Therapy Management – PIP Arthroplasty

Therapist must know:
- Which implant used
- What surgical approach/procedure was performed
- OA?
- Traumatic?
- RA?

PIP Joint Arthroplasty

3 basic types in US
- Silicone Implant (Swanson), low demand, older pts, most reliable, standard to which all other joint compare
- Pyrocarbon Implants – offers better wear characteristic, reproduces the normal mechanic of the PIPJ
- Cobalt Chrome Implant – convex proximal phalangeal component with bi-condylar configuration – approximated normal anatomy of PIPJ
- Titanium – intramedullary stem to support distal component

3 Surgical Approaches
- Dorsal Approach – central slip of dorsal apparatus of extensor mechanism disrupted
- Volar Approach – volar plate disrupted
- Lateral Approach – either radial/ulnar collateral ligament is disrupted

Acknowledgements
Sheri Feldscher OT, CHT
Katie Froehlich, OTR/L, CHT

For handouts email: terri@eriehandcenter.com
PIP Post-op Course
Dependent upon Pre-op Condition

• Sufficient PIPJ
• PIP with lateral deviation
• Boutonniere deformity
• Swan neck deformity
• RA vs OA traumatic

PIP Arthroplasty

Swanson - PIP

• Flexible hinge
• Acts as dynamic spacer
• Early motion
• Implant stabilized by encapsulation process
• Post-op management by soft tissue reconstruction
• Goal 50 degrees index and long 70 degrees ring and small
• High patient satisfaction
• Significant pain relief
**Swanson Silicone Implant**

3-5 days

- A/AROM initiated
- Static PIP extension splint – maintain extension
- Edema control
- Wound care

**Swanson Silicone Implant**

1-4 Weeks

- PROM initiated
- Dynamic flexion splinting if needed
- Scar management
- Emphasis on isolated AROM to PIPJ
- Avoid lateral deviation!

**Swanson Silicone Implant**

ROM goals

<table>
<thead>
<tr>
<th>Joint</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index</td>
<td>0-45</td>
</tr>
<tr>
<td>Ring</td>
<td>0-60</td>
</tr>
<tr>
<td>Small</td>
<td>0-60</td>
</tr>
</tbody>
</table>

Precaution

- Implant unable to withstand full PIP motion, functional stress
- >70° flexion strain in implant
- >90° increases risk of implant fracture

**Swanson Silicone Implant**

4-8 Weeks

- Light activities
- Passive flexion if lacking

6-12 Weeks

- Nighttime extension orthosis

12 Weeks

- D/C Orthosis
- Resume full activities

**Functional ROM PIPJ**

- Function restored – less than 20° extension lag
- Joint 70 to 80° flexion

Bain et al (2015) - used Sollerman hand grip fx test
- Measured functional finger ROM needed for ADLs
- Functional ADLs defined range required 90% of activities (N=20)
- Results:
  - MPJ: 19-71°
  - PIPJ: 23-87°
  - DIP: 10-64°
- Ulnar digits more functional, active ROM

**Silicone Implants**

- Longest f/up
- Most reliable, most widely used
- Standard to which new approaches are compared

Systematic Review - Squitieri and Chung (2008)
- Average arc of AROM: 44°

Foliot 1995: over time stress and wear may lead to mechanical failure/degradation, implant fracture, silicone synovitis, infection, recurrence of pain, stiffness, deformity

**Feldscher Philly**
JHS 2014

Silicone Proximal Interphalangeal Joint Arthroplasty for Primary Osteoarthritis Using a Volar Approach, Proubasta, Lamas et al. Barcelona Spain

Retrospective review 36 implants 26 patients
Average f/u 18 months
Pain pre op 7.2 to 0.4 postop
Arc of motion 33 degrees to 72 degrees
Satisfaction 4.8/5.0 all would have procedure again
All patients achieved full extension
No complications, no revisions

Surface Replacement Arthroplasty (SRA) Ascension PIP/Avanta (Feldscher)

Post operative planning
• What structure released/repaired
• What structures require protection
• Experienced hand therapist
• Problem solving approach
• Ease of communication with referring surgeon
• Constant evaluation of ROM-treatment modification

Surface Replacement Arthroplasty (SRA) (Feldscher)

