

Interrater Reliability, Acceptability, and Practicality of Real-Time Video Pediatric Gait, Arms, Legs, and Spine for Musculoskeletal Assessment of Children During Telemedicine Visits

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Background/Objective: With the COVID-19 (coronavirus disease 2019) pandemic, telemedicine applications gained momentum, and clinicians tried to develop various musculoskeletal examination methods to be used in telemedicine visits. The aim of this study is to investigate the interrater reliability, acceptability, and practicality of the real-time video Pediatric Gait, Arms, Legs, and Spine (v-pGALS) assessment used in the evaluation during the telemedicine visit.

Methods: The study was designed as cross-sectional. Twenty school-aged children who presented to outpatient clinics with musculoskeletal complaints were included. For interrater reliability, the children were evaluated by face-to-face examination with v-pGALS, and then the child was reevaluated by another physiatrist with real-time evaluation (online video call) with the help of a parent. For acceptability, the time taken and the discomfort caused were evaluated by patients/parents with the smiley face visual analog scale, whereas to assess practicality, the ratio of completeness to duration of examination completion was recorded.

Results: κ coefficient of the agreement was found to be 0.88 between the results of the face-to-face examination and online video examination, suggesting very good agreement between the 2 raters. Acceptability of v-pGALS by parents and patients was high; 60% of children and 80% of parents found the duration of examination acceptable, and 70% of the patients and 95% of parents reported no discomfort caused by examination. The duration of face-to-face examination was 5.75 ± 1.29 minutes, whereas the duration of online examination was 15.81 ± 4.9 minutes.

Conclusions: Video pGALS is a reliable, acceptable, and practical examination system that can be used for musculoskeletal assessment of children in telemedicine visits.

Key Words: child, musculoskeletal examination, pediatric clinical assessment, telemedicine, v-pGALS

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The Pediatric Gait, Arms, Legs, and Spine (pGALS) assessment system is an examination system developed for the screening of the musculoskeletal system in school-age children.¹ It has been adapted from Gait, Arms, Legs, and Spine (GALS) examination for adult patients.^{1,2} It enables simple, quick, and top-to-toe evaluation of musculoskeletal abnormalities even by inexperienced assessors such as medical students, primary care physicians, and general pediatricians.^{3,4}

The coronavirus disease 2019 (COVID-19) pandemic resulted in worldwide changes in health care access and delivery.⁵ Governments applied lockdown and restrictions to limit the spread of COVID-19 and to prevent hospitals from being overwhelmed.⁵ Also, hospitals, which are one of the higher-risk places for contracting the COVID-19, have canceled and delayed elective appointments, and this caused limited patients' access to health care. Telemedicine visits and virtual examinations have gained importance for the continuum of health care. Most of the institutions shifted seeing patients in-person to virtual examinations using telemedicine platforms.⁶ Most of the medical practitioners had limited experience and training on telemedicine and examination methods that can be used in telemedicine visits. There has been a surge in the literature about information and advice on how to best apply telemedicine visits and virtual examinations.⁵ Musculoskeletal disorders constitute the majority of the most common reason for health care visits.⁷ The lack of access to the musculoskeletal examination can be remedied with the use of telemedicine.⁸ Telemedicine musculoskeletal examinations for adults and children have been proposed.^{5,9} Video pGALS (v-pGALS) is a proposed variation of pGALS, which was offered by Shenoi et al⁹ for telemedicine visits for pediatric rheumatology and can be found in the open and free Pediatric Musculoskeletal Matters' e-resource.¹⁰ Video pGALS aims to facilitate assessment in the context of remote/telehealth clinics. Video pGALS includes amended/additional maneuvers to pGALS derived from components of Pediatric Regional Examination of the Musculoskeletal System—Hip and Spine.^{11,12} A parent or a guardian of the child is involved in hands-on examinations (e.g., assessment of warmth/swelling/crepitation/tenderness in the knee). The use of telemedicine and virtual examination methods has advantages but also has limitations. Subtle examination findings can be missed during the virtual examination. Although involving the parent or caregiver to feel the joint for warmth/swelling or to palpate for point of maximal tenderness can add important information, there is a need to evaluate the reliability, acceptability, and practicality of virtual examination techniques.⁹ The aim of this

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study is to investigate the interrater reliability, acceptability, and practicality of the real-time v-pGALS assessment used in the evaluation during the telemedicine visit.

