score (*n* (%))	
– 0	36 (31.6)
– 1	22 (19.3)
– 2	11 (9.6)
– 3	06 (5.3)
– Unknown	39 (34.2)
Treatment modality (*n* (%))	
– Primary surgery	39 (34.2)
– RT alone	24 (21.1)
– Chemoradiotherapy	46 (40.4)
– Neo-adjuvant chemotherapy	01 (0.9)
– Intensity-modulated RT	01 (0.9)
– Best supportive care	03 (2.6)

WHO = World Health Organization; RT = radiotherapy

Discussion

This prospective multicentre audit showed that the statistically significant amount of weight lost by head and neck cancer patients whilst undergoing treatment does not coincide with a drop in hand-grip strength as might be expected.

There are a few possible explanations as to why a fall in body weight may not have coincided with a fall in hand-grip strength in this study. Firstly, the weight loss seen in this study may have represented fat loss rather than lean mass. Given that changes in body fat composition have little effect on strength,[23] hand-grip strength may not have been expected to fall in these patients. Furthermore, we did not routinely measure body fat composition in this study and we are unable

TABLE II
PRE- AND POST-TREATMENT AVERAGE WEIGHT

Time	Pts (*n*)	Mean weight (range) (kg)	SD
Pre-treatment	114	72.0 (35.8–133.8)	17.6
3 months	70	68.9 (40.5–114.4)	16.2
6 months	62	67.2 (38.0–106.0)	16.1
12 months	62	70.4 (42.1–104.0)	15.2

Pts = patients; SD = standard deviation

https://doi.org/10.1017/S0022215115001486 Published online by Cambridge University Press

TABLE III
PRE- AND POST-TREATMENT AVERAGE HAND-GRIP STRENGTH

Time	Pts (*n*)	Mean grip strength (range) (kg)	SD
Pre-treatment	77	29.2 (7.3–51)	11.3
3 months	59	28.2 (9.1–47.8)	9.4
6 months	53	26.7 (6.5–54.5)	11.2
12 months	55	29.9 (10–56.7)	10.8

Pts = patients; SD = standard deviation

to investigate this further. However, in healthy individuals, hand-grip strength is correlated less strongly with weight than other strength measures such as knee extension testing, probably resulting from the lower limb muscular strength being more dependent on weight for activities of daily living.[24] Despite this, hand-grip strength does show a correlation with lower limb muscular strength and we would have expected malnourished cancer patients experiencing weight loss such as those in this study to have a lower hand-grip strength.[25]

Another possible explanation for the lack of change in hand-grip strength could be related to it being a poor predictor of nutritional status and weight loss. Whilst hand-grip strength has been shown to improve in studies of nutritional intervention in malnourished patients with inflammatory bowel disease,[26] tuberculosis[27] and benign gastrointestinal disease,[28] stroke patients,[29] and those undergoing surgery,[30] results are inconsistent in other populations such as the elderly.[31–33] A meta-analysis of 10 studies failed to show any positive effect of active nutritional intervention on hand-grip strength in older people,[34] suggesting that hand-grip strength may be more of a reflection of function rather than nutritional status.[34] This is supported by data from the Danish Head and Neck Cancer 'DAHANCA 25' study, where head and neck cancer patients were randomised to either progressive strength training and nutritional supplementation, or progressive strength training and placebo, post-treatment. Both groups had equal strength outcomes as measured by knee extension.[35]

Whilst clearly hand-grip strength may be an important outcome itself in terms of strength and function, it seems to be less important as a nutritional marker. This represents a potential need for change in the nutritional assessment of patients with head and neck cancer. Indeed, the relatively larger standard deviations seen in the values for hand-grip strength compared with body weight would suggest a larger natural variation in hand-grip strength than in weight. Therefore, it may not be a useful measurement for making inferences related to associated nutritional variables such as weight loss.

Hand-grip strength may also be affected by a number of other factors, such as psychological well-being and impairments in dexterity secondary to co-morbidities, which are independent of cancer treatment such as joint disease. It may also be affected by factors that are dependent on treatment, such as primary site, the extent of primary therapy and the nature of adjuvant treatment. However, the heterogeneity of treatments for head and neck cancer at different subsites would make further subgroup analysis of little value in this study.

Limitations

The Parenteral and Enteral Nutrition Group of the British Dietetic Association changed their recommendations regarding hand-grip strength testing after our data collection, and advised recording an average of three tests rather than a best of three tests (which is what they had previously advised).[36] Hand-grip strength measurements were standardised in this audit and readings were consistent throughout data collection. Furthermore, there is evidence to suggest that there is no difference between measuring hand-grip strengths in these ways.[37]

- **Hand-grip strength has been shown to correlate with post-operative complications, functional status and survival**
- **Hand-grip strength does not correlate with weight loss in head and neck cancer patients**
- **Hand-grip strength may provide a more useful reflection of functional state than nutritional state**

Some patients did not undergo hand-grip strength or weight testing at all three time points. Although we therefore do not have a complete data set for all patients, we have a relatively large sample size and we did adjust for incomplete data in our statistical analysis.