- Pyrocarbon
  - Introduced in 1969 as a component of artificial heart valves
  - Proven strength, fatigue-resistance and wear resistance
- Pyrocarbon implant
  - A ceramic-like material
  - Made of pyrolytic carbon
  - Biologically inert with great strength
    - Strength and wear properties between those of graphite and diamonds
    - Low-friction characteristics

Pyrocarbon Implant Fixation

- Minimally constrained
  - No mechanical or chemical fixation to bone
  - Stabilized by insertion into the medullary canals
  - Followed by appositional bone growth
    - Bone-implant interface does not develop osseous in-growth
    - On growth: Sclerotic bone forms up to the implant
    - Bone growth constantly remodels and stabilized according to Wolff’s law
  - Bone in a healthy person or animal will adapt to loads it is placed under

Pyrocarbon Implant Stabilization

- Final implant fixation stabilization occurs 6-24 months postoperatively
- Precautions:
  - Implant attains stabilization from surrounding capsuloligamentous structures
  - Soft tissue reconstruction must provide adequate stabilization
  - If adequate stabilization is not provided
    - Subluxation
    - Dislocation
    - Lateral or longitudinal deformities
    - Minimal motion or loss of motion

Ascension PIP Joint Implant

Need IRB approval
- Pyrolytic carbon coating over a graphite substrate
  - Provides strength, durability, wear-resistance
- Two-component (Titanium), Secondary, semi constrained joint prosthesis
  - Designed to replace articulating surfaces of PIP joint and accommodate maximum anatomic ROM
  - 2 convex articulating surfaces on the proximal component engage with and glide on 2 mating concave articulating surfaces on the distal component
Pyrocarbon Implant Advantages

- More accurately reproduces joint surface
- Less bone is removed than with Swanson implant
  - Preserves collateral ligaments for improved stability
    - Reduces stress on prosthesis-bone interface
    - Decreases risk of loosening
    - Potential for better long term clinical results
- Improved biomechanics
  - Mimics physiologic articulation of PIP joint
  - Restores more normal motion based on a virtual axis
  - Has an elastic modulus similar to cortical bone
    - With an assumed higher durability and wear resistance
    - Potentially a better option for younger active patients

Pyrocarbon Implant Disadvantages

- Pyrocarbon is brittle – susceptible to breakage during impaction
- Poor bone quality may affect component fixation

Ascension Total Joint Protocol
1-877-370-5001

- Program dictated by extensor tendon status
- Splinting – forearm based/hand based
- 3-7 days post-op
- 30 degrees of PIP flexion allowed wk. 1

Ascension

- 2 wks – PIPJ flexion to 45 degrees if no extension lag
- 4 wks – full PIP extension then flexion to 60 degrees
- 6 wks – goal of 0-75 degrees PIPJ
- 3 months – activities as tolerated

AVOID –

Extension Lag

- Hyperextension (check in splint)
- Lateral deviation/rotation

AVOID –

HYPEREXTENSION

NO!!!!!
Modifications to program – based on extensor tendon integrity

- Forearm vs. hand based splint
- Dynamic PIP extension vs. static gutter splint
- Evans protocol for repaired central slip

Evidence

- Feldscher (2010) – case report
- Wijk et al (2010) reported on 53 pyrocarbon implants in 43 patients

- Early results
  - Experienced joints that progressed into hyperextension and had difficulty initiating flexion
    - Resulted in alteration of postoperative protocol
      - Involves 15-20 degree extension block to avoid hyperextension
      - Full flexion is the goal during soft-tissue healing, not full extension

Pyrocarbon Implants Outcomes

- Inconclusive
  - Disappointing results
    - Pyrocarbon did not significantly improve pain, ROM, satisfaction or function; high complication rate (migration of components; unstable prosthesis)
  - Potential
    - Conclude pyrocarbon implants have potential to relieve pain, restore joint function, and are safe for index fingers
    - Report high satisfaction, significant pain reduction, and improved ROM
    - Dickson et al (2015) found higher implant revision rate than with other prostheses

- Potential but not Superiority
  - Found no change in ROM, 50% pain relief, squeaky joints
    - Tuttle and Stern (2006)
      - Concluded both implants provide excellent pain relief and comparable ROM; Complications are implant-specific

Avanta Implant (SR™ PIP/Small Bone Innovations)

