CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

PIP Joint Fusion

PIP Joint Fusion — Procedure Outcomes & Post-operative Rehabilitation (Proximal Interphalangeal Arthrodesis)

Topic scope: post-operative rehabilitation after **arthrodesis (fusion) of the proximal interphalangeal (PIP) joint** of a finger — a worn, painful or unstable PIP joint is fused solid in a functional flexed position. This is a *fusion*, not a reconstruction or a motion- preserving procedure: the PIP is **deliberately made stiff** to trade motion for a stable, pain-free, load-bearing digit. The rehab is therefore not about regaining PIP motion but about **protecting the construct until bony union** while keeping every other joint of the hand moving, then restoring grip and pinch.

> *Defining principle of the rehab here: PIP arthrodesis **eliminates motion at one joint by design to gain stability for pinch and grip.** The fused joint is set in a functional flexed position that increases ulnar-ward across the hand (index/middle ≈ 15–20°, ring/little ≈ 25–40°, following the digital cascade) and held by internal fixation (tension-band wire, headless intramedullary screw, K-wires, or plate) until union. Because nothing here needs to move to heal — it needs to unite — the single governing rule is **"protect the fused joint, mobilise everything else."** DIP, MCP, adjacent digits, thumb and wrist move from day one to prevent tendon adhesion and stiffness; oedema and scar are managed early; grip and pinch are restored only after radiographic union (~6 weeks, up to 9–12). The branch point is the indication — primary degenerative/post-traumatic fusion versus **salvage of a failed PIP arthroplasty**, where union is slower and the construct more demanding.*

A. PROCEDURE OUTCOMES (PIP arthrodesis)

PIP arthrodesis is a reliable, well-established salvage and reconstructive operation, but its evidence base is **uniformly low-level** — predominantly retrospective level-4 case series and expert opinion, with **no**

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randomised controlled trials. Outcomes are reported as union, complication and reoperation rates rather than from comparative trials.

- **The evidence base is low-level and consensus-driven.** A systematic review of PIP arthrodesis found the literature is overwhelmingly **level-4 (~94%)** with **no RCTs**; conclusions on fixation choice and outcomes rest on case series and expert consensus [EFORT Open Rev 2021, DOI 10.1530/eor-21-0102]. *Low (level-4 SR, no RCTs).*
- **Fixation holds the angle to union; nonunion and reoperation are the principal concerns.** Series reporting nonunion and reoperation identify **patient factors** (including smoking and comorbidity) as drivers of failure, underscoring that the rehab job is to protect the construct until the bone joins [HAND 2020, DOI 10.1177/1558944720939196]. *Low–moderate (case series).*
- **The fusion angle is chosen for function, especially pinch.** A biomechanical/kinematic study of index PIP fusion (simulated **30–50°**) shows the set angle is a functional trade-off: fusing the index/middle PIP stabilises **lateral (key) pinch** at the cost of PIP motion, which is why these digits are common fusion sites [J Hand Surg Am 2011, DOI 10.1016/j.jhsa.2011.09.010]. *Mechanistic / cadaveric.*
- **Arthrodesis is a dependable salvage for failed PIP arthroplasty, but union is slow.** A series of arthrodesis for failed PIP joint replacement reported a **mean time to union of 5.8 months**, illustrating that salvage fusions unite more slowly than primary fusions and need correspondingly extended protection [J Hand Surg Am 2011, DOI 10.1016/j.jhsa.2010.10.030]. *Low (case series).*
- **The biomechanics of digital loss/fusion frame the functional cost.** Reviews of the biomechanics of digital amputation and fusion describe how eliminating an IP joint redistributes grip and pinch mechanics — the rationale for accepting a stiff joint when it buys stability [Hand Clin 2016, DOI 10.1016/j.hcl.2016.07.003]. *Mechanistic / narrative.*

B. REHABILITATION / THERAPY EVIDENCE

There are **no trials of rehab regimens** after PIP arthrodesis; the programme is built on sound surgical principle and expert consensus. The two evidence-anchored levers are the **union timeline** (which sets when load may be applied) and the modifiable risk factor of **smoking** (which delays union).

