

Background

- K-wires, are smooth sharp stainless steel pins used in the field of orthopedics to stabilize bone fracture fragments in their correct position until the fracture has fully healed and the structure of the affected bone is restored.
- During bone reconstruction surgeries, the orthopedic surgeon uses x-ray imaging to guide K-wire insertion and ensure proper internal alignment of K-wires.
- The identical and 2D appearance of the K-wires on x-ray images presents surgeons with the challenge of identifying the correct K-wires to adjust, leading to more x-ray images, which lengthen the surgical procedure and expose the patient to unnecessary radiation.



Fig 1. X-ray of K-wires inserted into a patient's wrist

Design Description

- Once the K-wire (A) has been inserted into the body, various washers (B) are slid onto the distal end of the K-wire, outside of the patient's body
- X-rays are taken to confirm proper internal alignment of the K-wires.
- The washers are removable, allowing the K-wire to be adjusted until the K-wires are in the correct position.
- Washers can be cut or slid off the end of the wire and discarded.
- Since, it is washer-inspired design, this is called K-washer.

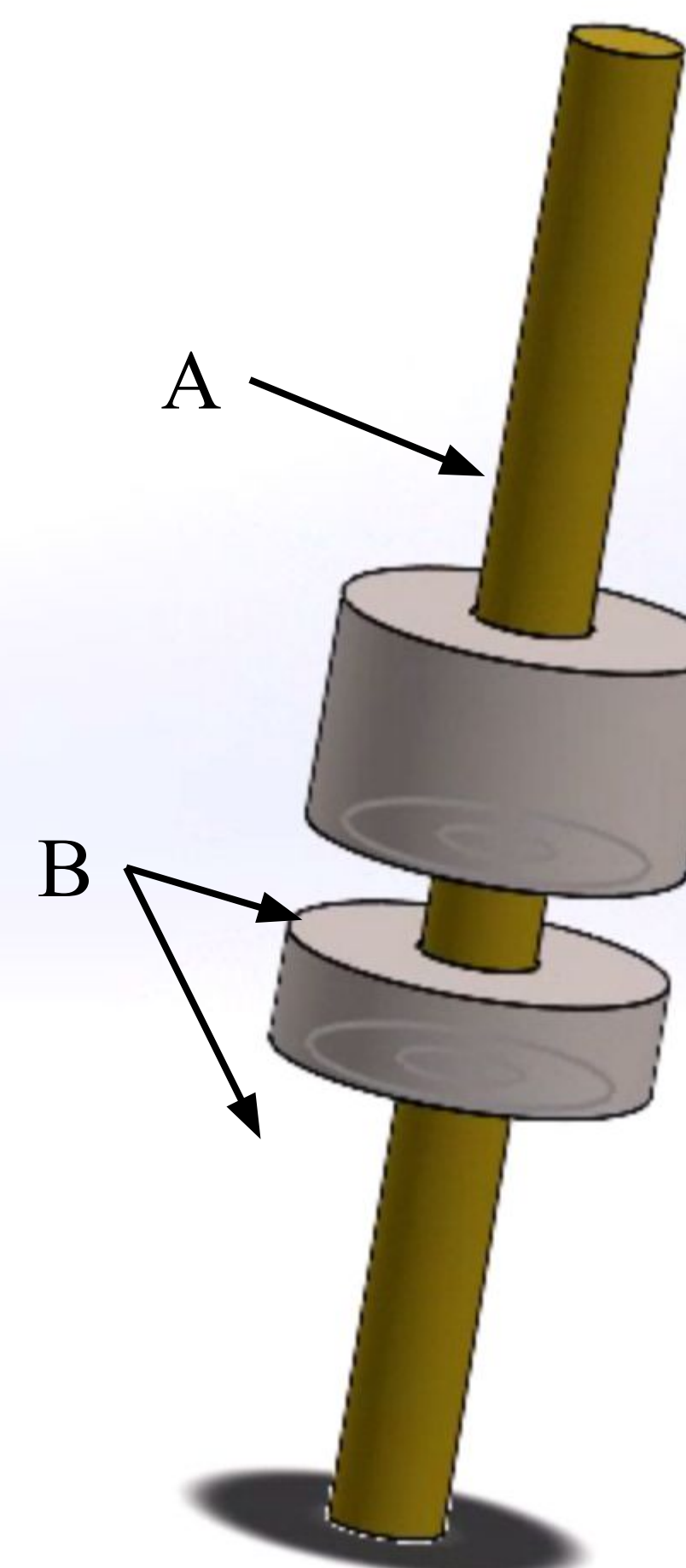


Fig 2. Kwasher design using SolidWorks

Current Testing Results

- To test our design functionality, methods of testing for compatibility and distinguishability were proposed in Table 1.
- Since our model K-wire had identical diameters, we were not able to test compatibility with different diameters.
- Kwashers of different shapes are distinguishable from each other on low-confidence x-ray simulated images, shown in Fig. 3 and 4.

Table 1. Results of testing methods corresponding to functional requirements

Functional Requirements	Testing	Yes/No
Compatible with different diameters	Try the Kwasher on K-wires of different diameters	No
Distinguishable on the x-ray images (in different planes)	Take pictures of the Kwashers on the K-wire in the lateral/medial, anterior/posterior, and oblique planes	Yes

Design Objectives & Functions

- We are designing a K-wire attachment to be used by the surgeon during large bone fixation procedures. The attachment gives each K-wire a unique appearance on the x-ray, increasing the safety and efficiency of bone reconstruction surgeries.
- The functional requirements of the attachment are the following:
 - The attachment stays on the K-wire during surgery.
 - Minimal force is needed to attach and detach the attachment.
 - The attachment is compatible with K-wires of different diameters.
 - Removal of the attachment from the K-wire takes less than a minute.

Current Design

- We built our low-fidelity type of prototypes shown in Figure 3 and 4. These figures were represented in black and white for demonstrating/mimic x-ray images. Note that K-wires are not threaded, and this is a model.

