MR Microscopy of both normal and abnormal skin layers

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정상 및 비정상 피부층에 대한 자기공명현미영상법

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ABSTRACT

In-vivo and in-vitro MR Microscopy has been performed to investigate any differences in-between the normal and the abnormal skin layers. Noninvasively acquired images could provide the skin histology. Also, it was found that the epidermis of the abnormal skin was thickened more than that of normal skin. MR Microscopy utilized for the present study may be applicable to the noninvasive investigation of skin pathology and this technique may be of use in the development of cosmetics.

Introduction

Human skin is composed of very thin layers that are hardly discriminated by the conventional MRI technique. The reason is that the conventional MRI do not provide high enough resolution (on the order of mm) to distinguish the thin skin layers. Among the skin layers, the epidermis is very important from the cosmetic point of view due to its initial contact to cosmetics. However, the thickness of the epidermis is on the order of sub-mm and is hardly visible on the conventional MR images. Although the ultrasound technique has been widely utilized to study skin layers since it has valuable properties including noninvasiveness, this technique often lags of visualizing the morphological changes in skin layers.[1] In the present study, the morphological changes in both the normal and the abnormal skin tissues were observed by dermal MR Microscopy for the evaluation of skin pathology. Also, the feasibility study for in-vivo MR study was performed for the thin skin layers of both hairless mice and guinea pigs.

Materials and Methods

Preparation of specimens: For the in-vivo experiment, hairless mice and guinea pigs were anesthetized before positioned in the rf (radio-frequency) coil. Hair was removed from the imaging regions for guinea pigs. Abnormal skin was generated to produce erythema by the irradiation of 200mJ/cm^2 of UV-B using a solar simulator (Solar Light Co. USA). Each skin tissue for the in-vitro experiment has been prepared from a guinea pig. In the in-vitro experiment, each skin tissue was positioned in a 6mm (i.d.) acryl tube filled with glycerol which reduced the swelling effect as well as the susceptibility artifact. Each tissue was attached on the inner wall of a tube so that a skin surface was directly contact with glycerol.

Hardware: For the in-vivo experiment, 1.5cm diameter surface coil was utilized as a rf coil along with both a 13cm diameter gradient coil

(for guinea pigs) and a 6cm diameter gradient coil (for hairless mice). For imaging in-vitro specimens, a shielded solenoid coil (i.d. of 9mm) was used and positioned in a 6cm diameter high gradient coil that was capable of producing up-to 100G/cm. Each rf coil along with a gradient coil was located in a 2.0T whole body MRI system.

Pulse sequence: The conventional spin echo sequence has been utilized with different imaging parameters depending on the objective information.

Results and Discussion

In-vivo images for hairless mice are shown in Fig.1a,b. The epidermis of abnormal skin (Fig.1a) is somewhat thicker than that of normal skin (Fig.1b). These images were obtained by the conventional spin echo imaging sequence with the following parameters: the FOV (field of view) of 10mm, matrix size of 128x128, slice thickness of 1mm, number of acquisitions of 14 and TR/TE=1500/30ms. The thickness of the abnormal epidermis was increased due to its protection role against the UV-B irradiation.

(a) (b)

Fig.1 In-vivo image for both the abnormal skin (a), and the normal skin (b) of hairless mice.

From the skin images obtained in the in-vitro experiment, different shrinking behavior in the abnormal skin tissue is observed in comparing with the normal skin. Superficial layers (epidermis and dermis) of the abnormal skin tissue were contracted more than those of normal skin tissue since the immersion in glycerol.

Figure 2 displays four images obtained from both normal and abnormal skin tissues. The conventional spin echo imaging sequence was used with the following parameters: the FOV (field of view) of 12mm, matrix size of 128x128, slice thickness of 1mm, number of acquisitions of 10 and TR/TE=200/30 (a), 1500/30(b,d), 1500/70ms(c).