TABLE IV
PAIRWISE COMPARISON OF PRE- AND POST-TREATMENT MEAN WEIGHT AND HAND GRIP STRENGTH

Time comparison	Mean weight difference ± SEM (kg)	*p*	Mean change in grip strength ± SEM (kg)	*p*
Pre-treatment *vs* 3 mth	4.8 ± 1.2	0.001	1.8 ± 1.0	0.462
Pre-treatment *vs* 6 mth	4.8 ± 1.6	0.029	1.2 ± 1.0	1.00
Pre-treatment *vs* 12 mth	3.7 ± 1.7	0.207	0.2 ± 1.1	1.00

SEM = standard error of the mean; mth = months

https://doi.org/10.1017/S0022215115001486 Published online by Cambridge University Press

Conclusion

Changes in weight do not correspond with changes in hand-grip strength in patients receiving treatment for head and neck cancer. Nutritional assessment should be multifactorial and hand-grip strength should not be relied upon to routinely monitor changes in nutritional status.

Acknowledgements

The authors are grateful to the North of England Cancer Network for supporting the audit data collection process. We would like to additionally acknowledge Alan Davidson (Dietetic Assistant) for his role in the collection of data.

References

1 Frisancho AR. *Anthropometric Standards for the Assessment of Growth and Nutritional Status*. Ann Arbor: University of Michigan Press, 1990
2 Norman K, Stobäus N, Gonzalez MC, Schulzke JD, Pirlich M. Hand grip strength: outcome predictor and marker of nutritional status. *Clin Nutr* 2011;**30**:135–42
3 Daniel PM, Pratt OE, Spargo E. The metabolic homoeostatic role of muscle and its function as a store of protein. *Lancet* 1977;**310**:446–8
4 Heymsfield SB, Arteaga C, McManus C, Smith J, Moffitt S. Measurement of muscle mass in humans: validity of the 24-hour urinary creatinine method. *Am J Clin Nutr* 1983;**37**:478–94
5 Peng S, Plank LD, McCall JL, Gillanders LK, McIlroy K, Gane EJ. Body composition, muscle function, and energy expenditure in patients with liver cirrhosis: a comprehensive study. *Am J Clin Nutr* 2007;**85**:1257–66
6 Windsor JA, Hill GL. Grip strength: a measure of the proportion of protein loss in surgical patients. *Br J Surg* 1988;**75**:880–2
7 Norman K, Schutz T, Kemps M, Josef Lubke H, Lochs H, Pirlich M. The Subjective Global Assessment reliably identifies malnutrition-related muscle dysfunction. *Clin Nutr* 2005;**24**:143–50
8 Chilima DM, Ismail SJ. Nutrition and handgrip strength of older adults in rural Malawi. *Public Health Nutr* 2001;**4**:11–18
9 Pieterse S, Manandhar M, Ismail S. The association between nutritional status and handgrip strength in older Rwandan refugees. *Eur J Clin Nutr* 2002;**56**:933–9
10 Guo CB, Zhang W, Ma DQ, Zhang KH, Huang JQ. Hand grip strength: an indicator of nutritional state and the mix of postoperative complications in patients with oral and maxillofacial cancers. *Br J Oral Maxillofac Surg* 1996;**34**:325–7
11 Klidjian AM, Foster KJ, Kammerling RM, Cooper A, Karran SJ. Relation of anthropometric and dynamometric variables to serious postoperative complications. *BMJ* 1980;**281**:899–901
12 Webb AR, Newman LA, Taylor M, Keogh JB. Hand grip dynamometry as a predictor of postoperative complications reappraisal using age standardized grip strengths. *JPEN J Parenter Enteral Nutr* 1989;**13**:30–3
13 Bohannon RW. Hand-grip dynamometry predicts future outcomes in aging adults. *J Geriatr Phys Ther* 2008;**31**:3–10
14 Kerr A, Syddall HE, Cooper C, Turner GF, Briggs RS, Sayer AA. Does admission grip strength predict length of stay in hospitalised older patients? *Age Ageing* 2006;**35**:82–4
15 Humphreys J, de la Maza P, Hirsch S, Barrera G, Gattas V, Bunout D. Muscle strength as a predictor of loss of functional status in hospitalized patients. *Nutrition* 2002;**18**:616–20
16 Vecchiarino P, Bohannon RW, Ferullo J, Maljanian R. Short-term outcomes and their predictors for patients hospitalized with community-acquired pneumonia. *Heart Lung* 2004;**33**:301–7
17 Bohannon RW, Maljanian R, Ferullo J. Mortality and readmission of the elderly one year after hospitalization for pneumonia. *Aging Clin Exp Res* 2004;**16**:22–5
18 Rantanen T, Avlund K, Suominen H, Schroll M, Frändin K, Pertti E. Muscle strength as a predictor of onset of ADL dependence in people aged 75 years. *Aging Clin Exp Res* 2002;**14**(3 suppl):10–15
