The 1-minute sit-to-stand test to evaluate quadriceps muscle strength in patients with interstitial lung disease.

Benoit Wallaert, Justine Briand, Helene Behal, Thierry Perez, Ludivine Wemeau, Cecile Chenivesse

The 1-Minute Sit-to-Stand Test to Evaluate Quadriceps Muscle Strength in Patients with Interstitial Lung Disease

Benoit Wallaert [1,2,3], Justine Briand [1], Hélène Behal [2,4],

Thierry Perez [1,2,3], Lidwine Wemeau [1,2,3] and Cécile Chenivesse[1,2,3]

[1]CHU Lille, Service de Pneumologie et Immuno-Allergologie, Centre Constitutif de Référence des Maladies Pulmonaires Rares, Lille, France

[2]University of Lille, Lille, France

[3]Institut National de la Santé Et de la Recherche Médicale, U1019, UMR 9017, Center for Infection and Immunity of Lille, Institut Pasteur de Lille, Lille, France

[4] CHU Lille, ULR 2694 - METRICS: Évaluation des Technologies de Santé et des Pratiques Médicales, Lille, France

Corresponding author: Pr. B. Wallaert, bwallaert@gmail.com

Running head: Quadriceps Muscle Strength and the 1-Min STS test

Keywords: interstitial lung disease, sarcoidosis, pulmonary fibrosis, muscle strength, sit-to-stand test

Number of words: 983

Number of references: 10

Skeletal muscle dysfunction is prevalent in patients with chronic respiratory diseases. In patients with interstitial lung diseases (ILDs), such dysfunction has been associated with lower exercise capacity and reduced quality of life [1–4]. Although evaluation of quadriceps strength is useful for monitoring progress during pulmonary rehabilitation (PR), it is not easily performed outside of specialized units. Exercise training is the most effective method for improving quadriceps strength [5]. Therefore, we investigated whether an exercise test could act as a surrogate measure of quadriceps strength in ILD patients.

We recently found that the number of repetitions performed during the 1-minute sit-to-stand test (1STST) correlated strongly with exercise performance in the 6-minute walk test (6MWT) in patients with ILDs [6]. The 1STST requires a chair but no specialized equipment and it is easy to perform, making it an ideal exercise test for use in the physician's office. The aim of the present study was to determine whether performance in the 1STST correlates with quadriceps muscle strength in patients with ILDs.

We enrolled all patients with ILDs (n = 107) who were admitted for assessment at the Rare Lung Disease Reference Center in Lille between May and December 2015, regardless of disease etiology or severity. Exclusion criteria were an inability to perform the 1STST, unstable respiratory status, or recent respiratory infection. Approval for the use of these retrospectively collected data was provided by the Institutional Review Board of the French Learned Society for Pulmonology (CEPRO 2011-039), and informed consent was obtained from all patients.

As routinely performed, clinical characteristics and pulmonary function tests were recorded. Patients performed muscle strength tests followed by the 1STST, or vice versa, on the same day in a random order. A rest period of at least 30 minutes was allowed between

the tests to ensure complete recovery. One technician supervised the 1STST for all patients, and another technician supervised the muscle strength test for all patients. Both technicians were blind to the results of the other test. The 1STST was performed as previously described [6]. Briefly, the patient was seated upright on a chair of standard height (46 cm) without arm rests positioned against a wall. The patient sat with knees and hips flexed at 90°, feet placed flat on the floor hip-width apart, and arms held stationary by placing hands on the hips. Subjects were asked to perform repetitions of standing upright and then sitting down in the same position, as many times as possible at a self-paced speed (safe and comfortable) for 1 minute, without using their arms for support while rising or sitting. Subjects were permitted to rest within the 1-minute period. The maximum isometric voluntary force of the quadriceps muscle was measured by an isometric method using a hand-held dynamometer (MicroFet2; Hoggan Health Industries, Salt Lake City, UT, USA) held by a strap at a fixed point. A total of five measurements per leg, each for 5 s, were taken and the maximum value was used for analysis [7].

Continuous variables are presented as the mean ± standard deviation. Normality of distribution was checked graphically and using the Shapiro–Wilk test. The relationship between quadriceps muscle strength and 1STST repetitions in the overall population was evaluated by Pearson's correlation coefficient. Data were analyzed using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA) and all tests were performed with a two-tailed alpha error of 0.05.

A total of 107 patients were included in this retrospective analysis (62 men, 45 women, age 57 ± 14 years, BMI 28 ± 5 kg/m², FVC 83 ± 19 % predicted, FEV1 75 ± 22 % predicted, and DLCO 75 ± 22 % predicted). Of the 107, 31 patients had sarcoidosis, 21 had idiopathic

pulmonary fibrosis, 25 had fibrotic non-specific interstitial pneumonia, 5 had chronic hypersensitivity pneumonitis and 25 had miscellaneous other ILDs. The average number of 1STST repetitions for all patients was 21 ± 6, and the average strengths of the right and left quadriceps were 354 ± 135 N and 332 ± 124 N, respectively. As shown in Figure 1, the number of 1STST repetitions for all patients correlated with the right quadriceps strength, left quadriceps strength, and age, but not with weight, body mass index, or FVC.

