

CASE REPORT

Single-Stage Tension Band Wiring with Circumferential Cerclage for a Transverse Patellar Fracture Neglected for One Month after Traditional Bone-Setting: A Case Report

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ABSTRACT

Background: Displaced transverse patellar fractures disrupt the knee extensor mechanism. When treatment is delayed, for example by traditional bone-setting, fibrous tissue fills the gap and the proximal fragment retracts, complicating fixation in fragile bone.

Objective: To describe single-stage fibrous curettage and fixation with parallel Kirschner-wire tension band wiring (TBW) plus a circumferential cerclage wire for a transverse patellar fracture neglected for one month, and the six-week outcome.

Methods: We report a 66-year-old postmenopausal woman (body mass index 26.3 kg/m²; 25-hydroxyvitamin D 21.0 ng/mL) who presented 30 days after a fall and traditional bone-setter manipulation with an AO/OTA 34-C1 fracture (gap 10 mm; step-off 3 mm) and Kellgren–Lawrence grade II osteoarthritis. Open curettage of the fibrous interposition, two parallel 1.8-mm Kirschner wires with a 1.0-mm figure-of-eight wire, and a 1.0-mm circumferential cerclage wire were used. Outcomes to postoperative day 42 (day 72 after injury) are reported descriptively (CARE guideline).

Results: Reduction closed the gap and the step-off (both 0 mm), and fixation was stable through 0°–90° of passive flexion. An active straight-leg raise returned and the 20° extension lag resolved by postoperative day 21. Active flexion increased from 20° to 30° at week 4 (+50%) and to 45° at week 6 (+125%); resting pain fell from 7/10 to 1/10 (–85.7%), and early cortical callus was reported at week 4. No complication occurred.

Conclusion: In this patient, TBW with an additional circumferential cerclage allowed single-stage fixation one month after injury without quadricepsplasty or bone grafting, with early functional recovery at six weeks. Longer follow-up is needed.

1. Introduction

Patellar fractures account for about 0.5%–1.5% of all fractures¹, yet their functional impact is large because the patella is the central sesamoid fulcrum of the knee extensor mechanism. Older trauma registries described patellar fractures mainly as high-energy, direct-impact injuries in young men after road-traffic collisions, whereas recent population-based studies show a second, growing peak of incidence in people older than 60 years, highest in women aged 60–80 years^{2–4}. In older adults these fractures occur mainly in postmenopausal women, usually after a fall from standing height onto a flexed knee^{2,4–6}. In the aging musculoskeletal system, estrogen-related loss of trabecular bone, low vitamin D, pre-existing patellofemoral and tibiofemoral osteoarthritis, sarcopenic slowing of neuromuscular responses and impaired balance lower the failure threshold of the anterior knee, so that a simple fall at home can produce a displaced articular fracture^{5,6}.

From a biomechanical standpoint, the intact patella increases the effective moment arm of the quadriceps tendon about the instantaneous center of rotation of the tibiofemoral joint, which amplifies extension torque during stance, stair climbing and rising from a chair⁷; after patellectomy, full extension may require up to 30% more quadriceps force⁸. Transverse fractures through the middle of the patella (AO/OTA 34-C1, where AO/OTA denotes the Arbeitsgemeinschaft für

Osteosynthesefragen/Orthopaedic Trauma Association classification) are the most common pattern: 56% of 3,194 fractures in the Swedish Fracture Register were transverse⁴. When a transverse fracture has a gap of more than 3 mm or an articular step-off of more than 2 mm, the medial and lateral retinacula are usually torn, the quadriceps is uncoupled from the tibial tubercle, and active terminal extension is lost^{7,9,10}. Operative fixation is therefore generally indicated to restore the articular surface and tensile continuity and to allow early motion before intra-articular adhesions and patellofemoral cartilage damage develop^{9–11}.

