Project Proposal: External Elbow Fixator

Our group decided to focus on an external elbow fixator to help with fractures and/or dislocations of the radial head of the elbow. Using a hinged external fixation allows for an axis of rotation to provide elbow stability and motion following any trauma or reconstruction to still allow flexion and extension [1]. The device can be adjusted externally to ensure the bones remain in an optimal position during the healing process for both the damaged muscle and skin [2]. The primary therapeutic goal is to allow joint motion while protecting the healing ligaments from stresses caused by the injury. For inspiration of design, we are looking at the elbow hinge fixator from DePuy Synthes, part of Johnson & Johnson's family of the company [3]. The design more specifically is an alternative, as seen in Figure 1 [4] to a normal construction, as seen in Figure 2 [5] because it involves fewer rods when connecting both the bicep and forearm to the hinge. This is considered due to the limited time frame we have and will allow us to focus on the overall capability of the hinge rather than increase the complexity due to the geometry involved with more rods. For our moving parts, we have the actual elbow hinge joint as a rotational movement, and both of the rods attached to the forearm and bicep will be translationally adjustable to accommodate each group member's arm length for demonstration purposes of universal usability.

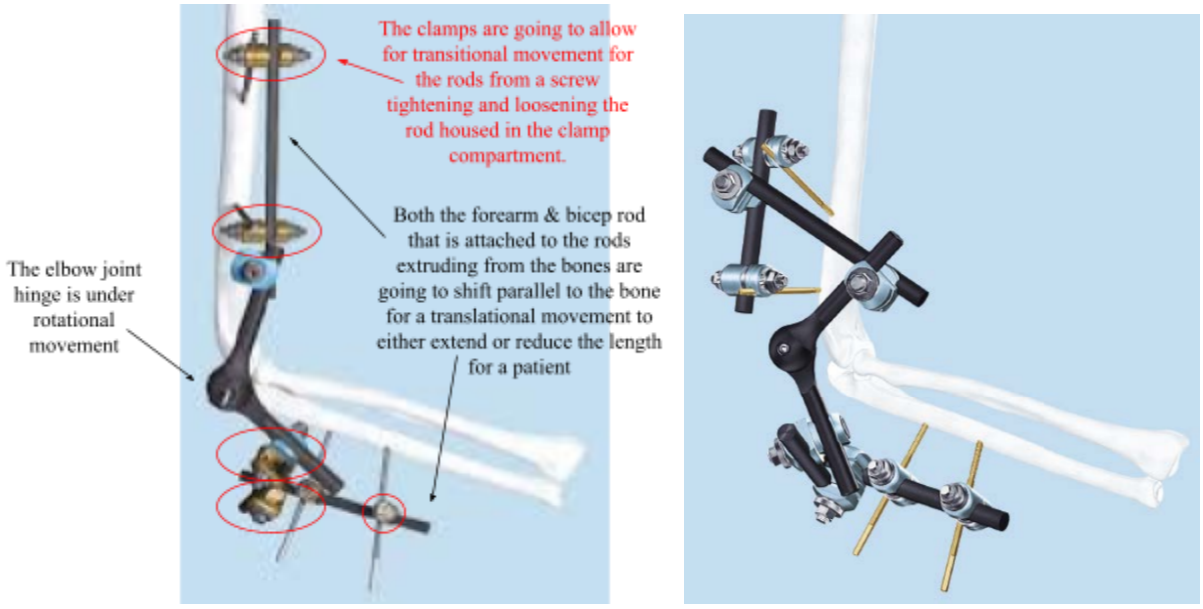

Figure 1: (left image) Elbow hinge fixator with medium external fixator components from the Johnson & Johnson Company. This is the design we are looking at for design and construction inspiration.

Figure 2: (right image) Elbow hinge fixator with large external fixation connectors that allows early mobilization access or lockable positions depending on the patient's condition.

As mentioned, the period in which we have to construct this device is 10 weeks. We have divided our time and when we plan to meet the deadlines in a rough outline in Figure 3 to visually see what we have, or have not accomplished. We have also started to track certain materials needed that will save us more time if not 3D printed shown in Figure 4. Regarding our materials, our intention of construction is to format the project as a prototype of what an external elbow fixator should be attuned to. Instead of using actual medical screws for attaching the device to the bones, we are representing the dimension with wooden dowels. This is seen again for what connection rods we are using as medically, carbon fiber rods are used but we are using stainless steel rods under the same dimension. This helps narrow our focus towards our moving parts as well as how the parts will fit together. Looking back at Figure 1, we are designing a similar structure of the hinge to allow full extension but into two parts that are 3D printed. The two 3D printed parts of the hinge are going to follow a ball joint, represented in Figure 5 [6] to allow fluid movement for extension and flexion. The other 3D printed parts are the outer shell of the screws to enable change of length. Our plan is to have cotter pins clamp the screw and rod together in order to connect all of the rods and hinge together to create the final product. The outer shell will have varying pins alongside the edges for the cotter pin to go in and determine a length. An outline of the material and a schematic is shown in Figure 6.

