

Translation, cross-cultural adaptation and validation of the Hamstring Outcome Score (HaOS) in French for surgically treated hamstring injuries

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Background: The Hamstring Outcome Score (HaOS) is a patient-reported outcome measure designed to assess function following hamstring injuries. No French version currently exists.

Purpose: To translate, culturally adapt, and validate the HaOS in French (HaOS-Fr) in a cohort of patients undergoing surgical repair for proximal hamstring avulsion injuries (PHAI).

Methods: A prospective study was conducted between July 2020 and July 2022 in a sport surgery center. Forty-eight French-speaking patients who had undergone surgical treatment for PHAI were included at 6 months postoperatively. The HaOS questionnaire was translated and culturally adapted using international guidelines, including forward and backward translation, expert committee review, and pretesting. Psychometric evaluation was performed according to COSMIN criteria. Construct validity was assessed by comparing HaOS with the UCLA activity scale, Tegner scale, Lysholm score, and subjective hip value. Discriminant validity was tested by comparing injured vs. uninjured sides. Test-retest reliability was evaluated in 10 patients. Return to sport (RTS) was also documented.

Results: The HaOS-Fr showed excellent internal consistency (Cronbach's $\alpha = 0.93$) and excellent test-retest reliability (ICC = 0.90, 95% CI [0.86–0.94]). Construct validity showed strong correlation with Lysholm ($r = 0.801$), moderate with UCLA ($r = 0.478$), and weak with subjective hip value ($r = 0.297$); correlation with Tegner was not significant ($p = 0.066$). HaOS scores were significantly higher in uninjured limbs ($p < 0.001$). Among 48 patients, 64.6% returned to sport, and 64.5% of them at the same level. ROC analysis for RTS prediction showed AUC = 0.631 ($p = 0.14$). No floor or ceiling effects were detected.

Conclusion: The HaOS-Fr is a valid, reliable, and feasible tool for evaluating outcomes in French-speaking patients after surgical treatment for PHAI. It enables functional assessment and contributes to reinjury risk stratification.

What this study adds: This is the first French translation and cross-cultural adaptation of the Hamstring Outcome Score (HaOS) specifically validated in surgically treated proximal hamstring avulsion injuries (PHAI). The HaOS-Fr demonstrated excellent internal consistency ($\alpha = 0.93$) and test–retest reliability (ICC = 0.90), strong convergent validity with Lysholm and moderate with UCLA, clear discriminant validity between injured vs uninjured limbs, and no floor/ceiling effects—supporting its clinical feasibility.

How this study might affect research, practice or policy: The HaOS-Fr enables standardized, French-language functional assessment after PHAI surgery, facilitating research. Clinically, it supports follow-up and patient counseling and can contribute to reinjury-risk stratification pathways. Its adoption could harmonize outcome reporting across French-speaking centers and inform guideline development.

Study Design: Prospective translation, cross-cultural adaptation, and psychometric validation

Level of evidence: II

Keywords: Hamstring injury; Return to sport; PROMs; HaOS

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Introduction

Hamstring muscle injuries are very common, representing up to 12% of all injuries and are most frequent during sporting practices involving linear acceleration or high-speed running [1]. These injuries occur in both recreational and professional sports [1][2]. Among them, Proximal Hamstring Avulsion Injuries (PHAI) require specific treatment. The variability in prognosis and treatment of different types of lesions emphasizes the importance of rapid diagnosis by magnetic resonance imaging (MRI) to accurately classify lesions and plan appropriate management [3]. Nonoperative management is associated with variable times for convalescence and return to a pre-injury level of sporting function; it is indicated in case of partial PHAI when there is less than 2 cm retraction [4][5][6][7][8]. Patients with initial complete PHAI involving both conjoint tendon and semimembranosus tendon, and those with tendon retraction of more than 2 cm, can be treated surgically [9][10][11][12].

