Abstract (Program Number: 780.4)

Surface models are used to quantify differences in form in a variety of anatomical analyses. Different methods for obtaining surface models are used across studies and multiple methodologies may be used within a single study. The number of methodologies available for the collection of surface data has multiplied in recent years. Though this presents an opportunity, it also presents a potential problem. Are surface models obtained using different methodologies comparable? Here I quantify surface distances between aligned surface models obtained using a blue light scanner and photogrammetry.

Proximal tibiae from ten individuals were mounted to a rotating stand and scanned using an Artec Space Spider; surface models were automatically reconstructed using the real-time fusion setting in Artec Studio 16. The same tibiae were photographed from 65 angles using a Canon Coolpix camera set to the macro setting. Photographs for each individual were masked and aligned to build a surface mesh using Agisoft Metashape. Artec scanner and photogrammetry surface models for each individual were imported into Avizo Lite. The photogrammetry model for each individual was scaled and aligned to the Artec model by iteratively minimizing surface distance between the models. Once surface alignment reached a stable configuration, surface distances from the Artec model to the photogrammetry model were calculated. Surface distances were also calculated between aligned pairs of individuals obtained using the Artec scanner.

Surface distances between different individuals obtained using the same methodology were 73 times larger than those between models of the same individual obtained using different methodologies ($p<0.001$). Mean surface distance between models of the same individual was 0.020 mm and mean surface distance between models of different individuals was 1.477 mm. While surface distances exceeded 0.5 mm for approximately 75% of vertices in between individual comparisons, surface distances never exceeded 0.5 mm in comparisons of Artec scanner and photogrammetry derived models. These results suggest that surface models obtained using different methodologies are comparable, at least in this case.

Are Surface Models Obtained Using Different Methodologies Comparable?

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Purpose

Surface models are used in a variety of anatomical analyses. Different methods for obtaining surface models are employed across studies and multiple methodologies may be used within a single study. The number of methodologies available for the collection of surface data has multiplied in recent years. Though this presents an opportunity, it also presents a potential problem. Are surface models obtained using different methodologies comparable? Here I quantify surface distances between aligned surface models obtained using a blue light scanner and photogrammetry.

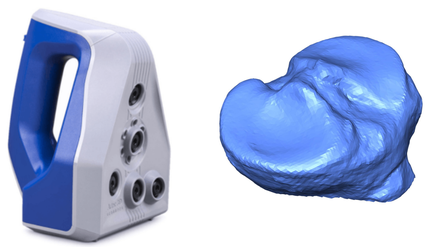
Sample

Proximal tibiae of ten individuals were dissected to reveal the tibial plateau.

Individual	Sex	Age
1	M	74
2	M	85
3	F	96
4	F	84
5	F	91
6	F	63
7	M	80
8	M	84
9	F	89
10	M	87

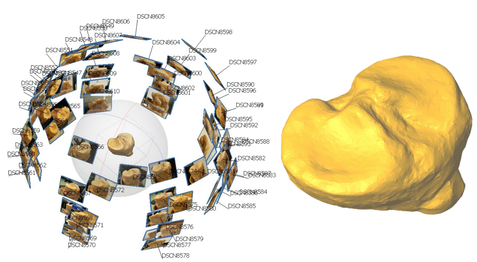
Blue Light Scanning

Proximal tibiae from ten individuals were mounted to a rotating stand and scanned using an Artec Space Spider; surface models were automatically reconstructed using the real-time fusion setting in Artec Studio 16.[1]



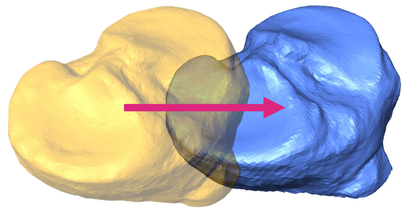
Photogrammetry

The same tibiae were photographed from 65 positions using a Canon Coolpix camera set to the macro setting. Photographs for each individual were masked and aligned to build a surface mesh using Agisoft Metashape.[2]



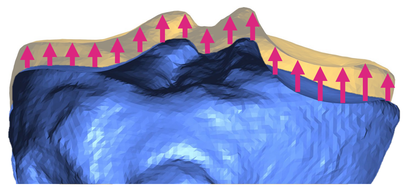
Surface Alignment

Artec scanner and photogrammetry surface models for each individual were imported into Avizo Lite.[3] The photogrammetry model for each individual was scaled and aligned to the Artec model using an iterative closest point algorithm that included scale.



Surface Distance

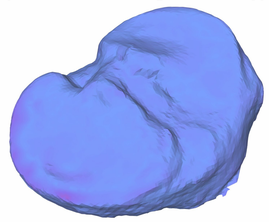
Once surface alignment reached a stable configuration, surface distances from the Artec model to the photogrammetry model were calculated. Surface distances were also calculated between aligned pairs of individuals obtained using the Artec scanner.



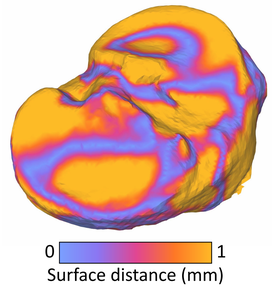
Results

Surface distances between different individuals obtained using the same methodology were 73 times larger than those between models of the same individual obtained using different methodologies ($p<0.001$). Mean surface distance between models of the same individual was 0.02mm and mean surface distance between models of different individuals was 1.48mm.

Same Individual
(Artec vs. Photogrammetry)



Different Individuals



While surface distances exceeded 0.5mm for approximately 75% of vertices in between-individual comparisons, maximum surface distances ranged from 0.1-0.4mm in comparisons of Artec scanner and photogrammetry derived models.

Conclusions

These results suggest that surface models obtained using different methodologies are comparable. Measurements should be taken of physical elements using calipers prior to digitization if a methodology that does not automatically incorporate scale (like photogrammetry) is used.

Acknowledgements

Thank you to the donors for their anatomical gifts as well as the Maryland State Anatomy Board for providing access. The equipment used for this research was purchased using a generous donation by the Stibel family.

References

1. Artec Studio 16 (Artec3D, 2021)
2. Metashape Professional 1.6.5 (Agisoft, 2020)
3. Avizo Lite 9.0.1 (FEI Visualization Sciences Group, 2015)