Interestingly, Lord et al. [8], in their study of 669 subjects aged 75–93 years, indicated that STS performance was influenced not only by multiple physiological and psychological processes such as sensorimotor, balance, and psychological factors, but also by quadriceps strength; indeed, the latter was the most important variable in explaining the number of repetitions during a STST. Four previous studies have identified reduced quadriceps endurance and strength in patients with sarcoidosis [1][4] or f-IIP [2][3][9]. Skeletal muscle weakness is associated with exercise intolerance (maximum oxygen uptake or 6-minute walking distance) and is a predictor of exercise capacity. In a study of 25 patients with sarcoidosis, Spruit et al. reported that skeletal weakness might be related to corticosteroid treatment [1], and in their study of 98 patients with various ILDs, Hanada et al. found that corticosteroid treatment contributed to muscle weakness [10]. Evaluation of the influence of steroids was beyond the scope of the present study.

Nishiyama et al. studied 25 patients with sarcoidosis and showed that exercise limitation was observed even in patients with mildly impaired lung function, and that maximum oxygen uptake and muscle weakness were correlated [2]. It is also interesting to note that the reduction in skeletal muscle endurance in idiopathic pulmonary fibrosis patients identified here was not related to hypoxia or disease duration. Taken together, these results imply that peripheral muscle training during PR could increase the exercise capacity of

patients with ILDs.

In conclusion, we found that quadriceps strength correlated with performance in the 1STST in patients with ILDs, suggesting that this simple exercise may be a valuable tool for assessing skeletal muscle dysfunction in a clinical setting. However, this should be further evaluated in prospective studies.

Conflicts of interest

The authors disclose no financial or personal relationships with people or organizations that could inappropriately influence this work.

Ethical statement

Approval for the use of these data was provided by the Institutional Review Board of the French Learned Society for Pulmonology **(**CEPRO 2011-039) and informed consent was obtained from all patients.

Figure 1. Correlation between 1STST repetitions and right and left quadriceps strength and age.

N, Newton.

References

[1] Spruit MA, Thomeer MJ, Gosselink R, Troosters T, Kasran A, Debrock AJT, et al. Skeletal muscle weakness in patients with sarcoidosis and its relationship with exercise intolerance and reduced health status. Thorax 2005;60:32–8. https://doi.org/10.1136/thx.2004.022244.

[2] Nishiyama O, Taniguchi H, Kondoh Y, Kimura T, Ogawa T, Watanabe F, et al. Quadriceps weakness is related to exercise capacity in idiopathic pulmonary fibrosis. Chest 2005;127:2028–33. https://doi.org/10.1378/chest.127.6.2028.

[3] Watanabe F, Taniguchi H, Sakamoto K, Kondoh Y, Kimura T, Kataoka K, et al. Quadriceps weakness contributes to exercise capacity in nonspecific interstitial pneumonia. Respir Med 2013;107:622–8. https://doi.org/10.1016/j.rmed.2012.12.013.

[4] Marcellis RGJ, Lenssen AF, Elfferich MDP, De Vries J, Kassim S, Foerster K, et al. Exercise capacity, muscle strength and fatigue in sarcoidosis. Eur Respir J 2011;38:628–34. https://doi.org/10.1183/09031936.00117710.

[5] Maltais F, Decramer M, Casaburi R, Barreiro E, Burelle Y, Debigaré R, et al. An official American Thoracic Society/European Respiratory Society statement: update on limb muscle dysfunction in chronic obstructive pulmonary disease. Am J Respir Crit Care Med 2014;189:e15-62. https://doi.org/10.1164/rccm.201402-0373ST.

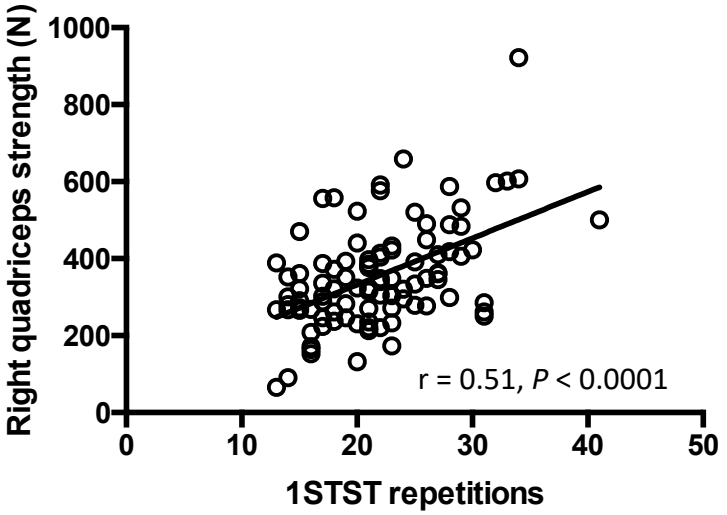
[6] Briand J, Behal H, Chenivesse C, Wémeau-Stervinou L, Wallaert B. The 1-minute sit-to-stand test to detect exercise-induced oxygen desaturation in patients with interstitial lung disease. Ther Adv Respir Dis 2018;12:1753466618793028. https://doi.org/10.1177/1753466618793028.