- 2 components
  - Distal component
    - Combines a titanium alloy stem (that has an external surface to allow bone growth) with an ultra-high molecular weight polyethylene (UHMWPe) articulating surface
  - Proximal component
    - Consisting of a cobalt-chromium-molybdenum articulating surface
  - The components articulate on each other to form a semi-constrained prosthetic replacement for the PIP joint

Good stable pain-free arc of motion
Avanta Implant
(SRT™ PIP/Small Bone Innovations)

- Like a little knee
- The kinematics of this implant have been found to closely mimic that not a normal joint with well-preserved soft tissues
- The implant is designed to allow a 90° arc of flexion/extension
  - A stable, pain-free 60° PIP joint arc of motion is considered a good result

Complications

- Infection/joint dislocation

Postoperative Management

Journal of Hand Therapy 2010
Phase I (0-3 Weeks)
Phase II (3-6/8 Weeks)
Phase III (6/8-12 Weeks)

Protective orthotics

- Dynamic orthoses, buddy tapes, Static orthoses
- Patients with RA may require up to 3 weeks immobilization to provide soft tissue stabilization
- Riggi et al. (2011) compared 9 patients receiving static orthoses with 10 patients receiving dynamic orthoses following pyrocarbon implant arthroplasty in OA patients
  - Found similar outcomes and concluded static protocol is promising and warrants further study

Splinting – Two Splints

- A low profile dynamic PIP extension splint to be worn during the day with exercise.
- A forearm based static resting splint to be worn at night and during rest periods from the dynamic splint.

Postoperative Management

Phase I (0-3 Weeks)

- Wound care
- Scar management
- Edema control
- Avoid wrapping techniques that cause torsion on the joint
- Joint protection education
Postoperative Management

Phase I (0-3 Weeks)

• Protected ROM
  • Depending on surgical repair
  • Pyrocarbon
  • Avoid PIP joint hyperextension
    • If noted, fabricate DBO with PIP joint 30 degrees
  • Flexion must not be regained at the expense of extension
  • If an extension lag develops
    • Flexion increments are more modest
    • Emphasize A/AROM extension exercises and extension orthotics

Phase II (3-6 Weeks)

• Protective orthoses continue nightly and between exercise sessions
• Modalities may be used
  • To help facilitate exercise
  • Control pain and swelling
• Treatment focus
  • Tendon gliding
  • Blocking
  • Scar management
  • Edema control

• Dynamic or static progressive orthoses may be initiated to increase PROM
• Light functional use
  • With controlled alignment
  • Use stronger/larger joints when possible
  • Avoid 1 position for prolonged periods
  • Avoid lateral stress to PIP joint to prevent fracture of the prosthesis or deformities from developing

Phase III (8-12 Weeks)

• Strengthening
  • Begin gentle resistive exercise while maintaining proper joint alignment
  • Progress as tolerated to full grip/UE strengthening as needed for RTW and ADL
• Assess ADL/work status
• Provide adaptive equipment as indicated
• Joint protection
  • Avoiding deforming positions
  • Night resting orthosis
• Precautions
  • Avoid lateral stress to PIP joint for a minimum of 12 weeks
  • Index must be closely monitored due to lateral forces applied during pinch

Exercises

• Active PIP flexion should be limited to 30 degrees for the first week to allow for healing of the extensor repair.
• All exercises should be done hourly, 10 repetitions in the dynamic splint.

Dorsal Extension Block PIP Joint

• Protective orthoses continue nightly and between exercise sessions
• To help facilitate exercise
• Control pain and swelling
• Treatment focus
  • Tendon gliding
  • Blocking
  • Scar management
  • Edema control

• Dynamic or static progressive orthoses may be initiated to increase PROM
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  • Index must be closely monitored due to lateral forces applied during pinch
Joint Protection

Dr. Amy Ladd, Chase Hand Center, Stanford

https://www.dropbox.com/sh/3m4p1leonpsrbly/AAD4thk6-TI2u8AK6AuPalyd?dl=0

link for iPad pt info (also iPhone but not all videos work on phone version):


Clinical Tips

As OT/PT’s
• Continually evaluate splints/exercise techniques
• Address the needs of our patients
• Evaluate pts. with OA vs. RA
• Hyperextension PIP – extension block – 60 degree flexion static resting PIPJ
• Angular deformity – provide radial/ulnar support
• Extension lag DIP – mallet splint

