DISCUSSION

What reference system is preferably used when visualising and analysing motion at the basal thumb joint? The ISB recommends an anatomical-based coordinate system, yet more recently, Cobburn et al pointed to its limitations and suggested to calculate inertial axes for each carpal bone and use these as coordinate system (Fig. 4). But does this approach allow easy interpretation of motion data in terms of flexion/extension, pro/supination, abduction/adduction, movements which occur in a different plane for the thumb than for the other fingers?

Anatomical vs. Inertial Reference System

- Ligament position and dimensions can be accurately extracted from MRE.
- DRL is thicker, broader and shorter than AOL and most important (Table 1).
- Ligaments at volar (AOL) and dorsal (DRL) side of the joint are important for stabilization, as well as surrounding muscles, and should be included in accurate musculoskeletal models.
- Collect arthrokinematics in human volunteers and combine this with kinetics (thumb tip forces) and muscle activation patterns (EMG) to drive MSS model.

Medical imaging based data collection

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- Ligaments at volar (AOL) and dorsal (DRL) side of the joint are important for stabilization, as well as surrounding muscles, and should be included in MSS model as (rigid or elastic) constraints.

REFERENCES

- Reference list with full citations.
- Relevant literature and additional resources.

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APPENDIX

Specific project aims To build an accurate musculoskeletal model of the human thumb and use dynamic simulations to achieve a better understanding of the function and dysfunction of the basal thumb joint.

Research questions - Does the human basal thumb joint function as a saddle joint with 2 non-orthogonal axes of rotation? - Is there a gender-based difference in the functional anatomy of the human thumb basal joint?

Anatomical Data Collection

Detailed anatomical data is needed to build an accurate musculoskeletal model:

- Joint geometry is obtained via segmentation of CT scan images (voxel size = 0.158 x 0.158 x 0.6 mm) and 3D reconstruction using Mimics software (Materialise).
- Ligament and tendon dimensions (path, length, CSA...) are obtained from 3D MRI.
- 3D MRI offers the possibility to measure and create 3D models of soft tissues surrounding basal thumb joint and is applicable in vivo (volunteers/patients).
- Muscle parameters (path, volume, length, PCSA...) are obtained via detailed dissections of unfixed cadaveric hands.

Arthrokinematics

Basal thumb joint motion is recorded in vivo using dynamic CT or 4D CT scanning allowing calculation of functional joint axes:

- Powerful tool to accurately register internal bone motion in 3D.
- High spatial (voxel size = 0.158 x 0.158 x 0.6 mm) and temporal resolution (0.5 s; no motion blur).
- Continuous motion registration (vs. semi-dynamic approaches) during prehensile activities (precision and power grip, opposition...).
- Applicable in vivo (humans) and in vitro (nonhuman primates)

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