Quantification of Morphological Parameters of Forearm Skin Layers using OCT with Circumstances Involving Dressing Tape

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Abstract. The usage of skin grafts, wound dressings and wearable technologies is expected to quadruple by year 2020 [1]. The effect of these external devices or grafts on the nearby skin sites still needs lot of research. Two separate studies were carried out using optical coherence tomography (OCT) with the aim to investigate the deformation in sub-layers of volar forearm skin under different local loading conditions. Study A corresponds to the presence of adhesive tape used in wound dressings. In study B the natural stretching of skin through extension of the forearm is replicated using 2.5 kPa tangential stress. Both studies were then compared to previous data collected from natural stretching of forearm skin. Addition of tape to the skin does not significantly ($p=0.12$) change the epidermal thickness however, it does significantly reduce (70%) the roughness on the nearby skin surface and dermal epidermal junction compared to unaffected skin ($p=0.02$).

Introduction

Design and evaluation of skin grafts for burnt wounds have been a topic for discussion since 1969 [2]. Wearable technology experts have concerns regarding generation of skin rashes due to the use of external devices [3]. The two studies presented here seek to assess the effect of skin loading using OCT through the use of wound dressing tape.

Materials and Methods

Two volunteers (38 year old male; Fitzpatrick skin type 2 and 26 year old female; Fitzpatrick skin type 1) were recruited for the studies in alignment with the University of Sheffield Ethics process. Hair was removed from the skin sites and they were then cleaned using alcohol wipes. The OCT set-up from previous study [3] was modified with loading arrangements, shown in Fig. 1.

A VivoSight OCT (Michelson Diagnostics, Kent), was used to capture the images at 20 frames per second with each image of size 1342 x 460 pixels. Images were analysed for morphological parameters (epidermal thickness and topography of both the surface and the epidermal-dermal (DEJ) junction) using a modified Michelson Diagnostic algorithm [4].

Scanpor CE marked wound dressing tape (Bio-Diagnostics Ltd, Worcestershire) 20 x 40 mm in size was placed between the region of interest (ROI) and elbow for study A and between the two ROIs in study B. The forearm was extended from 90^o flexion to 180^o extension (Fig. 1: Study A) and the morphological parameters were compared with earlier study [4]. A non-extendable string attached to a spring balance (Fig. 1: Study B) was used to induce a 2 N tangential force (equivalent to average shear stress of 2.5 kPa) to the in study B which reflects loading close to the maximum threshold where discomfort and pain occurs. The study B was performed at 90^o forearm flexion. The results were however compared to full extension scenario from

earlier study [4]. Comparison of morphological parameters between the current studies and earlier study [4] were assessed using Paired t-tests at -5% ($p<0.05$) significance level.

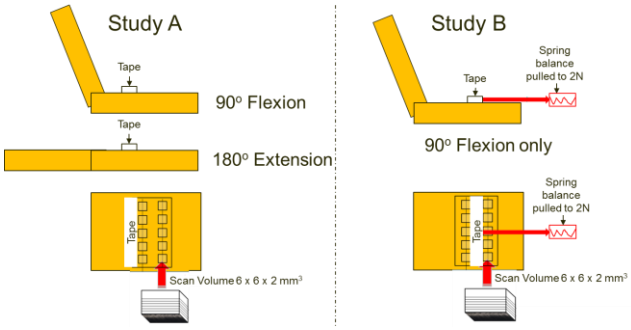

Fig. 1: Loading arrangements for studies A and B. Original setup detailed in Maiti et al. [3].

Result and Discussion

Addition of tape did not significantly ($p=0.12$) change the local epidermal thickness, 102.2±3 μm, (Study A) compared to the earlier study, (108±14 μm) [4]. However, the R_a, of the surface and DEJ junction reduced by 70% ($p=0.02$) compared to earlier study [4]. The slight pre-strain of tape material before attaching to the skin resulted in compression of the skin on attachment as the tape relaxes. This then stretches nearby skin causing a reduction in roughness as shown in Fig. 2. Hence, it is important to consider the posture when attaching adhesive tapes and sensors, to avoid unnecessary skin deformations during wear of the stick-to-skin device.

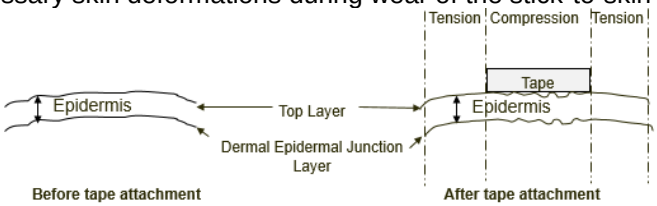

Fig. 2: Skin behaviour on attaching tape on the forearm.

The skin pulling in Study B resulted in a non-significant decrease in epidermal thickness ($p=0.23$), compared to the full forearm extension no tape condition in earlier study [4]. Similar to Study A, the roughness was lower in Study B ($p=0.03$) than was found in the earlier study [4] due to the use of non-rigid tape material.

Conclusions

The skin site adjacent to an adhesive tape shows extensive reduction in surface roughness when using adhesive tapes in comparison to earlier reported study. The skin graft, adhesive dressings and wearable technologies though exerts no change to the epidermal thickness, might significantly change the skin layer roughness. Care must be taken on the arm posture to avoid unnecessary stretching of the skin.

References

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