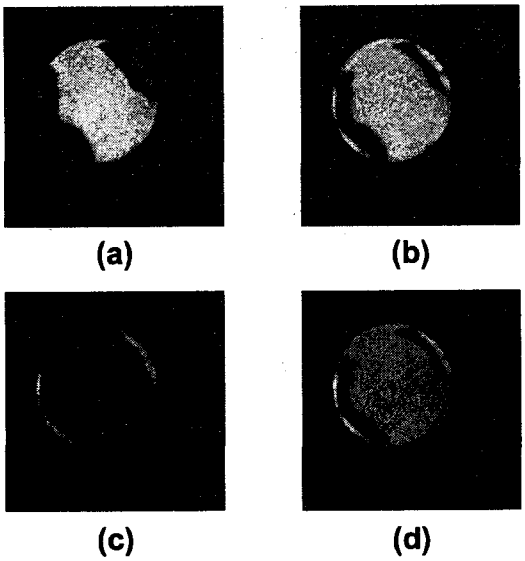

Fig.2. In-vitro MR images for hairless mice obtained 40 min.(minutes) (a), 1 hr.(hour) and 22 min., 3 hrs.(hours) and 31 min. (c), 5 hrs. and 13 min. (d) after the immersion of the tissues in glycerol

Lower left tissue is normal while upper right one is abnormal. Subcutaneous fat layer is clearly delineated on the T_2 weighted image as shown in Fig.2c. Figures 2a through 2d were obtained time sequentially. Three layers are clearly seen in the proton density weighted image as displayed in Fig.2b. Although in Fig.2d both skin tissues were shrunk in their superficial regions, the abnormal tissue was contracted somewhat faster than the normal tissue. This is due to the reason that the initially swollen region of the abnormal tissue may become more easily in the shrinking state. Erythema in the abnormal skin tissue makes the epidermis swollen with water during the irradiation of UV-B on the skin. Since glycerol has high water-holding capacity, the swollen skin tissue due to erythema is expected in the faster de-swelling process during the image acquisitions.

The skin tissues, prepared just after the in-vivo experiment as shown in Fig.1, was excised from both the normal region and the abnormal region (the region irradiated by UV-B). Figure 3 displays both the normal (a) and the abnormal (b) skin tissues which were

not immersed in any solution. On the figure corresponding density profiles are also depicted at the bottom of each image. These images were selected from the one image acquired using the conventional spin echo imaging sequence with the following parameters: the FOV (field of view) of 30mm, matrix size of 128x128, slice thickness of 2mm, number of acquisitions of 1 and TR/TE = 1500/30.

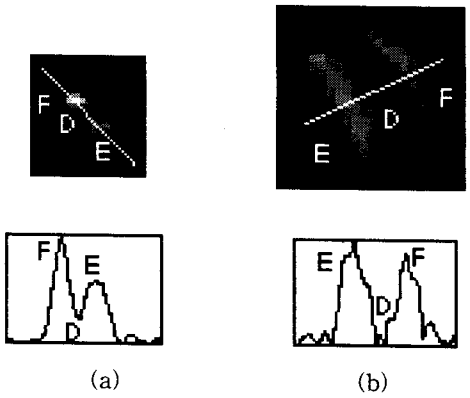

Fig.3. MR Microscopic images for both normal (a) and abnormal (b) skin tissues: three skin layers, denoted by E for epidemis, D for dermis, and F for subcutaneous fat, are clearly observed.

As obtained from the previous images in Figs.1 and 2, the superficial layers (including the epidermis and the dermis) of the abnormal skin are swollen in comparison with those of the normal skin.

Conclusions

As shown in the present preliminary study, MR Microscopy for thin skin layers offers noninvasive visualization of skin pathology. Especially, MR Microscopy of animal skin will be advantageous for testing new cosmetics before the application to the human skin. In-vivo MR Microscopy is found very feasible for the study of skin. More work relating noninvasive investigation of skin is currently in progress.

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References

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