Modified anterior tension band wiring (TBW) with two parallel longitudinal Kirschner wires (K-wires) and a figure-of-eight stainless-steel wire remains the most widely used technique for simple displaced transverse patellar fractures^{1,10,11}. According to Pauwels' tension-band principle, a wire placed across the anterior tensile surface converts the bending moments produced by quadriceps contraction and knee flexion into compression across the articular surface^{10,11}. However, retrospective cohorts report complications in 15.6%–18% of patients after patellar fixation, fixation failure in 8%–14.7%, reoperation in 22.3%, and implant removal in 56.7%–76% of patients after TBW^{12–14}. In osteoporotic patellae, in which trabecular density, trabecular thickness and the cortical shell at the poles are reduced, longitudinal K-wires are exposed

to high local bending stress at the superior and inferior poles, which may allow cutout and posterior articular gapping during early flexion¹⁴⁻¹⁶. To address this in osteopenic bone without the cost and soft-tissue stripping of fixed-angle locking plates, the anterior figure-of-eight wire can be augmented with a circumferential cerclage wire, which contains the fragments radially (hoop containment)¹⁷⁻¹⁹ and, in a cadaveric comparison, made the construct significantly stronger than tension band wiring alone²⁰.

The problem is greater when definitive treatment is delayed for weeks or months²¹⁻²³. Unlike metaphyseal bone, which heals with abundant periosteal callus, the patella has no true cambium periosteal layer on its anterior aponeurotic surface, and its deep articular surface is bathed in synovial fluid containing urokinase plasminogen activator (uPA), plasmin and matrix metalloproteinases^{21,22}. These fibrinolytic enzymes lyse the provisional fibrin-platelet hematoma, while the unopposed tone of the rectus femoris and vastus intermedius pulls the proximal fragment superiorly, creating high interfragmentary strain that steers mesenchymal stem cells toward fibroblastic rather than osteoblastic differentiation^{21,24,25}. In low- and middle-income countries (LMICs) of Southeast Asia and Sub-Saharan Africa, this process is often aggravated by reliance on traditional bone-setters (TBS) as the first providers of musculoskeletal trauma care²⁶⁻²⁹. Repeated manipulation without immobilization, deep friction massage, herbal poultices and tight non-rigid bindings disrupt granulation tissue, widen the gap, abrade the prepatellar skin and promote dense fibrous interposition and quadriceps contracture²⁶⁻³¹.

Many reports address acute patellar fractures treated within 48 hours to 14 days of injury^{10-14,17-19} and established non-unions treated months after injury, which may require quadricepsplasty, fractional tendon lengthening, traction or structural bone grafting^{21-23,32,33}. Fewer reports describe fractures treated four to six weeks after injury that follow active bone-setter manipulation. In particular, it is not well documented whether single-stage open curettage of the fibrous tissue, combined with parallel K-wire TBW and a circumferential cerclage, can restore a one-month neglected AO/OTA 34-C1 fracture in osteoporotic bone with pre-existing knee osteoarthritis without extensor lengthening or autologous bone grafting. This case adds an example of single-stage fixation at this intermediate delay after bone-setter treatment, documents the course with serial percentage changes, average daily changes and laboratory threshold ratios, and describes an approach that secondary-level hospitals in LMICs can provide. We report the presentation, operative technique and six-week clinical, radiographic and functional course of a 66-year-old postmenopausal woman with a one-month neglected transverse patellar fracture and Kellgren–Lawrence grade II osteoarthritis treated with TBW and a circumferential cerclage wire.

2. Methods

Case design and reporting framework

This case report was prepared according to the CARE guideline³⁴. It is based on serial clinical goniometry, standardized pain and knee-function scores, radiographic measurements and a qualitative comparison of fixation configurations. The patient was treated at the Department of Orthopedics and Traumatology and the Outpatient Rehabilitation Unit of Pringsewu Regional General Hospital, a secondary-level referral hospital in Pringsewu Regency, Lampung Province, Indonesia. The observation period covered 72 days, from the injury (day 0, T_{-30d}) through admission (day 30, T₀), surgery (day 31, T₁), discharge from inpatient

rehabilitation (day 58, postoperative day [POD] 28, T₅) and the six-week postoperative visit (day 72, POD 42, T₆); rehabilitation targets were set to week 12 (day 114, POD 84). Clinical, goniometric, radiographic and perioperative findings were recorded prospectively with the hospital's standard orthopedic trauma protocols; pain at the time of injury was estimated retrospectively.

