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| Weekly Research Report | | | |
| Name | Aiyung | Duration | 2024/10/11 ~ 2024/10/16 |
| Date | 2024/10/16 | (week 6) | |

* Bring your research notebook every time for cross check when present your weekly report.
* The weekly report should be written over 1 page.

1. Brief title of this report (本報告主題)

模擬計算用之軟組織機械性質

1. Research issue address at … (研究過程中發現的問題)

是否需要個別量測激性性質後才能模擬。

臉部軟組織的解剖細節需要多仔細。

1. Method or possible solutions (提出可能的解決方法)

* Knoops PGM, Borghi A, Ruggiero F, Badiali G, Bianchi A, Marchetti C, Rodriguez-Florez N, Breakey RWF, Jeelani O, Dunaway DJ, Schievano S. A novel soft tissue prediction methodology for orthognathic surgery based on probabilistic finite element modelling. ~~PLoS One~~. 2018 May 9;13(5):e0197209. doi: 10.1371/journal.pone.0197209. PMID: 29742139; PMCID: PMC5942840.

該文提出一種將機械性質視為隨機變數的改進有限元素法（probabilistic finite element modelling）用以預測臉部變化。

雖然結果的正確性並未超越商用軟體，但計算時間遠低於FEM方法。

一張含有 文字, 數字, 字型, 螢幕擷取畫面 的圖片

自動產生的描述

圖 1 計算用變數範圍

* Chanda, Arnab & Singh, Gurpreet. (2023). Mechanical Properties of Human Tissues. 10.1007/978-981-99-2225-3.
* Olivetti, Elena Carlotta, Sara Nicotera, Federica Marcolin, Enrico Vezzetti, Jacqueline P. A. Sotong, Emanuele Zavattero, and Guglielmo Ramieri. 2019. "**3D Soft-Tissue Prediction Methodologies for Orthognathic Surgery—A Literature Review**" *Applied Sciences* 9, no. 21: 4550. <https://doi.org/10.3390/app9214550>

本文分析了2007至2019年間24篇針對正顎手術後軟組織變化預測的研究，共計752項病患資料、

表格 1 商用軟組織預測軟體與演算法比較

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 軟體 | 特徵維度 | 演算法 | 考慮材料參數 | 考慮複合材料行為 | 臨床可用  (原作者結論) |
| OrthoForecast | 2D | 資料庫擬合(線性回歸)  資料量：200位病患 | X | X | V |
| TIOPS | 2D | 定義軟/硬組織變化比率，以Cephalometric planning的變化量計算 | △ | X | △：建議針對病患定義比率 |
| CASSOS | 2D | 依照手術計畫特徵點進行線性回歸 | △ | X | △：除了嘴唇其他可**參考** |
| Dolphin VTO | 2D | ? | ？ | X | V |
| Dentofacial planner plus (DFP) | 2D | 依照手術計畫特徵點進行線性或非線性回歸[[1]](#footnote-1) | X | X | V |
| Maxilim | 3D | Mass tensor model algorithm | V | X | V |
| Dolphin 3D | 3D | Landmark photographic morphing algorithm (79 landmarks, 47 on hard tissue, 32 on soft tissue) | X | X | △：臉正面可以；側向不行。 |
| 3dMDvultus | 3D | Mass Spring Model | V | X | X：It has no true bio-mechanical relevance[[2]](#footnote-2) |
| SurgiCase\_CMF | 3D | Iterative closet point algorithm  (data-based) | X | X | △：除了嘴唇其他準確 |
| Simplant Pro | 3D | Finite Element Method | V | ？ | V |
| Proplan CMF | 3D | Finite Element Method | V | ？ | V |

\*\*\*動機\*\*\*

1. Outcomes and new derivative problems (因應該方法產生的結果，及或衍生的新問題)

找不到在模擬結果中「< 3 (or 2) mm is clinically acceptable」的出處。 Assume that is common sence