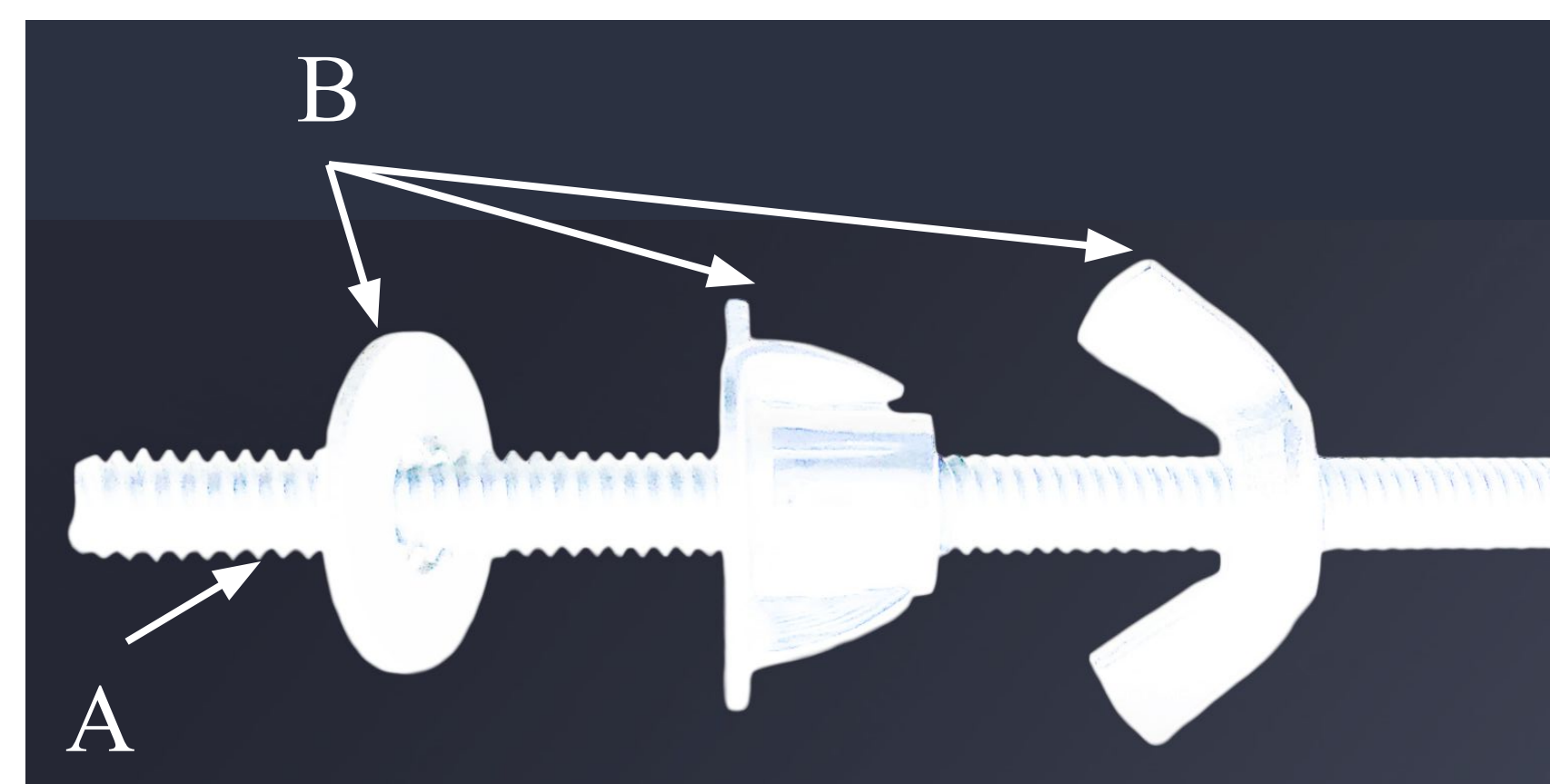


Fig 3. Side view of attachment (A) on a model K-wire (B). Different attachment morphologies can be used for differentiation.

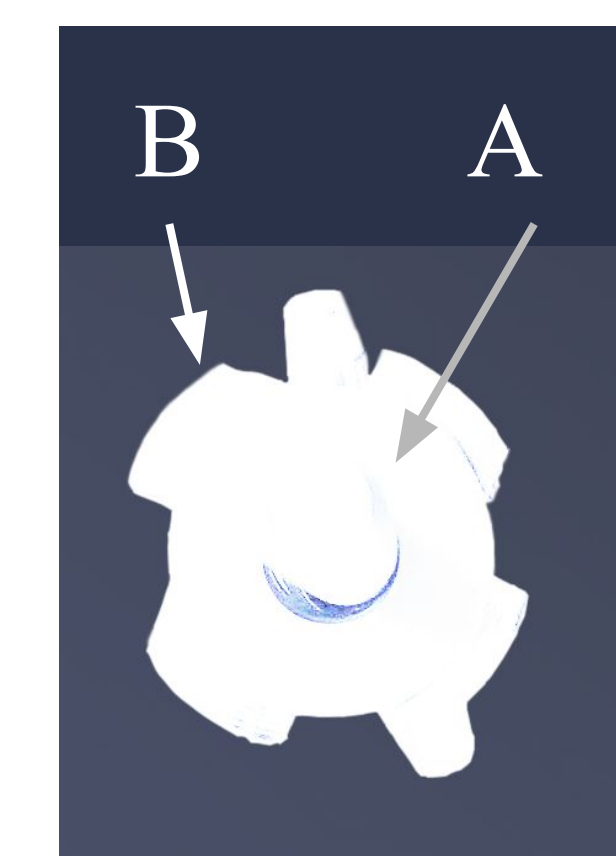


Fig 4. Top view of attachment (A) on a model K-wire (B). This view shows the Uniqueness present at different angles.

Future Plans/ Next Step

- For our next step of prototyping, we will use and evaluate high-density metals that would best work for our application.
- To prevent dislodgement of the attachments, we plan to test the efficiency of dental impression putty against other materials that could serve as stoppers, such as silicon.
- We will also conduct a Solidworks simulation to obtain a quantitative measure of the force required to attach and detach the Kwasher.

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