METHODS

The study was designed as cross-sectional. Twenty school-age children (6–18 years) who presented to the outpatient clinics of physical medicine and rehabilitation with a musculoskeletal complaint were included in the study following informed consent obtained from the patients and their parents/guardians. Exclusion criteria were as follows: (1) children who are nonambulatory; and (2) children who are not able to respond to acceptability questions or cooperate with the examinations due to cognitive deficits. The sample size for interobserver assessments of v-pGALS was estimated for a 2-observer study on a dichotomous variable with an α level of 0.05, power of 80%, and a 2-tailed test. An a priori sample size of 17 participants was estimated based on the minimum expected κ value of 0.70.^{13,14} The trial was registered with ClinicalTrials.gov (no. NCT04668820). The study protocol was approved by the Institutional Human Research Ethics Committee of Marmara University School of Medicine (approval no. 09.2021.32). After obtaining permission from the developers (based at Newcastle University, United Kingdom), the Turkish version of v-pGALS (Supplemental Digital Content 1, <http://links.lww.com/RHU/A436> and 2, <http://links.lww.com/RHU/A437>) was developed following the translation–back-translation method.¹⁵ Data regarding the patients' and parents' demographic characteristics, presenting complaints, and final diagnosis were recorded. A physiatrist conducted a face-to-face v-pGALS examination. Also, the final diagnosis was recorded after the face-to-face examination. Afterward, to test interrater reliability, the patient and his/her parent were placed in another examination room in which a laptop computer existed. Another physiatrist who was at another hospital connected via the Zoom application and reevaluated the child virtually using the Zoom application. The items were rated as normal/abnormal/not assessable by the 2 physiatrists.¹⁶ The v-pGALS screening was recorded as positive if at least 1 examination

item was rated as abnormal.^{3,17,18} The children and their parents were asked to rate acceptability in terms of time taken for the examination and degree of discomfort caused on a “smiley face” visual analog scale (0–10, 0 for full acceptability).^{3,17} The ratios of completeness to time taken for the completion of face-to-face and virtual v-pGALS examinations were recorded to determine practicality.^{3,18}

Statistical Analysis

Statistical analysis was performed using the IBM SPSS for Windows version 20.0 software (IBM Corp., Armonk, NY). The Histogram and normality plots and Kolmogorov-Smirnov normality tests were used to evaluate the distribution of data. Descriptive analysis was used in the analysis of patient characteristics. Wilcoxon test was used to compare 2 dependent groups, whereas the Mann-Whitney *U* test was used to compare independent variables. Interrater reliability was assessed using Cohen κ , whereas the value of κ between 0.0 and 0.40 is considered as poor agreement, between $\kappa = 0.41$ and 0.60 as moderate agreement, between $\kappa = 0.61$ and 0.80 as substantial agreement, and between $\kappa = 0.81$ and 0.99 as an almost perfect agreement.¹⁹ The sensitivity, specificity, and positive and negative predictive values of the virtual v-pGALS were calculated from comparison with the face-to-face examination. $p < 0.05$ was considered to be significant.

RESULTS

The flow diagram of subject inclusion is depicted in Figure. Among 22 children who were assessed for eligibility, 20 of them were included and assessed. Characteristics of patients and parents, presenting medical complaints, and final diagnosis are shown in Table 1. The answers to the screening question revealed that 8 of the patients had pain (40%), whereas none of them complained of stiffness. The mean intensity of pain according to VAS was 2.34 ± 0.65 (minimum 1, maximum 5). Two patients had difficulty in stair climbing (10%), and 6 patients needed assistance getting dressed (30%). Cohen κ analysis for interrater (face-to-face vs virtual) reliability of v-pGALS revealed high interrater reliability (0.88; 95% confidence interval [CI], 0.638–1.110),