Outcomes of surgical treatment for PHAI are well-documented in the literature, with follow-ups evaluated by several outcome measures [13]. Yet there is no consensus on the best outcome measures for evaluating patients post-repair. Some scores present the superiority of predicting return to sport, like the Proximal Hamstring Avulsion Score (PHAS) [14]. Others, like the Hamstring Outcome Score (HaOS), predict reinjury risk [15][16]. The HaOS is a patient-reported outcome measure developed to assess multiple aspects, including soreness, symptoms, pain, sports activities, and quality of life [15][16]. Engebretsen et al utilized the HaOS in a randomized controlled trial with 508 soccer players to determine if the questionnaire could identify players at high risk of injury and if targeted exercise could prevent injuries [15]. The study found that the HaOS effectively identified high-risk players. Studies following this publication confirmed the potential of this score in the prognostication and identification of previous and future reinjury risk [16]. Despite its utility, a French version does not yet exist.

The aim of the study was to translate, cross-culturally adapt and validate the Hamstring Outcome Score (HaOS) in French to examine its psychometric properties, and to confirm its validity and reliability.

Methods

Study design

This prospective study was conducted from July 2020 to July 2022 in sport surgery center. Native French-speakers patients presenting with a diagnosis of PHAI, surgically treated, were recruited in the 6th month following their operation. Patients were operated on following the technique described by Lefevre et al.

The exclusion criteria were patients who do not speak and/or understand French, patients who had surgery on both sides. The uninjured side was considered as a control group.

This study was approved by the regional Ethics Committee (IRB; CPPIDFIV, Groupe Hospitalier Pitié Salpêtrière, CNIL 1556375v0). Each participant provided written informed consent.

French translation and cross-cultural adaptation of the HaOS questionnaire

The HaOS questionnaire was translated according to the international recommendations for the cross-cultural

adaptation of self-administered questionnaires [17], composed of six steps:

- *Initial translation*

The original questionnaire (English language) was translated twice (T1 and T2) in French by two independent bilingual translators, native French-speakers one of whom is an orthopedic specialist, and the other is inexperienced in this area.

- *Synthesis of the translations*

During a meeting between the translators, a synthesized version (T1–2) of the two translations (T1 and T2) was developed, taking into account any difficulties encountered when translating certain words or expressions.

- *Back translation*

This was first back translated into English by two native English-speakers who spoke French as a second language. They were not doctors and not aware of the original version. From their translations, two new English versions (V1-1 and V1-2) were developed, allowing us to check that the French translation incorporated and respected the concepts of the original version.

- *Expert Committee*

A meeting to harmonize the French scale was held, with the experts to modify the different translations in case of linguistic inaccuracies or cultural differences. The different translations were analyzed, and a pre-final version was chosen.

- *Test of the pre-final version*

The pre-final version was tested on a population of 10 randomly chosen patients who had a proximal hamstring avulsion surgery. Each subject had to answer the questionnaire and was then asked about their ability to understand the items and answers provided, ensuring that the adapted questionnaires had the same equivalence when applied in clinical practice.

- *Approval of the expert committee*

The final version of the HaOS translation (HaOS-Fr) questionnaire was obtained in response to the remarks of the population, in particular their general impression and the specific words chosen (**Appendix 1**). To facilitate data entry, we kept the 19-point Likert score in the form of boxes to be ticked.

Psychometric evaluation

The final version was validated according to COSMIN international guidelines [18].

- *Outcome measures*

The reference scales used were the validated French version of the University of California – Los Angeles (UCLA) activity scale [19,20], Tegner Activity scale [21], Lysholm score [22] and the subjective hip value [23].

Patients were also asked about their RTS status.

- *Data collection*

Data was collected prospectively, using an online software (Websurvey®). The software was accessed and filled by both surgeons for history and physical examination findings and

patients for questionnaires and outcomes. Six months after surgery, all patients were evaluated by their surgeons, and each patient filled an online questionnaire containing all patient reported outcome measures. If there was no response, a second email was sent, and then, if there was still no response, they were contacted by telephone. In order to evaluate test-retest reliability of the HaOS-Fr, 10 patients completed twice the questionnaire at 4 days interval.

- *Participants and sample size*

The study included 48 patients. For each patient, their uninjured limb was used as an internal control, allowing for direct comparison between the injured and uninjured sides. HaOS scores were calculated separately for both the injured and uninjured limbs, which enabled us to perform discriminant analysis and assess differences in function and outcomes between the two sides.

Patients' characteristics are shown in **Table 1**.

