Measure Achilles Tendon Shorthening In Children With Severe Autism Spectrum Disorder And Tip-Toe Behavior Using a Photography-Based Goniometry Approach

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BACKGROUND

Tip-toe behavior (TTB) affects about 20%–30% of individuals with Autism Spectrum Disorder (ASD)[1] and it can manifest with varying degrees of increasing severity (i.e., TTB1 = TTB during running; TTB2 = TTB during walking and running; TTB3 = TTB during standing, walking and running)[2]. The TTB persistence may lead to shortening of Achilles' tendon[3] (the common tendon of Gastrocnemius muscle - GM and Soleus muscle – SM). The presence of an Achilles tendon shorthening influences motor function and quality of life.

Traditionally, GM and SM length assessment is performed by measuring ankle dorsiflexion range of movement (ROM) with the knee extended (GM assessment) and the knee 90° flexed (SM assessment) using a manual goniometer placed on the individual's skin. This clinical assessment could become problematic in individuals with ASD and intellectual disability (ID) and/or sensory hypersensitivity. A photography-based goniometry approach could be a solution to the limitation. In a previous pilot study, we found this approach feasible in children with ASD.

OBJECTIVES

1) to measure GM and SM lengths in subjects with severe ASD and ID using a validated photography-based goniometry (DrGoniometer® app);
2) to evaluate the relationship between TTB severity and GM and SM length values.

MATERIALS AND METHODS

- We measured SM and GM length values in a sample of **36 individuals with ASD**, diagnosed according to the DSM-5 criteria.
- ASD severity and ID were evaluated by the Childhood Autism Rating Scale - Second Edition (CARS-2) and the Raven's Colored Progressive Matrices (RCPM), respectively.
- The presence/absence of TTB and its severity, was assessed using an applied a standardized qualitative assessment[2].
- The photography-based goniometry measurements were conducted using the methodology described by Wang et al. (2019)[4]. (see Figure 1)

RESULTS

- The mean age of the study sample was 8.42 years (SD 2.62), with no significant difference between NO-TTB and TTB individuals. The participants presented moderate to high ASD severity (mean CARS-2 score: 39.61, SD 6.46; range: 24.50-57) and a low IQ (mean RCPM score: 70.83, SD 19.91; range: 50-120), with no significant difference between NO-TTB and TTB individuals.
- 36 % (13/36) of the subjects presented TTB (Table 1) .
- **TTB individuals showed significantly shorter GM and SM lengths bilaterally than NO-TTB individuals** (GM_left: U=52.00, p<0.001; GM_right: U=51.50, p<0.001; SM_left: U=70.00, p=0.008; SM_right: U=62.00, p=0.003).
- **Muscle length was inversely correlated with TTB severity, with greater severity associated with shorter muscle length** (GM_left: r=-0.593, p<0.001; GM_right: r=-0.567, p<0.001; SM_left: r=-0.490, p=0.002; SM_right: r=-0.506, p=0.002).

