Original Article

Hand grip strength measurement in haemodialysis patients: before or after the session?

Pierre Delanaye¹,*, Kevin Quinonez¹,*, Fanny Buckinx², Jean-Marie Krzesinski¹ and Olivier Bruyère²

¹Department of Nephrology, Dialysis, Hypertension, University of Liège (ULg CHU), Liège, Belgium and ²Department of Public Health, Epidemiology and Health Economics, University of Liège (ULg CHU), Liège, Belgium

Correspondence and offprint requests to: Pierre Delanaye; E-mail: pierre_delanaye@yahoo.fr

*These authors equally contributed to this work.

Abstract

Background: Hand grip strength (HGS) is a key measurement in the assessment of frailty phenotype in haemodialysis patients. However, the measurement is not very standardized, and notably, current data on the potential impact of a haemodialysis session on the results are both limited and controversial. In the present analysis, we compared HGS results before and after a haemodialysis session in 101 patients.

Methods: In the current observational study, HGS has been measured in adult haemodialysis patients on the same day, first before connection to the dialysis machine and then just after disconnection. At each timing, measurements were repeated three times with an interval of 5 s between measurements and the higher value was used for analysis.

Results: One hundred and one patients (64% men) with a median (interquartile range, 25th percentile; 75th percentile) age of 66 (46; 76) years were included. In the whole population, a significant decline in HGS was observed after dialysis, with an absolute median decline of −4 (0; −6) kg and a relative median difference of −11 (0; −20)%. These differences were observed in both genders and were independent of the baseline HGS value.

Conclusions: Our results suggest that the timing (before or after the dialysis session) of hand grip assessment is clinically relevant and should be taken into account in clinical practice and also in epidemiological and clinical studies.

Key words: chronic haemodialysis, elderly, frailty, hand grip strength

Introduction

Hand grip strength (HGS) is a key parameter in the definition of several important phenotypes in medicine such as sarcopenia, malnutrition or frailty [1–3]. These concepts have also been studied in the specific population of dialysis patients, showing a high prevalence, and strong association with mortality [4–17]. The classical technique to measure HGS uses a dynamometer. The method is simple, rapid, inexpensive and standardized in the geriatric population [18]. The method is, however, less standardized in haemodialysis patients [8, 9, 19–21]. Few data are available about the influence of the timing of the measurement, i.e. before or after the dialysis session, on the results [9, 21]. This is the goal of the present study.
Materials and methods

In this observational study, HGS results were compared before and after a dialysis session in patients of the University Hospital of Liège, Belgium between February and October 2016. All patients at our centre who were able to walk on their own were considered for the analysis. Nineteen patients could not (dementia), or refused to sign the consent. HGS results were not available after the dialysis session in seven patients, leading to a final sample of 101 patients. HGS was measured in the same patient, in the same condition, and on the same day, before connection to the dialysis machine, and then just after disconnection. Before and after the dialysis session, measurements were repeated three times with an interval of 5 s between disconnections. Before and after the dialysis session, measurements were repeated three times with an interval of 5 s between disconnections.

The protocol was approved by the hospital Ethics Committee (Belgian number: B707201525774) and all patients signed informed consent.

Data are expressed as mean ± standard deviation when distribution was normal and as median with interquartile range (25th percentile; 75th percentile) when not. Wilcoxon tests were used to compare results before and after dialysis and Mann–Whitney test to compare results of different subgroups. McNemar test was used to study percentages of patients with low HGS results and Pearson’s coefficient of correlation to study association between HGS and age. Regression analysis was used to study the potential linear relationship between HGS before dialysis or the difference of results before and after dialysis on one hand, and clinical or dialysis parameters on the other. Multivariate analysis was performed using stepwise backward selection. The following variables were available to be used in the model: age, gender, body mass index (BMI), dialysis vintage, hours of dialysis and dialysis mode (haemodiafiltration versus haemodialysis). All statistics have been performed with MedCalc (Mariakerke, Belgium).

RESULTS

One hundred and one patients were included, and 64% were men. Median age was 66 (46; 76) years (mean value 60 ± 20). Mean dry weight was 68.1 ± 16.3 kg, mean height was 167 ± 11 cm and median BMI was 23.8 (20.8; 26.8) kg/m². Forty-two percent were diabetic, 88% were hypertensive and 44% had a history of cardiovascular disease. Among dialysis parameters, median dialysis vintage was 25 (11.5; 48) months, 71% were treated by haemodiafiltration and 29% by haemodialysis, and the vast majority of patients were treated by a 4-h session (only 4% of patients were treated <4 h). Twenty percent of patients were dialysed on a catheter, whereas 80% were dialysed on a fistula [among the 81 patients dialysed on a fistula, 15 (19%) had fistula on the dominant arm]. Median HGS values before dialysis session was 28 (20; 38.5) kg.