Because a single patient is reported, no inferential statistics (p-values, t-tests, analysis of variance or χ^2 tests) were used. Changes from admission (T₀) to each later time point (T_n) in radiographic, range-of-motion, pain and functional variables were expressed as relative percentage changes, $\Delta\% = [(T_n - T_0)/T_0] \times 100\%$. The average change per day over an interval was calculated as $v = (T_n - T_0)/\Delta t$, where $\Delta t = t_n - t_0$ in days. Preoperative hematological, biochemical, coagulation, anthropometric and radiographic values were expressed as ratios to the upper or lower limit of normal or to the operative threshold, $R = X_i/X_{\text{cutoff}}$. Postoperative complications were graded with the Clavien–Dindo classification (grades I–V).

Case setting and patient information

The patient was a 66-year-old postmenopausal Javanese woman, about 15 years after menopause, with a body mass index (BMI) of 26.3 kg/m² and American Society of Anesthesiologists (ASA) physical status II because of essential hypertension controlled with oral amlodipine 5 mg once daily. She presented 30 days after a low-energy forward fall onto her flexed left knee in her rural yard while carrying a basin of water, with a neglected, displaced transverse patellar fracture (AO/OTA 34-C1) after unsuccessful manipulation by a traditional bone-setter. On admission the fracture gap was 10 mm and the articular step-off 3 mm, and she could not perform an active straight-leg raise against gravity. There was no open wound, no clinical or laboratory sign of prepatellar or intra-articular infection (serum C-reactive protein [CRP] <5 mg/L and a normal leukocyte count), no neuropathic (Charcot) arthropathy, no pathological fracture and no ipsilateral femoral or tibial shaft fracture.

Data collection and diagnostic assessment

Eight assessment points were used: day 0 (T_{-30d}; the fall and the start of four weeks of bone-setter manipulation with herbal pastes and tight circumferential cloth bindings); day 30 (T₀; first hospital orthopedic evaluation and preoperative optimization); day 31 (T₁; single-stage open reduction, fibrous curettage and fixation); day 33 (T₂; POD 2–3; protected extension immobilization and early isometric activation); day 44 (T₃; POD 14; start of physiotherapist-supervised active-assisted flexion after suture removal); day 51 (T₄; POD 21; progressive partial weight-bearing with crutches and assessment of active extension against gravity); day 58 (T₅; POD 28; week-4 discharge and radiographic evaluation); and day 72 (T₆; POD 42; week-6 outpatient follow-up). At T₀, the work-up included a complete blood count, renal and hepatic biochemistry, bone mineral markers (serum calcium, inorganic phosphate, alkaline phosphatase [ALP] and 25-hydroxyvitamin D [25(OH)D]), coagulation tests, three-view knee radiographs (anteroposterior, 30° lateral and Merchant axial) and high-frequency linear-array ultrasonography of the extensor mechanism (10–14 MHz). Range of motion was measured with a handheld goniometer, pain with the 11-point Numerical Rating Scale (NRS), and knee function with the Böstman patellar score (0–30) and the Lysholm knee score (0–100).

Intervention and follow-up

On T₁, under subarachnoid block at the L3–L4 interspace (12.5 mg of 0.5% hyperbaric bupivacaine with 25 µg of intrathecal

fentanyl) and after 2 g of intravenous cefazolin, a 10-cm longitudinal midline incision was made. The dense, organized fibrous tissue filling the 10-mm gap was curetted to bleeding cancellous bone, and articular congruity was restored under direct digital palpation through a 2-cm medial parapatellar mini-arthrotomy and checked with C-arm fluoroscopy. Fixation used two parallel longitudinal 1.8-mm stainless-steel K-wires driven from the superior to the inferior pole, an anterior figure-of-eight 1.0-mm stainless-steel wire passed through an 18-gauge cannula and tensioned with symmetric double parallel twists, and an additional 1.0-mm circumferential cerclage wire tightened around the periphery of the patella^{17-19,35,36}. All wire twists and K-wire ends were bent 180° and buried in the tendinous fibers of the quadriceps and patellar tendon insertions, and the retinacula were repaired with interrupted absorbable sutures. Postoperative immobilization, medication and the three-phase rehabilitation program are described in the Results.