- **Protect-until-union, mobilise-everything-else is the consensus regimen.** The fused PIP is splinted continuously until radiographic union (~6 weeks, up to 9–12); from day one the DIP, MCP, adjacent digits, thumb and wrist are actively moved to prevent tendon adhesion and global hand stiffness. This is **stable across sources** (surgeon protocols, hand-therapy guidance and patient-education material) even though it is not trial-tested [Melbourne Arm Clinic protocol; OrthOracle PIPJ arthrodesis; OrthoInfo finger IP fusion]. *Consensus / expert.*
- **Smoking is an evidence-supported delayed-union risk.** A study of hand and wrist arthrodesis found **smoking delays union**, making smoking cessation the one rehab-adjacent intervention with direct supporting evidence in this setting [J Hand Surg Am 2022, DOI 10.1016/j.jhsa.2022.05.016]. *Moderate (cohort, modifiable risk factor).*

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- **Union timing governs progression — and is slower in salvage fusions.** Primary fusions are typically protected to ~6 weeks; salvage of failed arthroplasty unites far more slowly (mean **5.8 months**), so loading must be union-led rather than calendar-led [J Hand Surg Am 2011, DOI 10.1016/j.jhsa.2010.10.030]. *Low (case series).*
- **The set fusion angle is the functional anchor of the rehab goal.** Because the index/middle PIP is fused at ~15–20° (and ring/little at ~25–40°) specifically to stabilise lateral pinch, the Phase III–IV strengthening rightly targets **pinch and grip** rather than any attempt at PIP motion [J Hand Surg Am 2011, DOI 10.1016/j.jhsa.2011.09.010]. *Mechanistic.*

RECOVERY TRAJECTORY (EXPECTED, EVIDENCE-ANCHORED)

Phase	Window	Restraint	Hand use / therapy focus	Strength / load	Notes
I — Protect & settle	**Week 0–2**	Volar finger splint/ cast spanning MCP + PIP, **DIP left free**	Elevation, wound/ pin-site care, oedema control; **active DIP within days** + full motion of all non-fused joints (adjacent digits, thumb, wrist)	**No grip / pinch / loading**	Fused PIP kept still; everything else mobilised from day one
II — Custom splint & free-joint motion	**Week 2–6**	**Custom thermoplastic splint** supporting the fused PIP, freeing adjacent joints; continuous splinting to ~6 wk	Active **DIP + MCP** of operated finger out of splint; tendon glides of adjacent digits; scar/oedema once healed	**No resisted grip / pinch / loading**	Union typically at ~6 wk (up to 9–12); load only after radiographic union
III — Wean splint & light use	**From ~6 wk (united)**	Splint weaned/cut down after union; **K-wire out ~6 wk** if used	Progress light use → **pinch, opposition, gripping**; begin grip/ pinch strengthening	Graded grip/ pinch, build gradually	Restraints lifted only once union confirmed
IV — Strengthen & return	**~8–12 wk+**	Restrictions lifted	Progressive strengthening/ loading; return to sport/heavy/manual work	Build load progressively; target lateral pinch	**Final settled result 9–12 months**

(Phase windows mirror the precautions in the patient protocol; they are expert-consensus, single-clinic guides — typical and individualised, not graded or trial-derived thresholds. Return milestones: driving ~6 wk, light use/gentle grip ~6 wk after union, lifting/gripping/pinch ~8 wk, full activity/sport ~12 wk, final result 9–12 months.)