Table 1: Characteristics of the patients

Variable	Value
N	48
Age, mean (range)	51.8 years (32 – 57)
Male Sex	48/48
Sports level	
Professional athletes	2/48 (4.2%)
Competitive athletes	10/48 (20.8%)
Regular leisure athletes	21/48 (43.8%)
Occasional leisure athletes	15/48 (31.2%)
Injury during sports	26/48 (54.2%)
Return to sport	
Yes	31/48 (64.6 %)
No	17/48 (35.4)
Level of Return to sport	
Same level	20/31 (64.5 %)
Lower level	11/31 (35.5 %)

Table 2: Correlation of the HaOS score with other outcome measures.

Outcome Measure	Pearson's r	Quality of Correlation	95% CI Upper	95% CI Lower	p-value
HaOS_score19	-		-	-	-
UCLA scale	0.478	Medium positive correlation	0.671	0.225	< .001
Lysholm score	0.801	Very high positive correlation	0.884	0.669	< .001
Tegner activity scale	0.311	low positive correlation	0.547	0.030	0.031
Subjective hip value	0.297	No correlation	0.536	0.014	0.041

CI, confidence interval; UCLA, University of California Los Angeles activity scale.

Statistical analysis

To describe quantitative variables, the mean and standard deviation (SD) were used. To describe dichotomous variables, their number of events and their percentage were used.

- *Sample size justification*

The sample size was calculated a priori for the primary outcome of construct validity (correlation with the Lysholm score). For a Spearman's correlation test to detect a strong correlation ($\rho \geq 0.70$) with 80% power and a two-sided alpha of 0.05, a minimum of 14 patients was required. We targeted

a larger sample (N=48) to ensure robust results for all secondary analyses.

- *Construct validity of HaOS*

To estimate the correlations between HaOS, UCLA, Tegner activity scale, Lysholm score and a functional score, Pearson coefficients were used. The strength of the correlation based on the coefficient value (r) and was interpreted as follows: 0.0 < 0.1: no correlation, 0.1 < 0.3: low correlation, 0.3 < 0.5: medium correlation, 0.5 < 0.7: high correlation, 0.7 < 1: very high correlation [24].

Table 3: Hamstring Outcome Score (HaOS) and components according to injury status.

	Overall, n = 48		Injured= 26		Not Injured, n= 22		p-value
	Mean $\pm$ SD	Median (IQR)	Mean $\pm$ SD	Median (IQR)	Mean $\pm$ SD	Median (IQR)	
HaOS score %	75.07 $\pm$ 19.87	80.26 (5.26, 94.74)	65.24 $\pm$ 20.61	89.47 (46.05, 94.74)	84.9 $\pm$ 13.27	67.11 (5.26, 94.74)	0.020
HaOS components							
- Symptoms	57.3 $\pm$ 29.6	50.0 (50.0, 75.0)	66.3 $\pm$ 27.3	50.0 (50.0, 100.0)	46.6 $\pm$ 29.2	50.0 (31.3, 50.0)	0.026
- Curvatures	71.2 $\pm$ 23.8	75.0 (50.0, 87.5)	77.2 $\pm$ 20.7	81.3 (64.1, 98.4)	64.2 $\pm$ 25.7	68.8 (43.8, 85.9)	NS
- Pain	71.0 $\pm$ 21.7	71.9 (56.3, 87.5)	77.0 $\pm$ 18.5	76.6 (67.2, 87.5)	63.9 $\pm$ 23.5	62.5 (50.8, 80.5)	0.044
- Function	65.6 $\pm$ 31.2	71.9 (50.0, 100.0)	76.0 $\pm$ 22.4	75.0 (57.8, 100.0)	53.4 $\pm$ 35.9	53.1 (28.1, 79.7)	0.026
- Quality of life	48.4 $\pm$ 12.0	50.0 (37.5, 50.0)	47.1 $\pm$ 10.8	50.0 (37.5, 50.0)	50.0 $\pm$ 13.4	50.0 (37.5, 50.0)	0.704
UCLA	7.3 $\pm$ 2.4	7.0 (6.0, 10.0)	8.6 $\pm$ 1.6	9.0 (7.0, 10.0)	5.7 $\pm$ 2.3	6.0 (4.0, 7.0)	<0.001
Lysholm	82.8 $\pm$ 23.0	91.5 (77.8, 99.3)	93.1 $\pm$ 10.9	96.5 (86.3, 100.0)	70.7 $\pm$ 27.6	79.5 (48.5, 94.3)	0.003
Tegner	4.5 $\pm$ 2.5	4.0 (3.0, 6.0)	5.7 $\pm$ 2.5	5.0 (4.0, 7.0)	3.1 $\pm$ 1.7	3.0 (2.0, 4.0)	<0.001
Subjective hip value	0.8 $\pm$ 0.1	0.8 (0.7, 0.9)	0.9 $\pm$ 0.1	0.9 (0.8, 0.9)	0.8 $\pm$ 0.1	0.8 (0.7, 0.8)	0.011