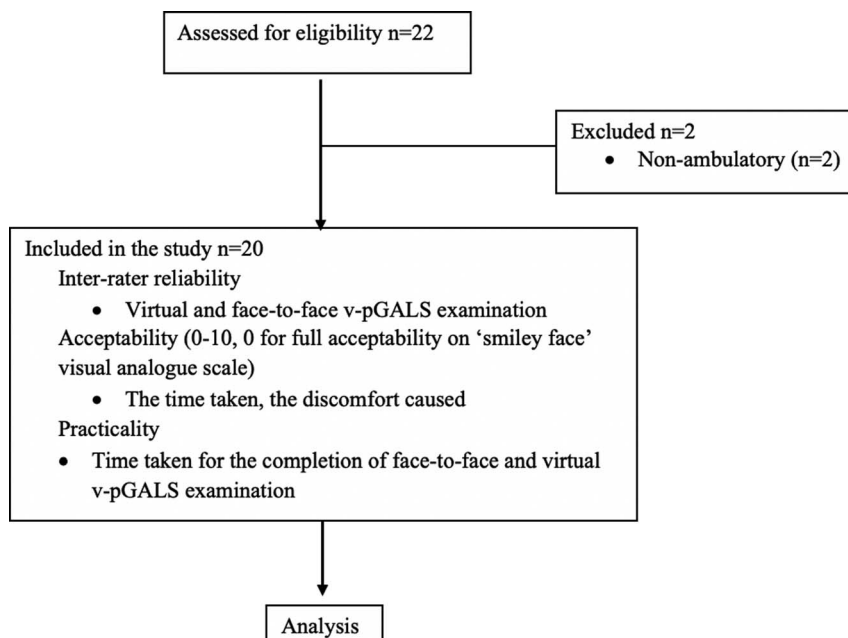


FIGURE. Flowchart of the study.

TABLE 1. Characteristics of Patients and Parents

Variable	(N = 20)
Age of children, y (mean ± SD)	10.6 ± 3.4
Gender of children, n (%)	
Female	8 (40)
Male	12 (60)
Parent/guardian who attended the examination, n (%)	
Mother	13 (65)
Father	6 (30)
Other	1 (5)
Age of parent/guardian, y (mean ± SD)	41.7 ± 6.0
Presenting medical complaint, n (%)	
Ankle pain	1 (5)
Leg pain	1 (5)
Neck pain	2 (10)
Structural abnormality of the chest	1 (5)
Hip pain	1 (5)
Kyphosis	1 (5)
Toe walking	3 (15)
Numbness in right leg	1 (5)
Right hand weakness	2 (10)
Leg length discrepancy	1 (5)
Arm weakness	1 (5)
Scoliosis	1 (5)
Congenital missing portion of forearm	1 (5)
Elbow fracture	1 (5)
Shaking left hand	1 (5)
Back pain	1 (5)
Final diagnosis, n (%)	
Skeletal dysplasia	1 (5)
Pectus carinatum	1 (5)
Femoroacetabular impingement	2 (10)
Idiopathic toe walking	2 (10)
Autism spectrum disorder	1 (5)
Right hemiplegic cerebral palsy	1 (5)
Juvenile idiopathic arthritis	1 (5)
Ewing sarcoma operated	1 (5)
Humerus fracture	1 (5)
Spina bifida occulta	2 (10)
Congenital transverse forearm deficiency	1 (5)
Olecranon fracture	1 (5)
Polyneuropathy	1 (5)
Normal	4 (20)

TABLE 2. Results for Intrarater (Face-to-Face vs. Virtual) Reliability of v-pGALS and Its Subdimensions

