Development of Infrared (IR) Marker for Thermoplastic Immobilization Tool

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INTRODUCTION

- The thermoplastic immobilization tool has the advantage that it can be manufactured according to the body shape of each patient by utilizing the property of the thermoplastic material and is one of the most commonly used fixing methods in clinical practice.
- In the case of a thermoplastic immobilization tool, the nature of the fixation method covers the surface of the patient's skin and performs compression. Therefore, there is a disadvantage in that the use of the patient motion monitoring method using the camera equipment is limited in radiation treatment.
- To overcome these drawbacks, we propose an IR marker designed to enable camera-based patient movement monitoring while using a thermoplastic immobilization tool.

AIM

- The purpose of this study is to develop the IR marker for thermoplastic immobilization tool that can detect the movement of the patient surface inside the thermoplastic immobilization tool by using 3D printing technique.

METHOD

A. 3D modeling

- Modeling of IR marker was performed using 3D modeling software called solidworks.

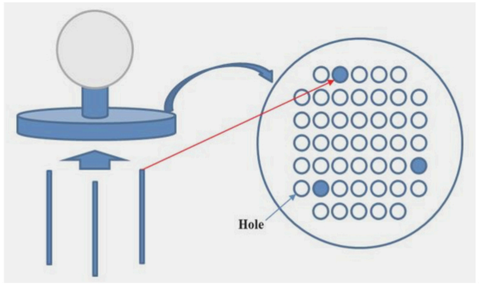

Figure 1. Diagram of IR marker for thermoplastic immobilization tool.

METHOD (CONT.)

- The structure of the IR marker was consisting of 1. spherical marker, 2. cylindrical marker posts to be attached to the skin, and 3. a disk-shaped marker base between a spherical marker and cylindrical marker posts. (Figure 1.)
- The IR marker proposed in the development is a method in which a plurality of holes are formed on the bottom surface of the IR marker structure and cylindrical marker posts are joined. Using the above structural features, it is designed to attach IR markers on the patient's surface inside the fixture and to monitor the camera-based patient movement.
- Infrared reflective material is applied to the top of the IR marker. (Spherical marker)
- The modeled IR marker is converted to STereoLithography (STL) file and output to the 3D printer.

B. Application

- The IR marker was attached to the skin using double-sided medical adhesive tape.
- Whether there is interference with the thermoplastic immobilization tool was confirmed by placing the IR marker on the back of the hand.

RESULTS

A. 3D modeling results

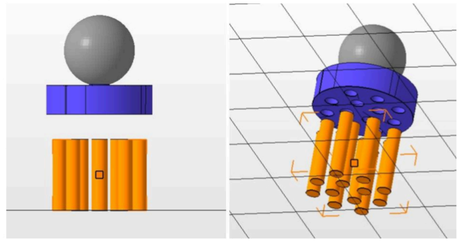

Figure 2. 3D modeling results

RESULTS (CONT.)

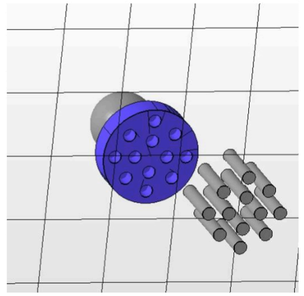

Figure 3. IR marker designed to prevent interference when using a thermoplastic immobilization tool.

B. IR marker

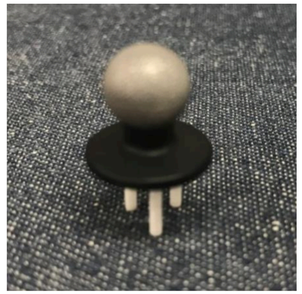

Figure 4. IR marker for thermoplastic immobilization tool

- IR marker for thermoplastic was developed to detect patient movement in thermoplastic immobilization tool.
- The IR marker was modeled using 3D modeling software and the structure was printed using a 3D printer. This IR marker was designed to be freely placed on the immobilization tool without interference.

C. Evaluation

- We confirmed that the IR marker is well located on thermoplastic immobilization tool without any other problems.

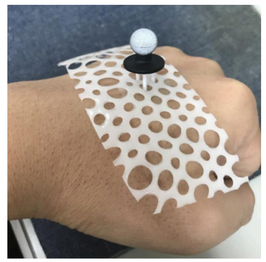

Figure 5. A photograph of an IR marker attached to the skin surface with the thermoplastic immobilization tool.

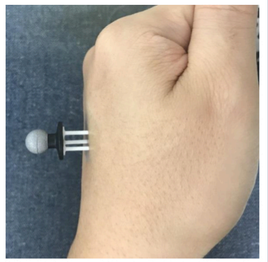

Figure 6. A photograph of an IR marker attached to the skin surface using double-sided medical adhesive tape.

- Although it is not a quantitative evaluation, we have confirmed that the IR marker moves according to the motion of the skin surface.

CONCLUSIONS

- Thermoplastic immobilization tool and camera-based patient monitoring equipment are the most commonly used patient setup auxiliary equipment in clinical practice in radiotherapy, but they are limited in their use in combination with equipment characteristics. The use of the developed IR markers is expected to help more accurate patient set-up since they can be used together without sacrificing the merits of the two devices.
- Further study, we will verify with the stereo vision that the developed IR marker detects movement of the patient surface.

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