Comparison with published series

Because there was no control group, published studies were used at two levels to place the case in context. First, the fixation configuration (two parallel 1.8-mm K-wires, an anterior 1.0-mm figure-of-eight wire and a 1.0-mm circumferential cerclage) was compared qualitatively with standalone parallel K-wire TBW and standalone circumferential cerclage, using published clinical, cadaveric and finite-element studies^{37,38}. Second, the delay to surgery, operative complexity, radiographic union and functional recovery were compared with eight cohorts and case series published between 2021 and 2026 on acute fractures (delay < 2 weeks) and on neglected non-unions treated months after injury^{2,11,17-19,21,22,36}.

Ethical approval and consent

Before surgery and data analysis, the Ethics Committee CMHC Research Center Indonesia reviewed and approved this report (protocol No. 2026/0421) in accordance with the governance framework of Pringsewu Regional General Hospital, the Declaration of Helsinki (2013 revision) and the privacy recommendations of the International Committee of Medical Journal Editors (ICMJE). Written informed consent was obtained from the patient and her legal family guardian for the single-stage open reduction and internal fixation and for anonymized publication of all clinical, laboratory, radiographic and schematic material. No identifiable facial or ocular features are shown.

3. Results

Presentation and preoperative assessment

At T₀ (day 30 after injury), the patient, a homemaker from a rural farming village in Pringsewu Regency, came to the orthopedic outpatient clinic walking without weight on the left leg, with a three-point crutch gait on the right. Thirty days earlier (day 0) she had fallen forward onto her flexed left knee on an unpaved yard while carrying a basin of water. She had immediate severe anterior knee pain (estimated retrospectively

at 8/10 at rest and 9/10 on attempted motion on the NRS), a rapid effusion and complete inability to straighten the knee actively against gravity. Instead of seeking hospital emergency care, the family took her to a local traditional bone-setter from day 1. Over the following 30 days (about four weeks; 15 times the 48-hour acute surgical window), the bone-setter repeatedly manipulated the knee without anesthesia, applied vigorous friction massage and herbal pastes, and bound the knee tightly with cloth without a rigid splint. Active extension did not return, and persistent pain and increasing dependence in walking led to referral.

Table 1 summarizes the baseline examination, laboratory, coagulation and radiographic findings. She weighed 61.5 kg and was 1.53 m tall (BMI 26.3 kg/m², 1.06 times the upper normal limit of 24.9 kg/m²). Hypertension was well controlled with amlodipine 5 mg daily (blood pressure 132/78 mmHg, heart rate 76 beats/min, respiratory rate 18 breaths/min, temperature 36.6 °C; ASA II). The left knee showed moderate suprapatellar and peripatellar swelling, fading medial ecchymosis and healed superficial lateral abrasions attributed to the repeated massage, without sinus tracts, burns or cellulitis. A tender, 10-mm transverse defect filled with firm, rubbery tissue was palpable across the middle of the patella. On goniometry, active flexion in the seated position was 20°, passive flexion 60° (limited by pain, with patellofemoral crepitus) and the active extension lag 20°, and an active straight-leg raise was not possible. The collateral and cruciate ligaments were stable within the testable range; the dorsalis pedis and posterior tibial pulses were 2+, capillary refill was < 2 seconds, and saphenous, tibial and peroneal nerve function was intact.

Laboratory tests at T₀ (Table 1) showed hemoglobin 12.4 g/dL, leukocytes 7.8 × 10³/μL, platelets 245 × 10³/μL and CRP 3.2 mg/L (below the 5.0 mg/L cutoff), making prepatellar or intra-articular infection unlikely despite four weeks of non-sterile herbal applications. Renal and metabolic values were normal: blood urea nitrogen 14.0 mg/dL, creatinine 0.9 mg/dL, fasting glucose 96.0 mg/dL, total calcium 9.2 mg/dL, inorganic phosphate 3.6 mg/dL and ALP 84.0 U/L. Serum 25(OH)D was 21.0 ng/mL, 0.70 times (30% below) the 30 ng/mL sufficiency threshold, consistent with vitamin D insufficiency. The prothrombin time (12.8 seconds), international normalized ratio (INR, 1.02) and activated partial thromboplastin time (aPTT, 32.0 seconds) permitted neuraxial anesthesia. Anteroposterior, lateral and Merchant views confirmed a displaced simple transverse fracture of the middle of the left patella (AO/OTA 34-C1), with 10 mm of superior fragment retraction (3.33 times the 3-mm operative cutoff) and a 3-mm articular step-off (1.50 times the 2-mm cutoff), on a background of Kellgren–Lawrence (KL) grade II patellofemoral and medial tibiofemoral osteoarthritis with mild medial joint-space narrowing, subchondral sclerosis and small marginal osteophytes. Ultrasonography showed continuity of the quadriceps tendon and the patellar ligament, placing the discontinuity in the fibrous-filled patellar defect.