	κ	95% CI
v-pGALS	0.88	0.638–1.110
Gait	0.80	0.544–1.056
Arms	0.73	0.404–1.070
Legs	0.40	0.083–0.667
Spine	0.60	0.244–0.914

of children and their parents/guardians deemed the length of time taken and discomfort caused by the virtual v-pGALS examination as acceptable (Supplemental Digital Content 3, <http://links.lww.com/RHU/A438> and 4, <http://links.lww.com/RHU/A439>). No statistically significant differences were found when children's and parents'/guardians' acceptability of virtual and face-to-face examination was compared (Table 4). The virtual v-pGALS examination was completed in 100% (20/20) of children. The time taken (median, 15 minutes; range, 9–26 minutes) was acceptable to most parents/guardians (VAS 0: 80%, VAS 2: 15%) and children (VAS 0: 60%, VAS 2: 35%) (Table 4; Supplemental Digital Content 3, <http://links.lww.com/RHU/A438>).

DISCUSSION

The present study demonstrates that v-pGALS is a reliable, practical, and acceptable musculoskeletal system examination tool in school-age children that can be used as a virtual examination tool during telemedicine visits.

Video pGALS is developed from pGALS, which is a validated child musculoskeletal system screening tool. Video pGALS contains amendments that included hip, spine, gait, and hand examination maneuvers derived from the Pediatric Regional Examination of the Musculoskeletal System in addition to existing maneuvers of pGALS. The v-pGALS examination is completed with the help of a parent/guardian/caregiver of a child for the range of motion and palpation maneuvers. We assessed how virtual v-pGALS examination compares with face-to-face examination. We found a high degree of interrater reliability between virtual and face-to-face examinations for the whole v-pGALS examination. Interrater reliability between virtual and face-to-face v-pGALS examination was found lowest for legs subdimension of v-pGALS. Interrater reliability between virtual and face-to-face v-pGALS for squat maneuver, fluency and balance assessments during squat maneuver, and feel for crepitus (hand on knee) maneuver was low among maneuvers assessing the legs. In our

indicating very good agreement. κ result regarding interrater reliability for gait subdimension of v-pGALS was highest among the whole subdimensions, whereas it was lowest regarding legs subdimension (0.40; 95% CI, 0.083–0.667), demonstrating poor agreement (Table 2). Cohen κ for squat maneuver (0.41), fluency (0.412), and balance (0.273) assessments during squat maneuver and feel for crepitus (hand on knee) maneuver (0.50) showed the lowest values among maneuvers assessing the legs. The sensitivity and specificity of v-pGALS for detecting musculoskeletal diagnosis were 93.75% and 100%, consecutively (Table 3). If leg maneuvers are excluded from v-pGALS, the sensitivity and specificity of v-pGALS became 68.75% and 100%. The vast majority

TABLE 3. Sensitivity, Specificity, and Positive and Negative Predictive Values of v-pGALS

	Musculoskeletal Diagnosis (+)	Musculoskeletal Diagnosis (–)	Total
v-pGALS (+)	15	0	15
v-pGALS (–)	1	4	5
Total	16	4	20
Sensitivity		93.75%	
Specificity		100%	
Positive predictive value		100%	
Negative predictive value		80%	

v-pGALS, video Pediatric Gait, Arms, Legs, and Spine.

TABLE 4. Comparison of Virtual and Face-to-Face v-pGALS Examination in Terms of Acceptability and Practicality

	Virtual v-pGALS Examination	Face-to-Face v-pGALS Examination	<i>p</i> value
Children's acceptability of v-pGALS in terms of time taken by the examination	0 (0–4)	0 (0–6)	0.52
Children's acceptability of v-pGALS in terms of discomfort by the examination	0 (0–4)	0 (0–4)	0.24
Parents'/guardians' acceptability of v-pGALS in terms of time taken by the examination	0 (0–4)	0 (0–2)	0.25
Parents'/guardians' acceptability of v-pGALS in terms of discomfort by the examination	0 (0–4)	0 (0–2)	1.00
Duration of examination, minutes	15.81 ± 4.90 (9–26)	5.75 ± 1.29 (4–8)	0.0001

Values are presented as median (minimum-maximum) for acceptability and mean ± standard deviation (minimum-maximum) for duration of examination.