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C. KEY CONTROVERSIES / EVIDENCE QUALITY

1. **Whole topic is low-level evidence.** PIP arthrodesis rests on level-4 case series and expert consensus with **no RCTs** (~94% level-4 in systematic review). All outcome and timing figures should be read as typical guides, not trial-validated thresholds [EFORT 2021]. *Low.*
2. **Fixation choice is unsettled.** Tension-band wire, headless intramedullary screw, K-wires and plate all achieve union; comparative data are weak and selection is largely surgeon preference and bone/soft-tissue quality [EFORT 2021; HAND 2020]. *Low.*
3. **Fusion angle is a functional trade-off, not a fixed number.** The ~15–20° (index/middle) to ~25–40° (ring/little) cascade is consensus-stable but individualised to the digit and the demands of pinch [J Hand Surg Am 2011 kinematics]. *Mechanistic / consensus.*
4. **Union timing is variable and indication-dependent.** Primary fusions ~6 weeks; salvage of failed arthroplasty far slower (mean 5.8 months). Loading must be union-led [J Hand Surg Am 2011 salvage series]. *Low.*
5. **Smoking and patient factors drive nonunion/reoperation.** Smoking is an evidence-supported delayed-union risk and a modifiable target [J Hand Surg Am 2022; HAND 2020]. *Moderate (for the smoking association).*

D. EVIDENCE STRENGTH FLAGS (summary)

- **STRONG (RCT / SR):** none — there are **no RCTs** in PIP arthrodesis; the best synthesis is a level-4 systematic review (~94% level-4 studies).
- **MODERATE:** smoking as a delayed-union risk after hand/wrist arthrodesis; patient factors driving nonunion/reoperation; cadaveric/kinematic basis for the functional fusion angle and pinch rationale.
- **WEAK / CONSENSUS:** the **protect-until-union, mobilise-everything-else** rehab regimen (mechanistically sound, not trial-tested); the specific **fusion angles** (consensus-stable); exact **timelines** (single-clinic, expert-consensus guides — typical, not graded thresholds); fixation choice (surgeon preference).

CITATIONS

RAG CORPUS (180,000+ ORTHOPAEDIC ARTICLES)

- Proximal interphalangeal joint arthrodesis: a systematic review (predominantly level-4 evidence; no RCTs). *EFORT Open Rev*. 2021. DOI: 10.1530/eor-21-0102
- Nonunion and reoperation after proximal interphalangeal joint arthrodesis: patient factors and outcomes. *HAND*. 2020. DOI: 10.1177/1558944720939196

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- Index finger proximal interphalangeal joint arthrodesis and pinch kinematics (simulated 30–50° fusion). *J Hand Surg Am*. 2011. DOI: 10.1016/j.jhsa.2011.09.010
- Arthrodesis as salvage for failed proximal interphalangeal joint arthroplasty (mean time to union 5.8 months). *J Hand Surg Am*. 2011. DOI: 10.1016/j.jhsa.2010.10.030
- Smoking delays union after hand and wrist arthrodesis. *J Hand Surg Am*. 2022. DOI: 10.1016/j.jhsa.2022.05.016
- Biomechanics of digital loss and fusion. *Hand Clin*. 2016. DOI: 10.1016/j.hcl.2016.07.003

PIP ARTHRODESIS REHABILITATION & PROCEDURE LITERATURE (URLS)

- Melbourne Arm Clinic. PIP / DIP arthrodesis rehabilitation protocol. https://melbournearmclinic.com.au/orthopaedic-rehabilitation/shoulder-rehabilitation/pip-dip-arthrodesis-protocol/
- OrthOracle. Proximal interphalangeal joint (PIPJ) arthrodesis in the hand using the Apex system (Extremity Medical). https://www.orthoracle.com/library/proximal-interphalangeal-joint-pipj-arthrodesis-in-the-hand-using-the-apex-system-extremity-medical/
- EFORT Open Reviews. Proximal interphalangeal joint review (PMC). https://pmc.ncbi.nlm.nih.gov/articles/PMC6598614/
- American Academy of Orthopaedic Surgeons (OrthoInfo). Finger (interphalangeal) joint fusion. https://orthoinfo.aaos.org/en/treatment/finger-ip-joint-fusion/

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