Pain Relief in Carpometacarpal (CMC) Arthritis Splint

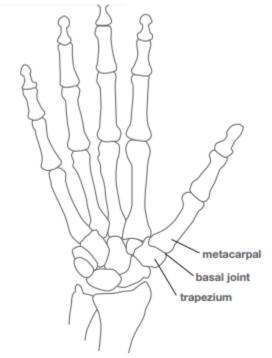
PUNEET KUMAR KESHAV KOHLI REITH SARKAR CLIENT: TIFFANY HARMON, OT

Presentation Outline

- Background
- Problem Statement
- Project Scope
- Design Goals
- Project Timeline

What is CMC Arthritis?

- Osteoarthritis (OA) of Carpometacarpal (CMC) Joint
 - Degradation of cartilage layer
 - Direct contact between bones
 - Results in pain and deformity
- Affects range of motion and ability to pinch



Normal

Arthritic

©MMG 2001

Cross Section CMC Joint

Diagnosis

• Typical Presentation

- Postmenopausal Women (50-70 years)
- Radial thumb pain, worsened by use
- Decreased mobility & strength

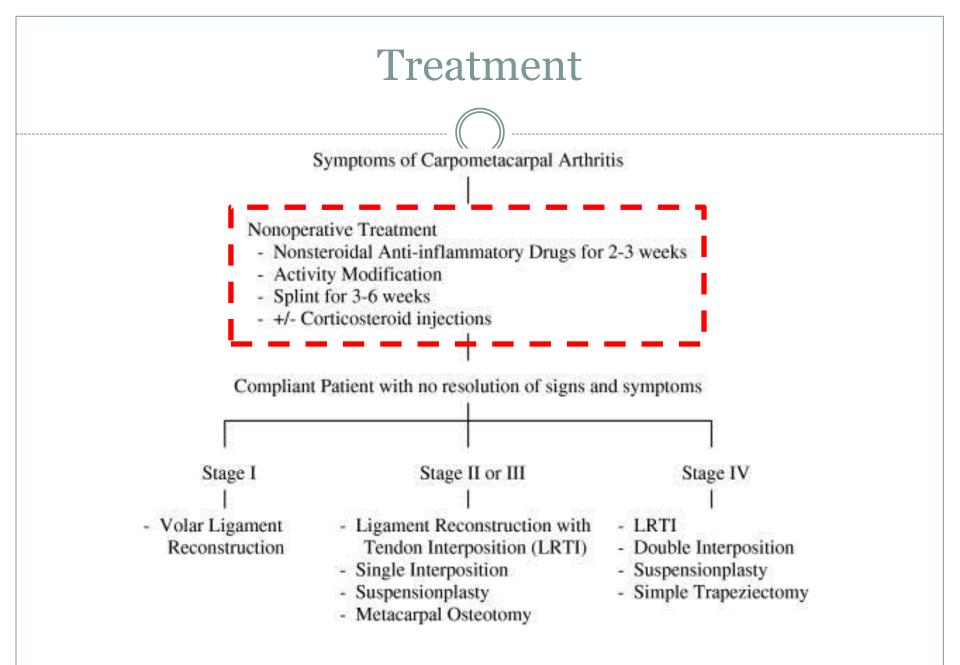
• Radiographic Evidence

- Degree of joint space loss
- Subluxation of joint

Eaton Classification

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Staging	Radiographic Characteristics							
	Normal or slightly widened trapeziometacarpal joint							
Stage I	Normal articular contours							
	Trapeziometacarpal subluxation (if present up to one third of the articular surface)							
Stage II	Decreased trapeziometacarpal joint space							
	Trapeziometacarpal subluxation (if present up to one third of the articular surface)							
	Osteophytes or loose bodies less than 2 mm in diameter							
Stage III	Further decrease in trapeziometacarpal joint space							
	Subchondral cysts or sclerosis							
	Osteophytes or loose bodies 2 mm or more in diameter							
	Trapeziometacarpal joint subluxation of one third or more of the articular surface							
Stage IV	Involvement of the scaphotrapezial joint or less commonly the trapeziotrapezoid or trapeziometacarpal joint to the index finger							



The Need

"I have been working with patients for over ten years that have expressed frustration with the **lack of conservative options for the pain** that they experience with [CMC arthritis].