Women had lower HGS values compared with men: 20 (14; 26) versus 34 (24; 40.5) kg, respectively, (P < 0.0001) (Table 2). A negative correlation was found between HGS results and age (r = −0.54, P < 0.0001). In the multiple regression analysis, age, female gender, BMI and dialysis modality (patients treated by haemodiafiltration had higher HGS results) were associated with HGS results. Using the widely adopted cut-off to define low muscle strength [1], 41% of patients had low HGS before dialysis session (39% of men and 42% of women, not significant). HGS results after dialysis are shown in Table 2. Results after dialysis were significantly lower than before [24 (16; 36) versus 28 (20; 38.5) kg, P < 0.0001]. The median decline was −4 (0; 6) kg and relative median difference was −11 (0;−20)% (Table 3). Such a significant difference was equally observed in both genders (Table 3). The decline in HGS was present in patients with normal baseline results (n = 60): 36 (28–44) versus 34 (23–41) kg before and after dialysis (P < 0.0001), respectively. In patients with low baseline results (n = 41), a significant lower value was also observed after dialysis: 20 (14–24.5) kg versus 16 (11.5–20.5) kg (P < 0.0001). The percentage of patients with low HGS values increased from 41% before the session to 54% after the session (P = 0.001).

DISCUSSION

In the current analysis, we showed that the timing of the hand grip measurement, i.e. before or after a dialysis session, impacts the results. Indeed, both a statistically significant and clinically relevant decline in HGS is observed after the dialysis session. The decline in HGS after dialysis leads to an increase of 13% of patients who would be considered to have low HGS, according to the Fried frailty score [1]. To the best of our knowledge, only two previous publications had studied the impact of the timing on the results of HGS in haemodialysis patients. Both were on Brazilian patients, but showed discrepant results [9, 21]. Leal et al. showed no difference in HGS before and after dialysis [9]. They also measured HGS with arm extended, but on the arm without fistula. Mean age, weight and height were similar to the current cohort. However, the sample size was limited (n = 43); HGS results were much lower in this cohort (14 ± 7 and

Table 1. Definition of low HGS results according to Fried criteria [1]

| Men | Cut-off for HGS criteria for frailty (kg) | Women | Cut-off for HGS criteria for frailty (kg) |
|-----|----------------------------------------|-------|----------------------------------------|
| BMI (kg/m²) | | BMI (kg/m²) | |
| ≤24 | ≤29 | ≤23 | ≤17 |
| 24.1–26 | ≤30 | 23.1–26 | ≤17.3 |
| 26.1–28 | ≤30 | 26.1–29 | ≤18 |
| >28 | ≤32 | >29 | ≤21 |

Table 2. HGS results in the global population and according to gender

| Median (P25; P75) | Median (P25; P75) | P-values | Percentage decrease in HGS |
|-------------------|-------------------|----------|---------------------------|
| before dialysis | after dialysis (Wilcoxon test) | | |
| HGS (kg) | HGS (kg) | (before and after dialysis) | |
| All (n = 101) | 28 (20–38.5) | 24 (16–36) | <0.0001 | 41 |
| Men (n = 65) | 34 (24–40.5) | 30 (20–40) | <0.0001 | 42 |
| Women (n = 36) | 20 (14–26) | 16 (12–22) | <0.0001 | 39 |

HGS results are significantly lower in women. All results after dialysis were significantly lower than results before dialysis. P25 and P75 for 25th and 75th percentiles, respectively.
In the current cohort, no correlation was found between ultrafiltration (absolute or scaled to dry weight) and results. The choice of the arm for HGS measurement should be taken into account in clinic practice as well as in further epidemiological and clinical studies. To decrease the intra-patient variability of HGS measurement observed in dialysis patients, it is mandatory to measure HGS at the same timing with regards to the dialysis session, and we suggest that before the dialysis session (before connection to the machine) would be the best moment.

### Acknowledgements

The authors gratefully acknowledge the data nurse manager Arnaud Borsu for his help in the collection of data.

### Conflict of interest statement

None declared.