SD, standard deviation; IQR, interquartile range; UCLA, University of California Los Angeles activity scale; HaOS Hamstring Outcome Score.

- *Discriminant validity*

A Wilcoxon test was used to compare the "injury" and "uninjured" groups to assess the discriminant validity. We also compared the patients who had returned to their sport level and those who returned at an inferior sport level or not returned at all. A Receiver Operator Characteristic (ROC) was done to assess the ability of this score to detect sports returner. The Area Under the Curve (AUC) was calculated, with values closer to 1.0 indicating excellent discrimination, 0.5 denoting no discrimination, between 0.7 and 0.8

considered acceptable, between 0.8 and 0.9 considered excellent, and >0.9 considered outstanding [25].

- *Internal consistency*

The Cronbach alpha coefficient was calculated to estimate the internal consistency and was "excellent" if $\alpha \geq 0.90$.

- *Test retest reliability*

The intraclass correlation coefficient (ICC) was used to evaluate the test-retest reliability [26]. Values less than 0.5 indicate poor reliability, values between 0.5 and 0.75 indicate

moderate reliability, values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability [26]. The percentage of missing responses, the ceiling and floor effects were used to evaluate the feasibility [17].

- *Ceiling and floor effect*

According to Ter- wee et al. [17], in the presence of a ceiling or floor effect of more than 15% there is an inherent problem with the validity of the contents when generating questionnaire items.

A $p < 0.05$ was considered to be significant. All tests were 2-sided. The R software (version 3.5.0) was used to perform the statistical analyses.

Results

Cross-cultural adaptation

The French translation and English back translation did not create any major linguistic problems. Some changes were made to the initial questionnaire after the comments made by the pre-final population.

Construct validity

The HaOS-Fr was shown to have a significant positive correlation with all the reference scales, except for the Tegner Activity scale ($p=0.066$). The correlation was strong with the Lysholm score ($r=0.801$, $p<0.001$), medium with the UCLA scale ($r=0.478$, $p=0.009$) and weak with the subjective hip value ($r=0.297$, $p=0.026$).

Discriminant validity

As compared between injured and injured group: A highly significant difference was found between the injured and control groups ($p<0.001$). The HaOS score was significantly higher in the control group for symptoms ($p<0.001$), soreness ($p<0.001$), pain ($p<0.001$), and function ($p<0.001$), except for quality of life, where no significant difference was observed ($p=0.704$).

As compared between those who return and those who did not return to sports: When comparing patients who returned to sport with those who did not, no significant differences were found in the overall HaOS score ($p=0.14$) (Table 4). The ROC curve analysis revealed an area under the curve of 0.631 ($p=0.1369$), indicating moderate predictive value (Figure 1).

Table 4 : Hamstring Outcome Score (HaOS) and components according to return to sport.