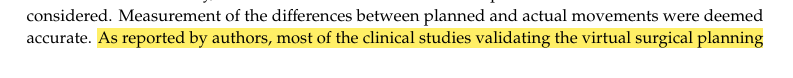




圖 3 「模擬結果誤差< 2.0 mm 為臨床可用」文字截圖1

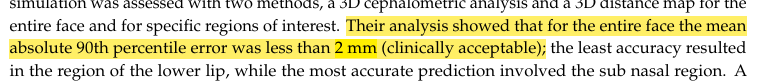


圖 4 「模擬結果誤差< 2.0 mm 為臨床可用」文字截圖2

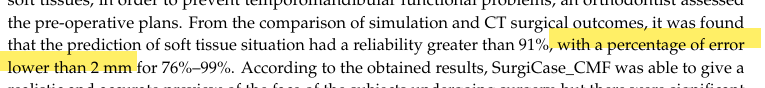


圖 5 「模擬結果誤差< 2.0 mm 為臨床可用」文字截圖3

一張含有 文字, 字型, 螢幕擷取畫面 的圖片

自動產生的描述

圖 6 「模擬結果誤差< 2.0 mm 為臨床可用」文字截圖4

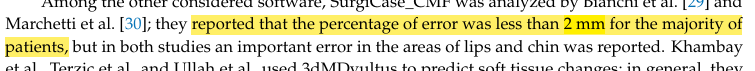


圖 7 「模擬結果誤差< 2.0 mm 為臨床可用」文字截圖5

一張含有 文字, 字型, 螢幕擷取畫面, 黃色 的圖片

自動產生的描述

圖 8 「模擬結果誤差< 2.0 mm 為臨床可用」文字截圖6[[3]](#footnote-3)

1. Conclusion & Discussions (小結與討論)

未來模擬可以考慮使機械性質在上文提到的範圍內進行連續變化。

給一個manual讓醫生參考(default value)

上文2間接說明不考慮臉部軟組織異向性也可以取得臨床可參考結果。

1. Plan for next week (下周預期工作內容，提出可能解決本周問題的幾種規劃)

尋找更多文獻參考模擬參數。

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Skin tissue is passive tissue:

Ní Annaidh A, Bruyère K, Destrade M, Gilchrist MD, Otténio M (2012) Characterization of

the anisotropic mechanical properties of excised human skin. J Mech Behav Biomed Mater

5:139–148. https://doi.org/10.1016/j.jmbbm.2011.08.016

Wu JZ, Cutlip RG, Welcome D, Dong RG. Estimation of the viscous properties of skin and subcutaneous tissue in uniaxial stress relaxation tests. Biomed Mater Eng. 2006;16(1):53-66. PMID: 16410644.

Wu JZ, Dong RG, Smutz WP, Schopper AW. Nonlinear and viscoelastic characteristics of skin under compression: experiment and analysis. Biomed Mater Eng. 2003;13(4):373-85. PMID: 14646052.

Limbert G. Mathematical and computational modelling of skin biophysics: a review. Proc Math Phys Eng Sci. 2017 Jul;473(2203):20170257. doi: 10.1098/rspa.2017.0257. Epub 2017 Jul 26. PMID: 28804267; PMCID: PMC5549575.

Singh G, Chanda A (2021) Mechanical properties of whole-body soft human tissues: a review. Biomed Mater 16:062004

1. Schultes G, Gaggl A, Kärcher H. Accuracy of cephalometric and video imaging program Dentofacial Planner Plus in orthognathic surgical planning. Comput Aided Surg. 1998;3(3):108-14. doi: 10.1002/(SICI)1097-0150(1998)3:3<108::AID-IGS2>3.0.CO;2-T. PMID: 9888197. [↑](#footnote-ref-1)
2. Mollemans, W.; Schutyser, F.; Nadjmi, N.; Maes, F.; Suetens, P. Predicting soft tissue deformations for a

   maxillofacial surgery planning system: From computational strategies to a complete clinical validation. Med.

   Image Anal. 2007, 11, 282–301. [↑](#footnote-ref-2)
3. Alkhayer A, Piffkó J, Lippold C, Segatto E. Accuracy of virtual planning in orthognathic surgery: a systematic review. Head Face Med. 2020 Dec 4;16(1):34. doi: 10.1186/s13005-020-00250-2. PMID: 33272289; PMCID: PMC7716456. [↑](#footnote-ref-3)