Outcomes

JHS – Nov. 2006 (Nunley, R. Bayer, M. Goldbarl, C.)
– Pyrolytic Carbon Arthroplasty for Post-traumatic Arthritis of PIPJ (Barnes Hospital St. Louis)
  • 5 patients
  • More than 1 yr. follow up
  • Disappointing – no longer use
  • Pain visual analog 9/10 before, 4/10 post
  • Average AROM decreased by 10 degrees
  • Grip strength improved 47 to 63 pounds post op

Avanta (SBI™) Outcomes

• Good gains in ROM, excellent pain relief
• Complications: implant loosening, swan-neck deformities
• Mild or no significant gains in ROM; high pt satisfaction; high revision rate
• Jennings and Livingstone (2008); Luther et al (2010)
• Jennings (2015) performed a long-term retrospective analysis (9 year follow up) in 39 of 43 joints reported on in 2008
  – Found ROM decreased from 64° to 56° (not stat sig); no major radiographic changes; no further revisions were required; subjective measures of satisfaction and function were unchanged
  – Concluded that this procedure remains an option for patients with OA of the PIP joint but not appropriate for rheumatoid JTs

Evidence comparing Implants

• Dacke et al (2012) prospectively compared outcomes of 3 implants in 43 pts (62 PIPJts): silicone, pyrocarbon, titanium-polyethylene
  • No sig differences were found between the 3 implants for pain, mean ROM, strength
  • SRA devices showed temporary superior postop ROM but higher postop complications and explantation rates
  • Pyrocarbon integrated less into bone tissue, causing higher occurrence of progressive shaft loosening

• Chan et al (2013) performed a SR comparing outcomes of silicone and pyrocarbon arthroplasties
  • Low level evidence that pyrocars do not demonstrate superiority over silicone implants
  • Both provided satisfactory pain relief, similar postop mean ROM, and similar grip/pinch strength
  • Concern over high complication rate with pyrocars

Outcomes cont....

JHS – 2006 (Tuttle, H. Stemp, J)
– Pyrolytic Carbon PIPJ resurfacing arthroplasty
• 8 women – average age 62
• 18 arthroplasties for OA
• 10° – 63° before surgery – average AROM
• 18-71 after surgery
• 50% had pain relief
• Demanding procedure unpredictable results
Outcomes cont...

German Literature
– Schultz 2005
  • 20 patients
  • Average arc of motion 50º
  • Satisfactory pain relief

Stutz et al
13 patients average ROM 28-51 degrees pre-op,
22-71 post-op. 80% improved pain

Outcome Studies

• JHS 2014 – Outcomes of Proximal Interphalangeal Joint Pyrocarbon Implants, Bales, Wall, Stern
  • 38 joints pain relief, preop flexion arc 50
  • post of flexion arc 55, silicone tx of choice

• JHS 2014, Proubasta, Lamas et al
  Silicone PIPJ arthroplasty for primary OA using volar approach, maintains extension integrity arc of motion 33 to 72 degrees

Outcome Studies

• Quick Dash
• SF-36
• Michigan Hand Outcomes Questionnaire
• Arthritis Input Measure

Outcomes

JHT – 2011 – Riggs, Lynden, Ann Arbor Michigan
• Static vs Dynamic Splinting for PIPJ Pyrocarbon

Conclusion
• Static splinting similar outcomes to dynamic splinting
• Static – requires less therapy & training, greater patient convenience

• Golfer with goal to achieve pain-free ROM
Key points

1. Knowledge of normal anatomy
2. OA/RA/traumatic
3. Surgical procedure/approach (lateral/volar/dorsal)
4. Implant used
5. Soft tissue healing for stability

Summary – PIPJ Program

- Ascension Pyrocarbon Total Joint post-op protocol
- ASHT guidelines
- JHT 2010 July-Sept, Volume 23, Issue 3

Summary – PIPJ Arthroplasty

- Skilled surgeon
- Skilled therapist
- Reliable, motivated patient
- Attention to detail
- No PIP hyperextension
- Precise adjustment to monitor pt progress

Dorsal Approach
- Simple static
- PIP gutter splint
- Protect central slip

Volar Approach
- Protect volar plate
- 30 degree of PIP flexion in splint

References


References


Thank you