Characteristic		Overall, n = 48		Return to sport n = 31		No return to sport n = 17		p-value
		Mean $\pm$ SD	Median (IQR)	Mean $\pm$ SD	Median (IQR)	Mean $\pm$ SD	Median (IQR)	
HaOS score	48	0.7 $\pm$ 0.2	0.7 (0.5, 0.8)	0.7 $\pm$ 0.2	0.7 (0.6, 0.8)	0.6 $\pm$ 0.2	0.6 (0.4, 0.8)	NS
HaOS components	48							
- Symptoms		57.3 $\pm$ 29.6	50.0 (50.0, 75.0)	62.9 $\pm$ 28.0	50.0 (50.0, 87.5)	47.1 $\pm$ 30.5	50.0 (25.0, 50.0)	NS
- Curvatures		71.2 $\pm$ 23.8	75.0 (50.0, 87.5)	75.2 $\pm$ 20.9	75.0 (62.5, 96.9)	64.0 $\pm$ 27.5	68.8 (37.5, 87.5)	NS
- Pain		71.0 $\pm$ 21.7	71.9 (56.3, 87.5)	74.5 $\pm$ 18.7	75.0 (64.1, 87.5)	64.7 $\pm$ 25.8	68.8 (50.0, 84.4)	NS
- Function		65.6 $\pm$ 31.2	71.9 (50.0, 100.0)	71.6 $\pm$ 26.3	75.0 (56.3, 100.0)	54.8 $\pm$ 36.9	62.5 (25.0, 81.3)	NS
- Quality of life	48	48.4 $\pm$ 12.0	50.0 (37.5, 50.0)	46.8 $\pm$ 11.2	50.0 (37.5, 50.0)	51.5 $\pm$ 13.2	50.0 (37.5, 62.5)	NS
UCLA scale	48	7.3 $\pm$ 2.4	7.0 (6.0, 10.0)	8.4 $\pm$ 1.8	9.0 (7.0, 10.0)	5.2 $\pm$ 1.9	6.0 (4.0, 7.0)	<0.001
Lysholm score	48	82.8 $\pm$ 23.0	91.5 (77.8, 99.3)	92.6 $\pm$ 13.2	96.0 (88.0, 100.5)	65.0 $\pm$ 26.6	72.0 (44.0, 85.0)	<0.001
Tegner activity scale	48	4.5 $\pm$ 2.5	4.0 (3.0, 6.0)	5.6 $\pm$ 2.4	5.0 (4.0, 7.0)	2.6 $\pm$ 1.4	3.0 (2.0, 4.0)	<0.001
Subjective hip value	48	0.8 $\pm$ 0.1	0.8 (0.7, 0.9)	0.8 $\pm$ 0.1	0.9 (0.8, 0.9)	0.8 $\pm$ 0.1	0.8 (0.7, 0.9)	NS

SD, standard deviation; IQR, interquartile range; ; UCLA, University of California Los Angeles activity scale; HaOS Hamstring Outcome Score.

ROC curve

Figure 1: Receiver Operating Characteristic (ROC) curve for the Hamstring Outcome Score (HaOS-Fr) predicting return to sport (RTS) at 6 months postoperatively. The Area Under the Curve (AUC) was 0.631 ($p=0.14$). The diagonal line represents the line of no discrimination ($AUC = 0.5$).

Internal consistency

The internal consistency of the scale based on the strength of the correlation among the 19 items was “excellent” with a

Cronbach's alpha of 0.93.

Reliability

The mean HaOS score when it was first filled out was 67.1% (IQR 27.3%), while it was 66.5% (IQR 26.3%) the second time. Reliability was “excellent” with an ICC = 0.90 [0.86–0.94], $p < 0.00001$.

Floor and ceiling effect

No floor or ceiling effect were detected.

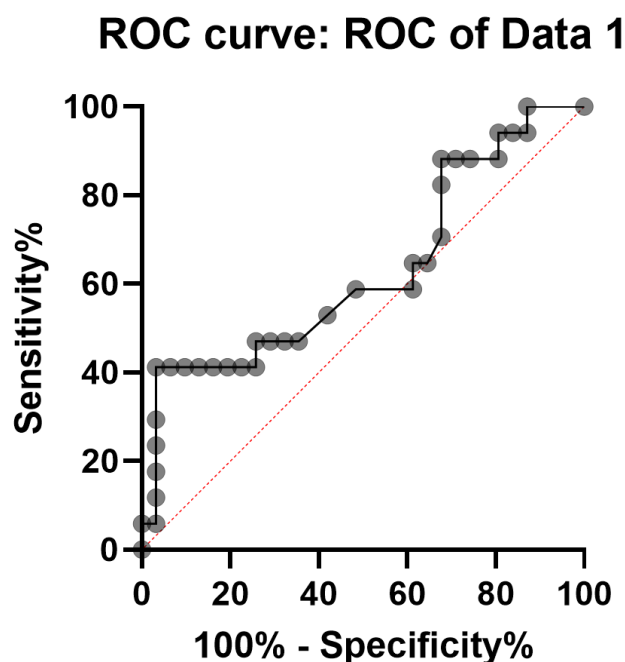


Figure 1: Receiver Operating Characteristic (ROC) curve.