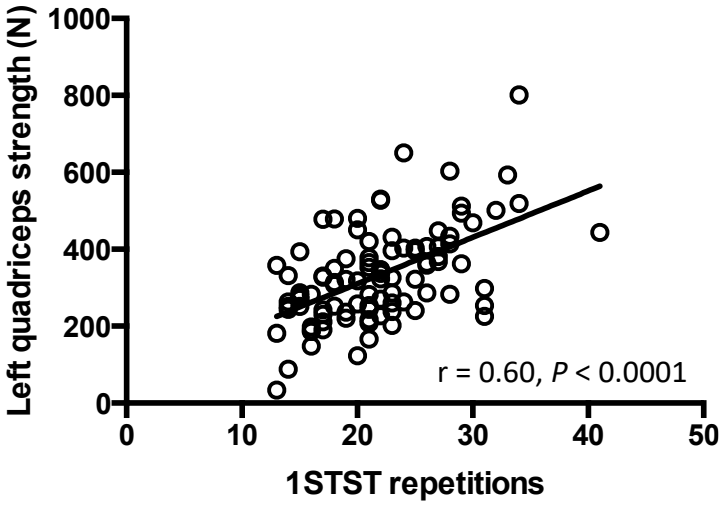
[7] Prévotat A, Godin J, Bernard H, Perez T, Le Rouzic O, Wallaert B. Improvement in body composition following a supervised exercise-training program of adult patients with cystic fibrosis. Respir Med Res 2019;75:5–9. https://doi.org/10.1016/j.resmer.2019.04.001.

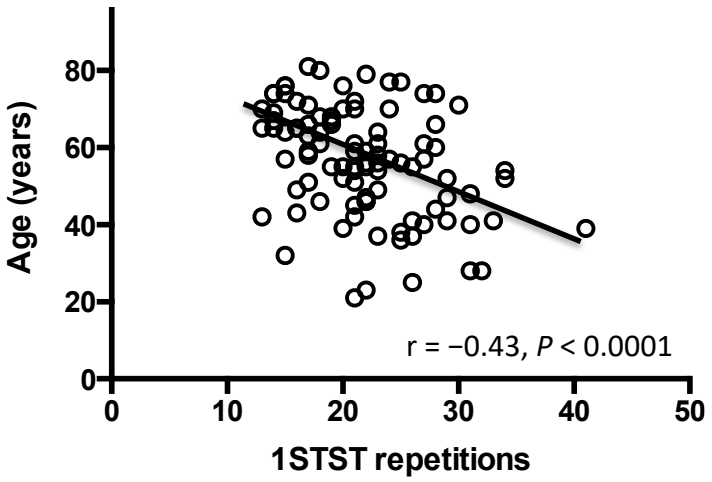
[8] Lord SR, Murray SM, Chapman K, Munro B, Tiedemann A. Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. J Gerontol A Biol Sci Med Sci 2002;57:M539-543. https://doi.org/10.1093/gerona/57.8.m539.

[9] Mendoza L, Gogali A, Shrikrishna D, Cavada G, Kemp SV, Natanek SA, et al. Quadriceps strength and endurance in fibrotic idiopathic interstitial pneumonia. Respirology 2014;19:138–43. https://doi.org/10.1111/resp.12181.

[10] Hanada M, Sakamoto N, Ishimatsu Y, Kakugawa T, Obase Y, Kozu R, et al. Effect of long-term treatment with corticosteroids on skeletal muscle strength, functional exercise capacity and health status in patients with interstitial lung disease. Respirology 2016;21:1088–93. https://doi.org/10.1111/resp.12807.


Right quadriceps strength (N)
1000
800
600
400
200
0
0
10
20
30
40
50
1STST repetitions
r = 0.51, P < 0.0001


Left quadriceps strength (N)
1000
800
600
400
200
0
0
10
20
30
40
50
1STST repetitions
r = 0.60, P < 0.0001


Age (years)
80
60
40
20
0
0
10
20
30
40
50
1STST repetitions
r = −0.43, P < 0.0001