2017

Ergonomic Immobilization Frame for Radiotherapy

Raheel Ahmed
Virginia Commonwealth University

Travis Alford
Virginia Commonwealth University

Talal Almutairi
Virginia Commonwealth University

Kaleem Farooq
Virginia Commonwealth University

MECHANICAL & NUCLEAR ENGINEERING

CAPSTONE DESIGN EXPO 2017

Ergonomic Immobilization Frame for Radiotherapy

Project team: Raheel Ahmed, Travis Alford, Talal Almutairi and Kaleem Farooq | **Faculty adviser:** Dr. Woon-Hong Yeo (Mechanical Engineering) |
Sponsor: Dr. Siyong Kim (Radiation Oncology) | **Sponsor adviser:** Mark Ostyn | **Project number:** MNE 520

Background

- Every year cancer patients are treated using radiotherapy.
- During radiotherapy the patient must be as still as possible and the radiation must be applied evenly and in a consistent area.
- Currently there is no system in place which is used for general torso immobilization when applying radiotherapy in those areas.

Objectives

- Our objective is to demonstrate that a patient can be safely immobilized using air in order to have radiotherapy administered to them.
- We aim to develop a prototype which will use an air medium to immobilize patients while standing.
- The system will be used to treat tumors and immobilize in the general torso area, namely to treat tumors in the lung and liver.

Project Overview

Design Development → Computational Modeling → Analysis → Construction

Design & Fabrication

Materials:

- Any areas in the system which would come into contact with radiation had to be built using radiographic safe materials.
- Therefore nonmetallic materials, wood and plexiglass, were used to build the system.

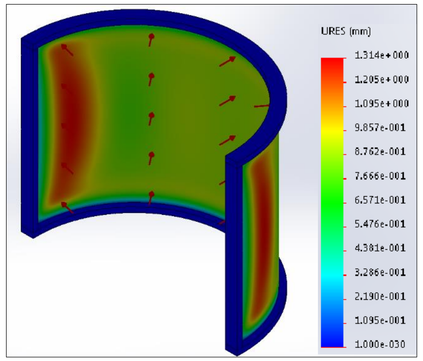
Air Immobilization: Air was chosen for immobilization because radiation can easily flow through air and it allows so there are no physical interferences while the radiation is being applied.

Fabrication:

- Each component was cut using a jigsaw this incudes any part with a curve in it.
- A frame was developed with a deep groove inside to insert the plexiglass in order to hold it in its desired curved position.
- As a replacement for screws in order to join parts together a series of dowels were used.

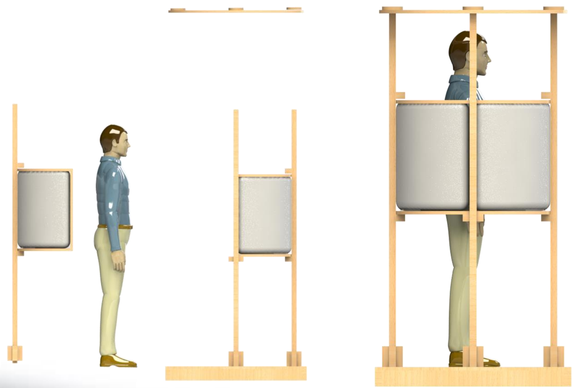
Strength Analysis:

- A mechanical shell structure was modeled in Solidworks.
- The shell is the area of the system which would have pressure exerted on it from the airbags. Therefore it was important to run an analysis on the shell at 6 Psi in order to calculate the displacement of the plexiglass from the wooden frame.



Device Operation

- Three of the four posts will be permanently fixed to the base.
- The person will stand in the middle of the base. The removable post will be placed and the patient will have the airbag shells on both sides of them.
- The airbags are then inflated on both sides immobilizing the patient.



Future Plan

- The system will need to be integrated with current clinical hardware.
- Smart electronic inflation and deflation systems need to be added.
- Custom airbags which will perfectly fit the semi-circular shells will need to be developed.
- There needs to be further development in making the shell adjustable to accommodate patients with different heights.

Conclusion

- We successfully fabricated a radiotherapy-compatible system which can be used to immobilize the torso region of a patient using air pressure during radiotherapy.

Acknowledgements

- We thank the generous support from Dr. Siyong Kim's research group at the Radiation Oncology, VCU Medicine.

VCU School of Engineering