



**HAL**  
open science

## Comparison of scapula soft tissue artefact compensation methods during manual wheelchair locomotion

Théo Rouvier, Claire Livet, Antoine Lombart, Georges Dumont, Charles Pontonnier, Christophe Sauret, Hélène Pillet

► **To cite this version:**

Théo Rouvier, Claire Livet, Antoine Lombart, Georges Dumont, Charles Pontonnier, et al.. Comparison of scapula soft tissue artefact compensation methods during manual wheelchair locomotion. *Gait & Posture*, 2022, 97, pp.S233 - S234. 10.1016/j.gaitpost.2022.07.143 . hal-03794174

**HAL Id: hal-03794174**

**<https://inria.hal.science/hal-03794174v1>**

Submitted on 3 Oct 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/363636365>

# Comparison of scapula soft tissue artefact compensation methods during manual wheelchair locomotion

Article in *Gait & Posture* · September 2022

DOI: 10.1016/j.gaitpost.2022.07.143

CITATIONS

0

READS

13

7 authors, including:



**Théo Rouvier**

Ecole Nationale Supérieure d'Arts et Métiers

7 PUBLICATIONS 1 CITATION

[SEE PROFILE](#)



**Claire Livet**

École normale supérieure de Rennes

8 PUBLICATIONS 2 CITATIONS

[SEE PROFILE](#)



**Georges Dumont**

École normale supérieure de Rennes

142 PUBLICATIONS 1,069 CITATIONS

[SEE PROFILE](#)



**Charles Pontonnier**

École normale supérieure de Rennes

90 PUBLICATIONS 562 CITATIONS

[SEE PROFILE](#)

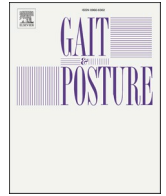
Some of the authors of this publication are also working on these related projects:



Help system for choosing and adjusting a manual wheelchair (SACR-FRM, ANR, TecSan 2006) [View project](#)



Biomechanics of Table Tennis [View project](#)



## Comparison of scapula soft tissue artefact compensation methods during manual wheelchair locomotion



T. Rouvier<sup>a,\*</sup>, C. Livet<sup>b</sup>, A. Lombart<sup>a</sup>, G. Dumont<sup>b</sup>, C. Pontonnier<sup>b</sup>, C. Sauret<sup>a,c</sup>, H. Pillet<sup>a</sup>

<sup>a</sup> Arts et Métiers Institute of Technology- Université Sorbonne Paris Nord- HESAM Université, IBHGC - Institut de Biomécanique Humaine Georges Charpak, Paris, France

<sup>b</sup> Univ Rennes, Inria- CNRS- IRISA - UMR 6074, Rennes, France

<sup>c</sup> Institution Nationale des Invalides, CERAH - Centre d'Études et de Recherche sur l'Appareillage des Handicapés, Créteil, France

### 1. Introduction

Two third of manual wheelchair (MWC) users report suffering or having suffered from shoulder pain or injury [1]. To favour the understanding of these disorders, it is crucial to quantify the shoulder kinematics and kinetics during MWC locomotion [2]. However, soft tissue artefacts (STA) are particularly present at the scapula, making it difficult to accurately track the bone motion [3], motivating researchers to propose compensation methods based on acromion or scapula spine marker clusters and a calibration pose [4]. Apart from invasive or irradiative methods, the reference method to localize the scapula bone is based on external palpation generally through the use of a scapula palpator (SP) [5]. In this study, we propose to compare the scapula kinematics reconstructed from a cluster with STA compensation based on one or two calibration static poses during the push phase with the reference method using a SP.

### 2. Research question

Which calibration method best compensates STA at the scapula when analysing locomotion in MWC from motion capture data?

### 3. Methods

The two calibration methods proposed in this study are:

- Rigid: rigid transformation of the cluster reference frame to the SP reference frame in one pose corresponding to the middle of the propulsion phase
- Linear: Linear transformation of the cluster frame to the SP frame between the start and end of propulsion. Transformation is computed using spherical linear interpolation [6] with regards to the position of the cluster frame.

During the experiments, 5 MWC users equipped with spinal cluster were seated in a static ergometer and were asked to reproduce MWC locomotion in slow motion. An experimenter followed the movement of the right scapula with a SP. Subjects performed between 2 to 6 trials of 5 propulsion cycles (10–30 cycles per subject). Calibration poses were extracted from each cycle and served to reconstruct SP markers from cluster. The comparison between calibration methods was done through the marker reconstruction root mean square error (RMSE) between measured and reconstructed SP [7].

\* Corresponding author.

