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ORIGINAL ARTICLE

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

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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 sarcopaenia, 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.

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

Men		Women	
BMI (kg/m^2)	Cut-off for HGS criterion for frailty (kg)	BMI (kg/m^2)	Cut-off for HGS criterion for frailty (kg)
≤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

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 measurements and the higher value was used for analysis [19]. The same Jamar dynamometer (Jamar® Hydraulic Hand Dynamometer, Model 5030J1, Patterson Medical, Warrenville, IL, USA) with a usual precision of 0.5 kg was used for all measurements, in Position 2 [22]. Measurements were realized in a sitting position with the dominant arm extended [18]. The criteria proposed by Fried was considered to define low versus normal HGS values (Table 1) [1].

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–Withney 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/m^2. 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.

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

	Median (P25; P75) HGS (kg) before dialysis	Median (P25; P75) HGS (kg) after dialysis	P-values (before and after dialysis) (Wilcoxon test)	Percentage decrease in HGS
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)	18 (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.

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 women and 42% of men, 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 3. Absolute and relative differences between HGS according to gender and baseline HGS (low versus normal)

	Absolute median (P25; P75) difference of HGS before and after dialysis	Relative median (P25; P75) difference of HGS before and after dialysis (%)	P-values (before and after dialysis) (Wilcoxon test)
All ($n = 101$)	−4 (0; −6)	−11 (0; −20)	<0.0001
Men ($n = 65$)	−4 (0; −6)	−9 (0; −17)	<0.0001
Women ($n = 36$)	−2 (1; −4)	−14 (−3; −23)	<0.0001
Low baseline results ($n = 41$)	−2 (0; −4)	−14 (0; −22)	<0.0001
Normal baseline results ($n = 60$)	−4 (0; −6)	−10 (0; −17)	<0.0001

P25 and P75 for 25th and 75th percentiles, respectively.

30 ± 10 kg in women and men, respectively) than in ours. Importantly, it was not clear from this publication when the measurements of HGS were realized (before or after the connection to the machine). Pinto *et al*. also measured HGS on the arm without fistula but with the elbow flexed at a 90-degree angle [21]. Measurement was realized before connection to the machine. The sample was larger than in Leal *et al*. or our study ($n = 156$). Mean weight and BMI were similar to our cohort but the patients were younger (median 56 years old) and fewer were diabetic (28.8%). HGS results were similar to the values we observed (24 ± 10 and 33 ± 11 kg in women and men, respectively). They also observed a significant decline of HGS after the dialysis session, even if the magnitude of this decline seems less important than in our patients (from 28.6 ± 11.4 to 27.7 ± 11.7 kg).

If the timing is relevant, there is also a debate in the literature regarding the choice of the arm to be tested. Some authors prefer to consider the arm without fistula, arguing that problems with the fistula could occur (especially a risk of bleeding because the arm is overexerted after the session) [8]. Like other authors [20], we measured HGS on the dominant arm but just before connection and just after disconnection (after bleeding stopped), to limit the impact on the fistula. The choice of the dominant arm can be justified in the light of a need for standardization. Indeed, measuring HGS on the dominant arm is the only way to compare adequately patients dialysed with a fistula versus a catheter (20% in the current cohort) or haemodialysed patients with patients on peritoneal dialysis or transplanted [23]. In our cohort, patients with fistula on the dominant arm ($n = 15$) had the same median HGS results (both before and after dialysis) as patients with fistula on the non-dominant arm ($n = 69$) (data not shown). Further studies with a larger sample size are mandatory to study the impact of the fistula on HGS results.

The current study is observational, and possible reasons that could explain such differences in results before and after the dialysis session are hypothetical: (i) ultrafiltration over a 4-h period is not physiological [8]; (ii) dialysis session is an important source of oxidant stress, which could impact the muscular function [24, 25]; and (iii) dialysis induces large modifications of different ions concentrations that could also impact the muscle strength [26]. In the current cohort, no correlation was found between ultrafiltration (absolute or scaled to dry weight) and the difference of HGS before and after the dialysis (data not shown).

There are limitations to this study. We used the definition of low HGS results according the references values proposed by Fried to define the phenotype of frailty [1]. Even though these normal reference ranges have been used by others in dialysis populations [7, 10, 27], the establishment of normality could require specific studies in dialysis cohorts [8]. We suspect that HGS results could be influenced by the dialysis session in itself (and events that can randomly occur during the session, such as hypotension), suggesting that HGS results before the session could be preferable. However, this remains to be proven by longitudinal studies comparing the predictive value of HGS before and after the session on clinical outcomes. In the present analysis, we focused on one important factor (the timing of measurement) potentially influencing the results in the same patient (intra-patient variability). We did not study the impact of the day of week on the measurement. Also, it was beyond the scope of the study to analyse the factors that explain differences in HGS between patients (inter-patient variability). In this context, we have not extensively studied all the potential factors (inflammation, dialysis efficiency, etc.) influencing the HGS results in dialysis patients. However, in our limited model, we confirmed that gender and age influenced HGS results [8, 12, 15, 21, 28, 29]. Also, the impact of dialysis modality is associated with HGS but there is a high risk of bias by indication, the frailer patients being treated by haemodialysis in our institution.

In conclusion, we confirmed that HGS significantly decreases after the dialysis session, in both males and females and in patients with both normal and low HGS results at baseline [21]. The timing of the 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.

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Conflict of interest statement

None declared.

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