sample, depending on our observations, it was not quick and easy for parents/guardians to perform palpation for knee effusion and warmth control and crepitation maneuvers. This could have caused relatively lower interrater reliability between virtual and face-to-face v-pGALS examination. Also, observation of squat maneuver only once might have caused overlooking of pathology. However, we have found that when leg maneuvers are excluded from v-pGALS, the sensitivity and specificity of v-pGALS did not increase, showing that low interrater reliability of legs subdimension of v-pGALS does not alter diagnosis and thus management. We suggest that multiple observations of the squat maneuver during video examination improve the assessment and overcome this issue. Similar to the results of the present study, Chan et al¹⁶ reported that hip maneuvers cannot be clearly evaluated in the videos, in their study assessing musculoskeletal abnormalities in children with mucopolysaccharidoses by analyzing recorded videos of children performing pGALS.

Foster et al¹ reported the sensitivity and specificity of subdimensions of pGALS ranging from 97% to 100% and 98% to 100%, consecutively. Batu et al¹⁷ reported the sensitivity and specificity of pGALS for detecting musculoskeletal system diagnosis as 93.7% and 97.4%, respectively. Similar to the results of the previous studies, based on the results of the present study, the v-pGALS demonstrated excellent sensitivity (93.75%) and specificity (100%).

In previous studies, the duration of pGALS examination completion ranged from 1.2 to 10 minutes.^{1,3,4,17,18,20} The mean face-to-face v-pGALS assessment completion time was 5.75 minutes (4–8 minutes) in the present study. Although it contains additional maneuvers to pGALS, the time taken to complete v-pGALS maneuvers face-to-face was comparable with previous studies.

Most of the children and parents/guardians found both the virtual and face-to-face v-pGALS examination to cause no or little discomfort as it happened in previous studies investigating the acceptability of pGALS.^{3,17,20} Although the duration of the virtual v-pGALS examination was found to be longer than face-to-face examination, the time taken for virtual examination and face-to-face examination was deemed to be acceptable at a similar level.

There are several limitations to the study. First, the number of children included in the study is relatively small. Second, the assessors were both physiatrists who specialized in pediatric rehabilitation. This could have led to the high level of interrater reliability between virtual and face-to-face v-pGALS examination and high sensitivity and specificity. However, different from the previous studies aiming to measure the strength of pGALS to screen musculoskeletal system abnormalities in children by nonspecialists, the present study aimed to investigate interrater reliability, acceptability, and practicality of real-time v-pGALS for musculoskeletal assessment of children for telemedicine visits, which are occasionally conducted by specialists. Third, face-to-face examination prior to the virtual examination might have resulted in patient bias and a

higher κ coefficient of agreement because patients might have understood their abnormalities by the examination of the first physician. Being the first study that investigated the interrater reliability between virtual and face-to-face v-pGALS examination and investigated the acceptability and practicality of v-pGALS can be viewed as the strengths of the study.

In conclusion, interrater reliability between virtual and face-to-face v-pGALS examination is excellent, and v-pGALS is a practical and acceptable tool that can be used for musculoskeletal assessment of children during telemedicine visits.

KEY POINTS

- The COVID-19 pandemic resulted in an increase in telehealth visits and need for examination tools that can be used in telemedicine visits.
- It is essential to know the reliability, practicality, and acceptability of these examination tools.
- Interrater reliability between virtual and face-to-face v-pGALS examination is excellent. It is a practical and acceptable tool that can be used for musculoskeletal assessment of children during telemedicine visits.

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The H. Ralph Schumacher's MD / JCR / PANLAR Award for PANLAR Projects, aims to stimulate valuable research of a working group that has demonstrated success in research studies. The Editorial Board of JCR and PANLAR Board of Directors have chosen to name this award after Dr. Schumacher in recognition of his many accomplishments and of his dedication to the betterment of Rheumatology in Latin America.

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The 2021 award was presented in the context of the 2021 PANLAR Congress to Dr. Fernando Figueroa from Santiago, Chile. See: <http://en.panlar.org/noticias/ganador-del-premio-h-ralph-schumacher-2021>.

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