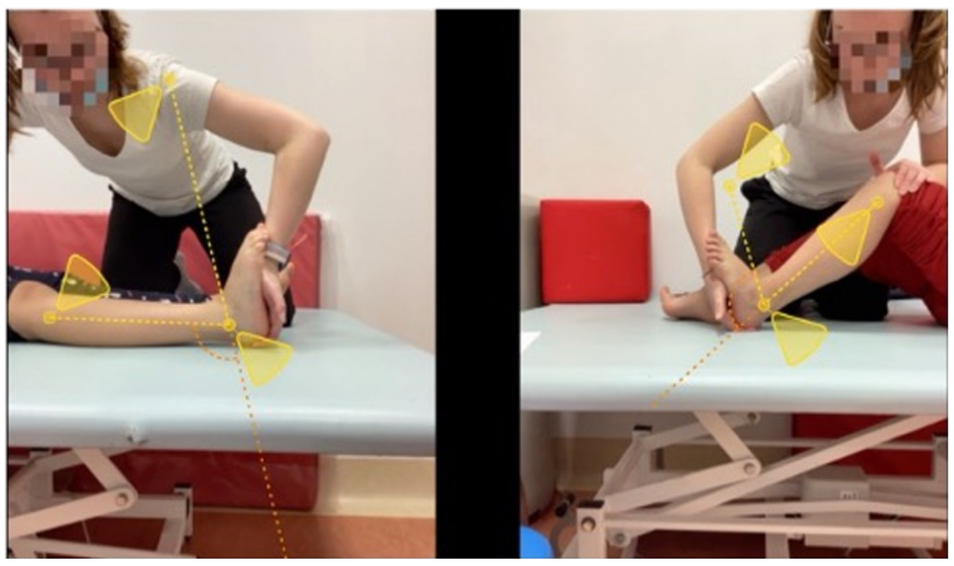

Figure 1: Example of Photography-based goniometry assessment

	Total sample (N=36)	NO-TTB subgroup (N=23)	TTB subgroup (N=13)	TTB 1 subgroup (N=2)	TTB 2 subgroup (N=8)	TTB 3 subgroup (N=3)
Age (yrs) mean (SD); Age Range (yrs)	8.42 (2.62); 5-14.06	8.57 (2.50); 5-12.55	8.16 (2.92) 5-14.06	8.23 (2.37); 6.56-9.91	6.66 (1.55); 5-8.96	12.11 (2.78); 8.93-14.06
CARS-2 mean (SD); range	39.61 (6.46); 24.50-57.00	39.26 (7.20); 24.50-57.00	40.23 (5.10); 29.00-48.00	34.50 (7.78); 29.00-40.00	41.13 (4.73); 36.00-48	41.67 (2.89); 40.00-45.00
RAVEN_IQ mean (SD); range	70.83(19.91); 50-120	72.17(22.15); 50-120	68.46 (15.73) 50-100	60.00(14.14); 50.00-70.00	70.00(19.27); 50-100	70.00(0.00); 70-70
Gastrocnemius left (°) mean(SD)	13.28 (7.65)	16.63 (4.74)	7.36 (8.38)	13.20 (11.31)	8.78 (7.42)	-0.30 (5.84)
Gastrocnemius left (°) range	-6.5 – 24.90	6.30-24.90	-6.50 – 23.60	5.20-21.20	-1.50 – 23.60	-6.50 – 5.10
Gastronemius right (°) mean (SD)	14.86 (8.50)	18.27 (7.10)	8.81 (7.50)	11.40 (12.45)	10.64 (5.08)	2.20 (9.20)
Gastronemius right (°) range	-6.40 – 29.70	5.20-29.70	-6.40 – 20.20	2.60-20.20	2.60-18.50	-6.40 – 11.90
Soleus left (°) mean (SD)	23.79 (9.01)	26.54 (7.81)	18.94 (9.23)	26.15 (18.31)	20.43 (5.46)	10.17 (7.92)
Soleus left (°) range	5.30-48.20	10.50-48.20	5.30-39.10	13.20-39.10	13.10-28.10	5.30-19.30
Soleus right (°) mean (SD)	26.07 (11.78)	30.26 (10.62)	18.65 (10.26)	24.95 (18.17)	18.63 (6.60)	14.53 (15.76)
Soleus right (°) range	4.50-53.00	14.70-53.00	4.50-37.80	12.10-37.80	11.50-28.60	4.50-32.70

Table 1: Demographic and clinical characteristics of this study sample and NO-TTB and TTB subgroups

CONCLUSIONS

- Photography-based goniometry has been used successfully to quantify GM and SM muscle lengths in severe ASD individuals with ID, both with and without TTB. GM and SM length values are reduced in the TTB group.
- There is a moderate inverse relationship between TTB severity and GM and SM lengths. Further research is warranted to confirm the results.

References:
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