Task	Week 3: 1/20-1/24	Week 4: 1/27-1/31	Week 5: 2/3-2/7	Week 6: 2/10-2/14	Week 7: 2/17-2/21	Week 8: 2/24-2/28	Week 9: 3/2-3/6	Week 10: 3/9-3/13
Phase 0: Project Proposal	Entire Team							
Parts Design: Dowel to Rod Connection (forearm)	HL							
Parts Design: Dowel to Rod Connection (bicep)	HT							
Parts Design: Elbow Hinge Base Desgin	KL							
Parts Design: Elbow Hinge Connectors to Rods	LN							
Phase 1: Presentation				2/11: Presentation 2/13: Presentaion Presenters: KL & HL				
Itemized Budget & Purchase Requests		KL						
Assembly Design			Everyone	Improvements	Engineering Drawing			
Construction						Everyone	KL	
Assembly of Parts						Everyone		
Testing					Everyone		Everyone	
Phase 2: Final Report								Due Finals
Roles:								
Kelsey Lawson - Materials Engineer/Researcher								
Hao H. Tran - Designer								
Linh Thi Thuy Nguyen - Manufactorer								
Haoxiang Li - Leader								
Complete								
In Progress								

Figure 3: A table outlining the dates each week and each team member's task to be handled. The table is color-coordinated according to what tasks are completed or still in progress in order for encouragement to keep up to date.

Device: External Elbow Fixator				
Item	**No. Units**	**Unit Cost**	**Location**	**Total**
Wooden Dowels	4	$3.70	Amazon	$3.70
Stainless Steel Rod (1/4" Diameter 6" long)	2	$8.88	Amazon	$8.88
Clamps (Dowel to Rod)	4	$6/hr	FABWorks	$6/hr + $7+$.30/ml
Connectors (Rod to Hinge)	2	$6/hr	FABWorks	$6/hr + $7+$.30/ml
Cotter Pins	4	$6.99	Amazon	$6.99
Shell Casing for Rods	2	$6/hr	FABWorks	$6/hr + $7+$.30/ml
Ball and Socket Joint	1	$6/hr	FABWorks	$6/hr + $7+$.30/ml

Figure 4: A rough estimate of what our group has decided to spend out of the maximum budget allowed. This is subject to change and is not finalized until the final submittal.

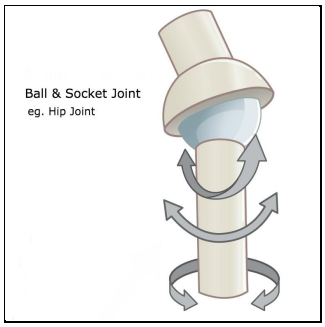

Figure 5: Schematic of ball and socket joint's rotational movement. Due to the wide range of motion this joint has, it will provide the patient without complications in extending their arm with an external hinge.

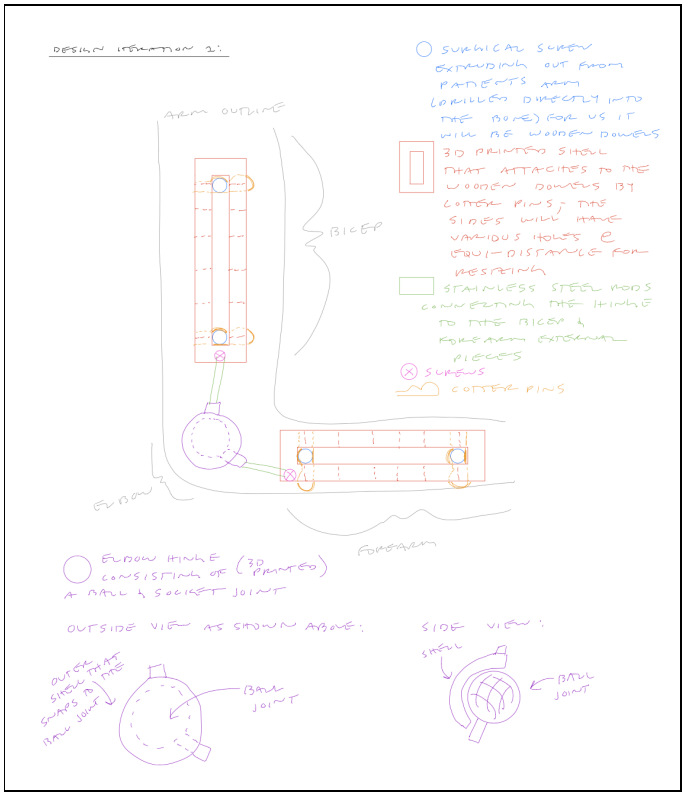

Figure 6: Here is a rough outline of how we attend to attach and form the external elbow fixator. As shown, we identified the various materials and what we expect to 3D print.

References

[1] "Hinged External Fixators of the Elbow." *Clinical Gate*, 11 Apr. 2015, clinicalgate.com/hinged-external-fixators-of-the-elbow/.

[2] "External Fixation Device: MedlinePlus Medical Encyclopedia Image." *MedlinePlus*, U.S. National Library of Medicine, medlineplus.gov/ency/imagepages/18021.htm.

[3], [4], [5] "Elbow Hinge Fixator: J&J Medical Devices." *Global Preferences*, www.jnjmedicaldevices.com/en-US/product/elbow-hinge-fixator.

[6] Case courtesy of OpenStax College, Radiopaedia.org, rID: 42684.