Discussion

The main finding of this study was that the French version of the HaOS scale demonstrated psychometric properties comparable to the original English version. These properties included: 1) moderate to strong construct validity, with a high correlation to the Lysholm score ($r=0.801$, $p<0.001$) and moderate correlation with the UCLA scale ($r=0.478$, $p=0.009$); 2) significant discriminant validity, differentiating injured and control groups for symptoms, soreness, pain, and function ($p<0.001$ for all); and 3) excellent internal consistency (Cronbach's alpha of 0.93) and high test-retest reliability (ICC=0.90, $p<0.00001$).

Four questionnaires were used to validate the HaOS-Fr, as these scores are commonly referenced in the literature for evaluating functional outcomes following hamstring injuries, particularly in French studies^{2,27–29}. There was a significant positive correlation between the HaOS-Fr and the UCLA and Lysholm- scale. Nevertheless, there was no correlation between the HaOS score and the Tegner activity scale. This can be explained by the fact that the Haos score is specific to the hamstrings whereas the Tegner score is very general and focused on sports practice. Patients can describe themselves as having improved hamstring symptoms without necessarily having access to a high level of sports

practice. While other scores exist for the evaluation of PHAI, such as the SHORE, LEFS, and PHAS, none of them, except for the PHAS, has been validated in the French population^{13,14,30}. The PHAS score was validated after the initiation of this study and was therefore not included in the analysis. Thus, the validated HaOS-Fr version contributes to the existing literature by offering another French-validated score for this pathology.

The discriminant value of the HaOS was also confirmed in this study, as the score was significantly higher in the uninjured limb ($p<0.001$). This finding aligns with the results of the original study by Van de Hoef et al., which reported significant differences in the total HaOS score between injury and no-injury groups ($p=0.000$). In the original study, the total HaOS score for the injured group was 77.07 ± 16.31 , and for the uninjured group, it was 85.53 ± 13.78 , with a mean difference of 8.46 ($p=0.000$). In our study, the total HaOS score for the injured limb was 65.24 ± 20.61 (median: 89.47, IQR: 46.05–94.74), while the uninjured limb had a higher score of 84.9 ± 13.27 (median: 67.11, IQR: 5.26–94.74), with a statistically significant difference ($p=0.020$)[16].

This study has several limitations. First, the sample size was relatively small, which may affect the generalizability of the results ; however, it exceeded the calculated minimum for validation and reflects the challenge of recruiting this specific surgical population. Future multi-center studies with larger

sample sizes are needed to confirm our findings and enhance the generalizability of the HaOS-Fr. Second, the study population consisted of patients who underwent surgical treatment for PHAI, which limits the applicability of the findings to non-surgically treated patients or those with less severe PHAI. Additionally, the PHAS and SHORE scores, which are also used to evaluate hamstring injuries, were not included in this analysis due to their validation timeline and scope, which may have provided further insight into patient outcomes.

Conclusion

The French version of the HaOS scale has been shown to be valid, discriminant, consistent, reproducible and comparable to the English version and can therefore be used on a large scale to evaluate the impact in French patients who undergo surgery for a PHAI.

Open access statement

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Competing Interest

NL: Consultant for Websurvey Society, Paris France. AH: Consultant for Arthrex and Depuy.

Contributors

AH: Study conception and design; data acquisition; drafting and critical revision of the manuscript. NL: Data acquisition; critical revision of the manuscript; supervision of clinical protocol. PEC: Methodology development; Statistical analysis translation and cross-cultural adaptation process; manuscript revision. CP: Coordination of back-translation and linguistic validation; expert committee member; critical revision. MKM: interpretation of results; manuscript writing; corresponding author. AH: Study supervision; protocol validation; critical revision of the manuscript and final approval.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research. Though feedback about the collection of information for the database is encouraged.

Ethics approval

This study involves human participants and was approved by ethics committee (CPP IDF VI). Participants gave informed consent to participate in the study/ collection of data before taking part. [ClinicalTrials.gov](https://clinicaltrials.gov) ID: NCT02511158

Data availability statement

Data are available upon reasonable request.

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