UNIVERSITY OF LEEDS
Institute of Medical & Biological Engineering

THE REDUCTION OF ANKLE RANGE OF MOTION IN HEMOPHILIC JOINT DISEASE: LIMITATION, OR ADAPTATION?

Miss Harriet Talbott*[1], Mr Richard Wilkins[2,3], Prof. Anthony Redmond[2,4], Dr Claire Brockett[1,2,4] and Dr Marlène Mengoni[1]

1. Institute of Medical and Biological Engineering, University of Leeds. 2. Leeds Institute of Rheumatology & Musculoskeletal Medicine. 3. Leeds Haemophilia Comprehensive Care Centre; 4. Versus Arthritis Centre for Sports, Exercise and Osteoarthritis

INTRODUCTION

Musculoskeletal bleeds occur in 80% of hemophilic patients [1], most commonly in the ankle joint [2]; arthritic changes occur in around 90% of patients that suffer recurrent bleeds [1]. A consequence of this Hemophilic Joint Disease in the ankle, is a significant reduction in joint range of motion (ROM) [3,4].

This gait adaptation has been hypothesized to be due to pain [5], with reductions in joint stresses alleviating pain, or physical limitations due to joint morphology [6].

To investigate these hypotheses, finite element analysis was carried out to simulate four patient specific hemophilic ankle models through stance phase of gait with three different ranges of motion: non-diseased, 50% reduction, and 80% reduction.

METHODS

Four hemophilic ankle models were built in Simpleware-ScanIP (Synopsis, 2019) from clinical MRI data (Local Ethical Approval: MEEC 18-022), and a quasi-dynamic simulation run through heel strike, mid stance and toe off (Abaqus 2017, Dassault Systèmes).

The loading applied was based on patient bodyweight, with the same load used for all three ROM.

Figure 1: Heel strike, at (A) non-diseased, (B) 50% ROM reduction, and (C) 80% ROM reduction

Contact Pressure and Contact Area Extracted for both cartilage components → Percentage changes calculated between non-diseased and 80% ROM reduction → Comparisons made at heel strike and toe off

Morphological measurement [6] were then used to ascertain if the ROM reduction could be a limitation linked to talar morphology

RESULTS

Table 1: Mean and maximum % change between non-diseased and 80% reduced ROM in both tibial and talar cartilage. With reduced ROM, % increased in contact area, and % reduced for peak and mean contact pressure.

		% Change in Contact Area	% Change in Contact Pressure	
			Peak	*Mean*
Tibial Cartilage	*Mean*	94.7	100.5	83.2
	Maximum	236.2	215.4	308.6
Talar Cartilage	*Mean*	96.2	62	79.4
	Maximum	288.8	188.7	198.3

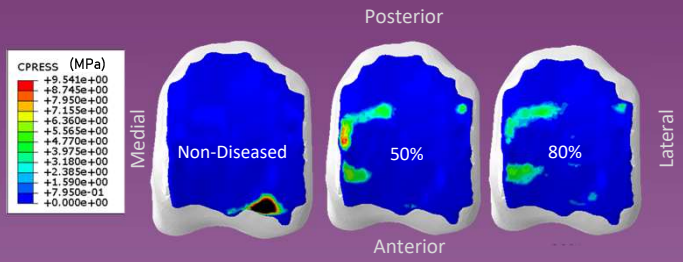

Figure 2: Change in contact pressure distribution in talar cartilage at heel strike between three different reductions in ROM

DISCUSSION & CONCLUSION

- 50% and 80% reductions in ROM saw significant reductions in peak and mean contact pressures, and increases in contact area.
- Reduction in ROM could therefore reduce pain, and potentially clinical bleeds as these are hypothesized to be onset by intra-articular stresses [7].
- One ankle opposed all findings in both heel strike and toe off
- No relationship between talar flattening and contact pressure was found in this small sample, as the degree of talar collapse was similar for the four ankles

REFERENCES

1) Rodriguez-Merchan (2010) HSS Journal
2) Stephensen *et al.* (2009) Haemophilia
3) Lobet *et al.* (2010) Haemophilia
4) Soucie *et al.* (2004) Blood
5) Lobet *et al.* (2012) Clinical Biomechanics
6) Talbott *et al.* (2021) Clinical Anatomy
7) Buckwalter and Saltzman (1999) Instructional Course Lectures

ORS Orthopaedic Research Society
2022 ANNUAL MEETING
ACCELERATING MUSCULOSKELETAL DISCOVERY
February 4–8, 2022 • Tampa, Florida

@HarrietTalbott
mnhgt@leeds.ac.uk
/harriettalbott

UKRI Engineering and Physical Sciences Research Council