I treat patients that are pre and post-surgical, both requiring some form of **orthosis to support the first metacarpal and decrease loading across the CMC joint.**"

- Tiffany Harmon

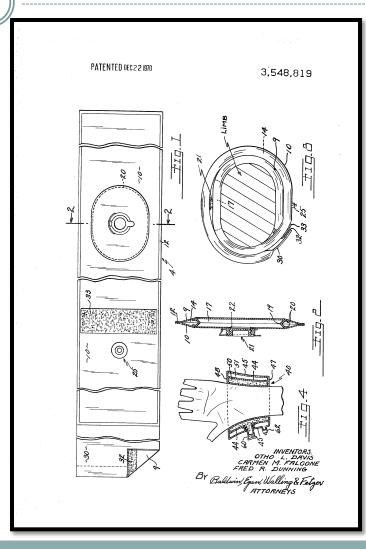
Problem Statement

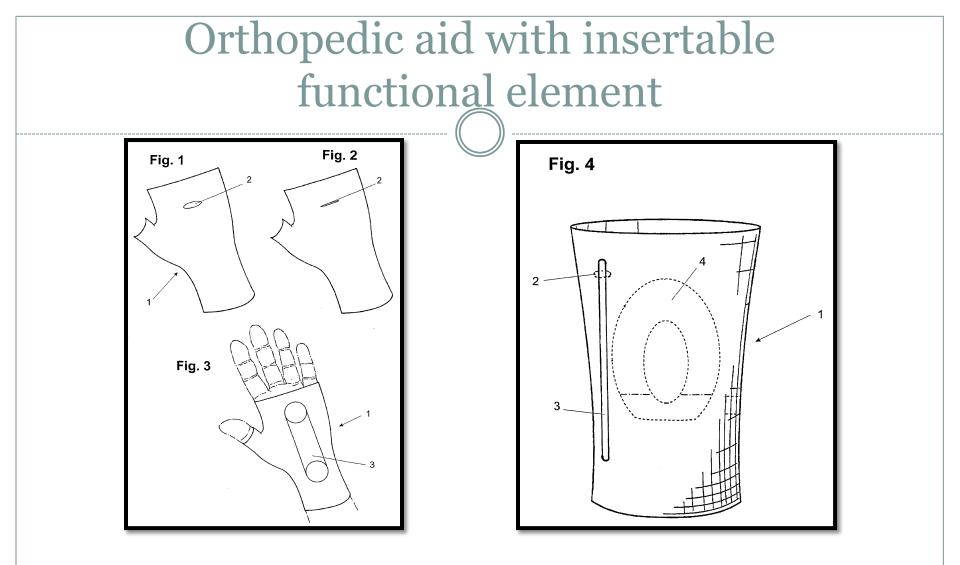
 In current CMC splints, there are no comprehensive, usercontrolled, pain alleviation mechanisms



Thermal-Pressure Splint (US 3548819 A)

- Incorporates pressure, thermal and cyrotherapy
- Attaches via Velcro strap
- Therapy is not user controlled
- C-Shape is not fixed

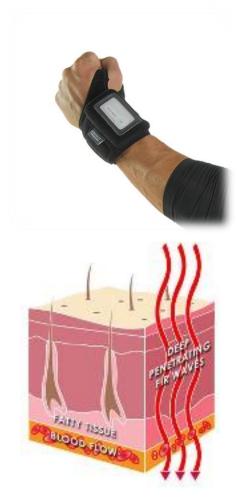




European Patent Number: EP2268245 B1

Venture Heat

- Far Infrared Ray (FIR) Heat
- Low-voltage and produce virtually no electromagnetic fields (EMF)
- User-controlled (4 settings)



Project Scope

- Incorporate a user-controlled pain-alleviation system into an existing CMC arthritis splint
- Evaluate designs on
 - Cost
 - Durability
 - Portability
 - Invasiveness
- Integration of user-controlled feedback-control system
- The final idealized prototype should (1) not interfere with functionality of the splint, (2) be portable, (3) immobilize the wrist, and (4) maintain the "thumb-C-arch" common to splint design.