## 4. Results

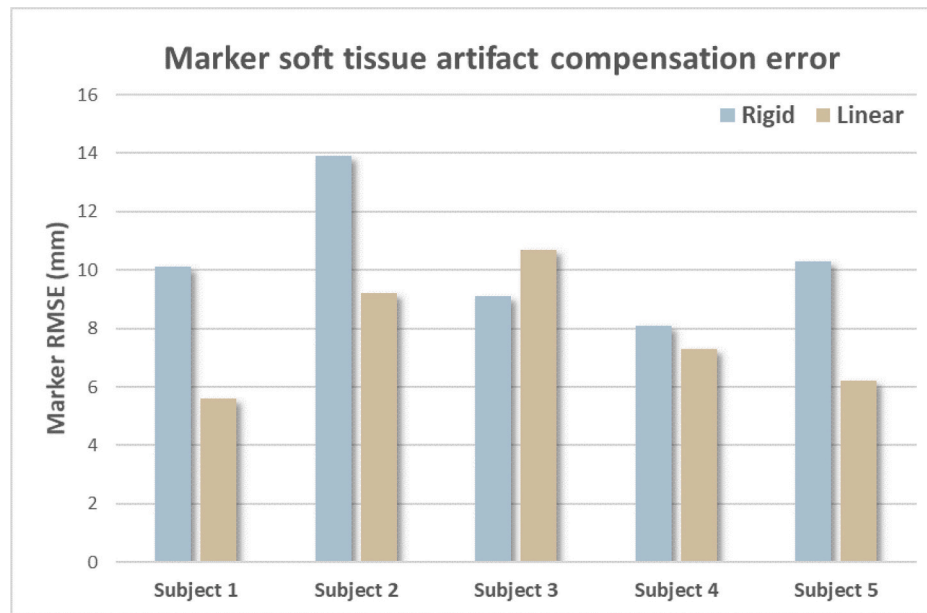


Fig. RMSE between experimental and reconstructed scapula landmarks for each subject.

Results show a reduction of the RMSE for 4 subjects using the 2 poses calibration method compared to the single pose method. Using this method, the RMSE ranged between 0.56 cm and 1.07 cm for the whole cohort.

## 5. Discussion

This study shows encouraging results with the two poses calibration method with RMSE that were lower than the error of the reference itself, as reported by De Groot et al. (i.e. 1.1 cm with a SP) [8]. If it can be hypothesized that more calibration poses would improve further the scapula reconstructed kinematics, the two poses could provide an acceptable trade-off between result accuracy and time dedicated to model calibration.

## References

- [1] Kathleen A. Curtis, George A. Drysdale, R. David Lanza, Morey Kolber, Richard S. Vitolo, Ronald West, Shoulder pain in wheelchair users with tetraplegia and paraplegia, *Arch. Phys. Med. Rehabil.* 80 (4) (1999) 453–457. ISSN 0003-9993.
- [2] Samuel Hybois, Pierre Puchaud, Maxime Bourgain, Antoine Lombart, Joseph Bascou, François Lavaste, Pascale Fodé, Hélène Pillet, Christophe Sauret, Comparison of shoulder kinematic chain models and their influence on kinematics and kinetics in the study of manual wheelchair propulsion, *Med. Eng. Phys.* 69 (2019) 153–160. ISSN 1350-4533.
- [3] Miroslav Senk, Laurence Chèze, A new method for motion capture of the scapula using an optoelectronic tracking device: a feasibility study, *Comput. Methods Biomech. Biomed. Eng.* 13 (3) (2010) 397–401.
- [4] Mathieu Lempereur, Sylvain Brochard, Fabien Leboeuf, Olivier Rémy-Néris, Validity and reliability of 3D marker based scapular motion analysis: a systematic review, *J. Biomech.* 47 (10) (2014) 2219–2230. ISSN 0021-9290.
- [5] Benjamin Michaud, Sonia Duprey, Mickaël Begon, Scapular kinematic reconstruction – segmental optimization, multibody optimization with open-loop or closed-loop chains: which one should be preferred? *International Biomechanics* 4 (2) (2017) 86–94, <https://doi.org/10.1080/23335432.2017.1405741>.
- [6] Mehdi Jafari, Habib Molaei, Spherical linear interpolation and Bézier curves, *Gen. Sci. Res.* 2 (1) (2014) 13–17. December, 2014.
- [7] Vincent Fohanno, Mickaël Begon, Patrick Lacouture, Floren Colloud, Improvement of upper extremity kinematics estimation using a subject-specific forearm model implemented in a kinematic chain, *J. Biomech.* 46 (6) (2013) 1053–1059.
- [8] H de Groot Jurriaan, The variability of shoulder motions recorded by means of palpation, *Clin. Biomech.* 12 (1998) 461–472.