### References

1. Fried LP, Tangen CM, Walston J et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001; 56: M146–M156
2. Dodds RM, Syddall HE, Cooper R et al. Global variation in grip strength: a systematic review and meta-analysis of normative data. Age Ageing 2016; 45: 209–216
3. Norman K, Stobâus N, Gonzalez MC et al. Hand grip strength: outcome predictor and marker of nutritional status. Clin Nutr 2011; 30: 135–142
4. Johansen KL, Dalrymple LS, Delgado C et al. Association between body composition and frailty among prevalent hemodialysis patients: a US Renal Data System Special Study. J Am Soc Nephrol 2014; 25: 381–389
5. Kittiskulnam P, Chertow GM, Carrero JJ et al. Sarcopenia and its individual criteria are associated, in part, with mortality among patients on hemodialysis. Kidney Int 2017; 92: 238–247
6. Johansen KL, Dalrymple LS, Delgado C et al. Factors associated with frailty and its trajectory among patients on hemodialysis. Clin J Am Soc Nephrol 2017; 12: 1100–1108
7. Johansen KL, Chertow GM, Jin C et al. Significance of frailty among dialysis patients. J Am Soc Nephrol 2007; 18: 2960–2967
8. Leal VO, Mafra D, Fouque D et al. Use of handgrip strength in the assessment of the muscle function of chronic kidney disease patients on dialysis: a systematic review. Nephrol Dial Transplant 2011; 26: 1354–1360
9. Leal VO, Stockler-Pinto MB, Farage NE et al. Handgrip strength and its dialysis determinants in hemodialysis patients. Nutrition 2011; 27: 1125–1129
10. van Loon IN, Goto NA, Boereboom FTJ et al. Frailty screening tools for elderly patients incident to dialysis. Clin J Am Soc Nephrol 2017; 12: 1280–1288
11. van Loon IN, Wouters TR, Boereboom FTJ et al. The relevance of geriatric impairments in patients starting dialysis: a systematic review. Clin J Am Soc Nephrol 2016; 11: 1245–1259
12. Wang AY, Sea MM, Ho ZS et al. Evaluation of handgrip strength as a nutritional marker and prognostic indicator in peritoneal dialysis patients. Am J Clin Nutr 2005; 81: 79–86
13. Fouque D, Kalantar-Zadeh K, Kopple J et al. A proposed nomenclature and diagnostic criteria for protein-energy wasting in acute and chronic kidney disease. Kidney Int 2008; 73: 391–398
14. Heimbürger O, Qureshi AR, Blaner WS et al. Hand-grip muscle strength, lean body mass, and plasma proteins as markers of nutritional status in patients with chronic renal failure close to start of dialysis therapy. Am J Kidney Dis 2000; 36: 1213–1225
15. Stenvinkel P, Barany P, Chung SH et al. A comparative analysis of nutritional parameters as predictors of outcome in male and female ESRD patients. Nephrol Dial Transplant 2002; 17: 1266–1274
16. Vogt BP, Borges MC, Goés CR et al. Handgrip strength is an independent predictor of all-cause mortality in maintenance dialysis patients. Clin Nutr 2016; 35: 1429–1433
17. Chang YT, Wu HL, Guo HR et al. Handgrip strength is an independent predictor of renal outcomes in patients with chronic kidney diseases. Nephrol Dial Transplant 2011; 26: 3588–3595
18. Roberts HC, Denison HJ, Martin HJ et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age Ageing 2011; 40: 423–429
19. Jamal SA, Leiter RE, Jassal V et al. Impaired muscle strength is associated with fractures in hemodialysis patients. Osteoporos Int 2006; 17: 1390–1397
20. Carrero JJ, Chmielewski M, Axelson J et al. Muscle atrophy, inflammation and clinical outcome in incident and prevalent dialysis patients. Clin Nutr 2008; 27: 557–564
21. Pinto AP, Ramos CI, Meireles MS et al. Impact of hemodialysis session on handgrip strength. J Bras Nephrol 2015; 37: 451–457
22. Limaye V, Frankham A, Disney A et al. Evaluation of hand function in patients undergoing long term haemodialysis. Ann Rheum Dis 2001; 60: 278–280
23. Kang SH, Do JY, Lee S-Y et al. Effect of dialysis modality on frailty phenotype, disability, and health-related quality of life in maintenance dialysis patients. Plos One 2017; 12: e0176814
24. Howden EJ, Fassett RG, Isbel NM et al. Exercise training in chronic kidney disease patients. Sports Med 2012; 42: 473–488
25. Chandwaney R, Leichtweis S, Leeuwenburgh C et al. Oxidative stress and mitochondrial function in skeletal muscle: effects of aging and exercise training. Age (Omaha) 1998; 21: 109–117
26. Babsky EB, Minajef PV. Combined action upon muscle of adenosine triphosphate, acetylcholine and potassium, calcium and magnesium ions. Nature 1946; 158: 238
27. Carrero JJ, Johansen KL, Lindholm B et al. Screening for muscle wasting and dysfunction in patients with chronic kidney disease. Kidney Int 2016; 90: 53–66
28. Schlüssel MM, dos Anjos LA, de Vasconcellos MT et al. Reference values of handgrip dynamometry of healthy adults: a population-based study. Clin Nutr 2008; 27: 601–607
29. Qureshi AR, Alvestrand A, Danielsson A et al. Factors predicting malnutrition in hemodialysis patients: a cross-sectional study. Kidney Int 1998; 53: 773–782