Design Specifications

Material Strength

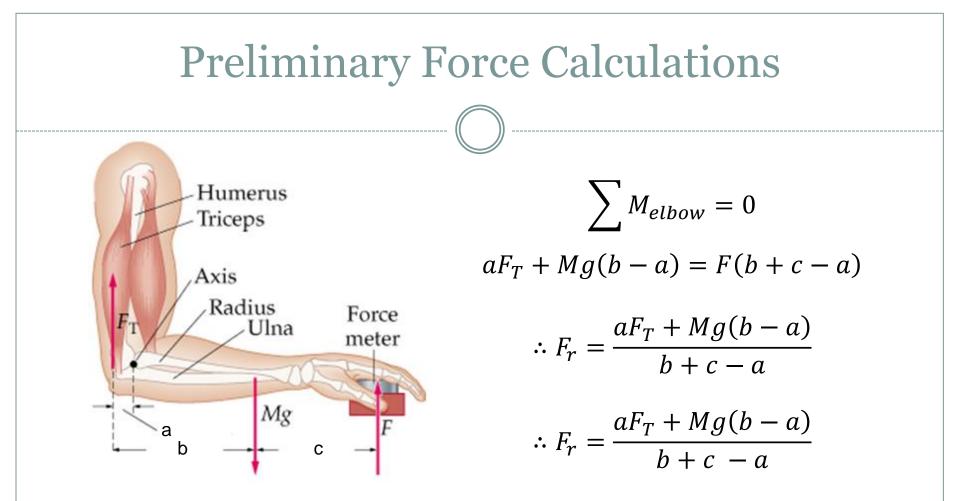
26.88 N (~18.13 lbs)

Sensor Sampling Rate

• 40-100Hz

Cost

- Retail Cost <\$250 (w/o insurance)
- Cost to Customer <\$100 (w/ insurance)
- L-Code (reimbursement code) necessary



• Scenario: many patients wear splints while typing because fine motor movements exacerbate pain

Preliminary Calculations

Example:

Subject: 73kg, 173.1cm Male (average participant in Plagenhoef 1983 study)

Term	Definition	Relationship	Values	Source	
а	Olecranon (triceps insertion) length	N/A	26.2mm	Wadia 2007	
b	Olecranon to center of mass (COM) of forearm	Height(0.157) – c	15.48cm	Derived	
С	Segment length to COM from proximal end	Height(0.157)*0.43	11.68 cm	Plagenhoef 1983	
Μ	Forearm mass	Total mass*0.0187	1.3651 kg	Plagenhoef 1983	
g	Gravitational acceleration	N/A	9.81 m/s ²	N/A	



$$F_r = mF_T + b = 0.0965 * F_T + 7.58$$
$$\therefore F_r = [0.0965 * F_T + 7.58]$$
$$= [0.0965 * 200 + 7.58] = 26.88N$$

Design Schedule

	September				October					November				December	
Date	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11
Project Selection									In Progr	ess			D	eadline	2
Project Scope															
Background															
Research															
Patent Research															
Preliminary Report															
Preliminary Oral Report															
Web Page															
Design Options															
Design Safe Report															
Progress Oral Report															
Progress Report															
Final Report															
Final Oral Report															
Competition Poster															

Team Responsibilities

Puneet Kumar

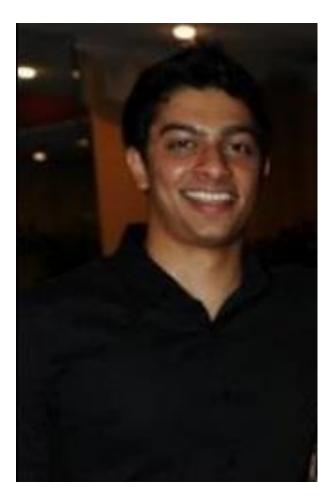
- Submission of Weekly Reports
- Research and Design of User-Controlled Therapeutic System



Team Responsibilities

• Reith Sarkar

- Computer Aided Design (CAD) Modeling
- Research and Design of Mechanical Aspects



Team Responsibilities

• Keshav Kohli

- Lead Correspondence Contact
- Webmaster
- Quality Control on Written Documents



Shared Responsibilities

• In Depth Research of CMC Arthritis

- Osteoarthritis treatment
- Clinical Prevalence
- Patient Profiles
- Communication with Client
- Patent/Literature Research
- Existing Solutions Research

Official References

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- 5. Tiffany Harmon (Client)

Questions/Comments