19 Roland N, Paleri V. *Head and Neck Cancer: Multidisciplinary Management Guidelines*, 4th edn. London: ENT UK, 2011
20 Chandrasekaran B, Ghosh A, Prasad C, Krishnan K, Chandrasharma B. Age and anthropometric traits predict handgrip strength in healthy normals. *J Hand Microsurg* 2010;**2**:58–61
21 Oken MM, Creech RH, Tormey DC, Horton J, Davis TE, McFadden ET *et al*. Toxicity and response criteria of the Eastern Cooperative Oncology Group. *Am J Clin Oncol* 1982;**5**:649–55
22 Todorovich TE, Micklewright A, eds. *A Pocket Guide to Clinical Nutrition*, 3rd edn. London: Parenteral and Enteral Nutrition Group of the British Dietetic Association, 2004
23 Goodpaster BH, Park SW, Harris TB, Kritchevsky SB, Nevitt M, Schwartz AV *et al*. The loss of skeletal muscle strength, mass, and quality in older adults: the health, aging and body composition study. *J Gerontol A Biol Sci Med Sci* 2006;**61**:1059–64
24 Bohannon RW, Magasi SR, Bubela DJ, Wang YC, Gershon RC. Grip and knee extension muscle strength reflect a common construct among adults. *Muscle Nerve* 2012;**46**:555–8
25 Norman K, Stobäus N, Smoliner C, Zocher D, Scheufele R, Valentini L *et al*. Determinants of hand grip strength, knee extension strength and functional status in cancer patients. *Clin Nutr* 2010;**29**:586–91
26 Christie PM, Hill GL. Effect of intravenous nutrition on nutrition and function in acute attacks of inflammatory bowel disease. *Gastroenterology* 1990;**99**:730–6
27 Paton NI, Chua YK, Earnest A, Chee CB. Randomized controlled trial of nutritional supplementation in patients with newly diagnosed tuberculosis and wasting. *Am J Clin Nutr* 2004;**80**:460–5
28 Norman K, Kirchner H, Freudenreich M, Ockenga J, Lochs H, Pirlich M. Three month intervention with protein and energy rich supplements improve muscle function and quality of life in malnourished patients with non-neoplastic gastrointestinal disease: a randomized controlled trial. *Clin Nutr* 2008;**27**:48–56
29 Ha L, Hauge T, Spenning AB, Iversen PO. Individual, nutritional support prevents undernutrition, increases muscle strength and improves QoL among elderly at nutritional risk hospitalized for acute stroke: a randomized, controlled trial. *Clin Nutr* 2010;**29**:567–73
30 Beattie AH, Prach AT, Baxter JP, Pennington CR. A randomised controlled trial evaluating the use of enteral nutritional supplements postoperatively in malnourished surgical patients. *Gut* 2000;**46**:813–18
31 Edington J, Barnes R, Bryan F, Dupree E, Frost G, Hickson M *et al*. A prospective randomised controlled trial of nutritional supplementation in malnourished elderly in the community: clinical and health economic outcomes. *Clin Nutr* 2004;**23**:195–204
32 Price R, Daly F, Pennington CR, McMurdo ME. Nutritional supplementation of very old people at hospital discharge increases muscle strength: a randomised controlled trial. *Gerontology* 2005;**51**:179–85
33 Smoliner C, Norman K, Scheufele R, Hartig W, Pirlich M, Lochs H. Effects of food fortification on nutritional and functional status in frail elderly nursing home residents at risk of malnutrition. *Nutrition* 2008;**24**:1139–44
34 Milne AC, Avenell A, Potter J. Meta-analysis: protein and energy supplementation in older people. *Ann Intern Med* 2006;**144**:37–48. Erratum in: *Ann Intern Med* 2006;144:538
35 Lønbro S, Dalgas U, Primdahl H, Overgaard J, Overgaard K. Feasibility and efficacy of progressive resistance training and dietary supplements in radiotherapy treated head and neck cancer patients–the DAHANCA 25A study. *Acta Oncol* 2013;**52**:310–18
36 Todorovich TE, Micklewright A, eds. *A Pocket Guide to Clinical Nutrition*, 4th edn. London: Parenteral and Enteral Nutrition Group of the British Dietetic Association, 2011
37 Innes E. Handgrip strength testing: a review of the literature. *Aust Occup Ther J* 1999;**46**:120–40

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Prof V Paleri takes responsibility for the integrity of the content of the paper
Competing interests: None declared