Fluid-Mixing Management During Radiology Fluid Injection

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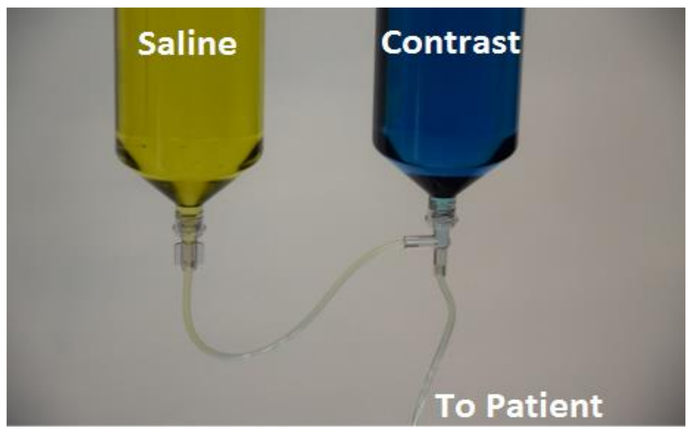
Motivation

- Computed Tomography (CT) Injections are one of the most common forms of imaging in a clinical setting
  - Can require the use of contrast in order to produce clear images.
- Current product for injecting contrast uses a dual injection system which causes mixing of the saline and contrast fluids
- Mixing causes fluctuations in the amount of fluid injected
  - This can cause unclear images and alarm for doctors who can see the fluids mixing in real time.

Objective Solution

Alter the tubing junction to keep the saline from entering the contrast syringe and vice versa.



The above is a schematic of the current tubing junction, with saline in yellow and contrast in blue

The above images show the current setup during an injection. The picture on the right was taken while the contrast (blue, left syringe) was being injected. This fluid can clearly be seen entering the saline syringe (clear, right syringe) and mixing.

Design Factors Considered

- Tubing Materials
- Junction Geometry
- Manufacturing Techniques
- Cost
- Use Cases

Use Cases During Which Mixing Occurs

Case 1: Upright Prime. Flushing fluid through the tubing to eliminate air in each syringe. Contrast is flushed first followed by saline

Case 2: Downward Prime

Case 3: Fluid Injection: Contrast followed by saline flush

Case 4: Density exchange: Denser contrast displaces saline within tube set forcing saline into contrast syringe

Design Process and Testing Methods

- Quantified mixing under current system for use as a baseline to compare our design solution
- Performed injection testing on initial designs in order to refine concepts
- Developed 7 initial designs to be narrowed down to 2
  - Final prototypes were 3D printed and assembled for testing
- Data was compared to the baseline to determine necessary modifications to the design
- Testing was performed on each use case; the new design should decrease mixing in each of these use cases.
- Went through multiple iterations to end up at the final design

New Junction Design Significantly Reduces Mixing

- Current design averages 15% mixing by volume of saline in the contrast syringe.
- New design visually shows negligible mixing during injection in both syringes.
- New design prevents mixing due to density exchange

Future Work

- Performance of injection molded design
- Manufacturing and storage considerations
  - Resistance to UV rays
  - Resistance to moisture and heat
- Durability under compression, tension and fluid flow

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