Table 1. Baseline demographic, anthropometric, biochemical, coagulation and radiographic profile at the first orthopedic presentation (T₀, day 30 after injury), with threshold ratios.

Parameter	Patient value (T ₀)	Reference interval / surgical cutoff	Ratio (R _{ULN} , R _{ULN} OR R _{thresh})	Clinical interpretation
Age / sex	66 years / female	Postmenopausal (~15 years)	—	Secondary peak of incidence in older adults; estrogen-deficient trabecular bone
Ethnicity / domicile / occupation	Javanese / rural Pringsewu, Lampung / homemaker	Pre-injury Katz ADL 6/6	1.00× (pre-injury)	Fully independent in household tasks, gardening and light farming before the fall
Body mass index (BMI)	26.3 kg/m ² *	18.5–24.9 kg/m ²	1.06× R _{ULN}	Overweight; higher patellofemoral compressive joint reaction force
Injury mechanism and delay	Low-energy fall; 30 days (4 weeks)	< 48 hours (acute window)	15.00× (delay ratio)	Four weeks of traditional bone-setter (TBS) manipulation and herbal binding

Parameter	Patient value (T ₀)	Reference interval / surgical cutoff	Ratio (R _{ULN} , R _{LLN} or R _{thresh})	Clinical interpretation
Comorbidity and ASA status	Hypertension (amlodipine 5 mg/day); ASA II	ASA I–II	—	Well-controlled blood pressure; lifelong non-smoker, no alcohol intake
Hemoglobin (Hb)	12.4 g/dL	12.0–16.0 g/dL	1.03 × R _{LLN}	Low-normal hemoglobin; no occult hemorrhagic anemia
White blood cell (WBC) count	7.8 × 10 ³ /μL	4.0–10.0 × 10 ³ /μL	0.78 × R _{ULN}	Normal leukocyte count; no systemic leukocytosis despite TBS massage
Platelet count	245 × 10 ³ /μL	150–400 × 10 ³ /μL	0.61 × R _{ULN}	Adequate platelet reserve for spinal anesthesia
Serum C-reactive protein (CRP)	3.2 mg/L	< 5.0 mg/L	0.64 × R _{ULN}	Below the inflammatory cutoff; deep prepatellar or intra-articular infection unlikely
Blood urea nitrogen (BUN) / creatinine	14.0 mg/dL / 0.9 mg/dL	7–20 mg/dL / 0.6–1.1 mg/dL	0.70 × / 0.82 × R _{ULN}	Preserved renal function; perioperative NSAID analgesia acceptable
Fasting blood glucose (FBG)	96.0 mg/dL	70–99 mg/dL	0.97 × R _{ULN}	Normoglycemic; low metabolic risk of surgical site infection
Serum total calcium (Ca ²⁺) / phosphate	9.2 mg/dL / 3.6 mg/dL	8.6–10.3 mg/dL / 2.5–4.5 mg/dL	0.89 × / 0.80 × R _{ULN}	Normal mineral homeostasis; no overt secondary hyperparathyroidism
Serum alkaline phosphatase (ALP)	84.0 U/L	30–120 U/L	0.70 × R _{ULN}	Osteoblast turnover within the reference interval
Serum 25-hydroxyvitamin D [25(OH)D]	21.0 ng/mL*	≥ 30 ng/mL	0.70 × R _{cutoff} (Δ% = –30.0%)	Postmenopausal vitamin D insufficiency; impairs mineralization and trabecular stiffness
Coagulation (PT / INR / aPTT)	12.8 s / 1.02 / 32.0 s	11–13 s / 0.9–1.1 / 25–35 s	0.98 × / 0.93 × / 0.91 × R _{ULN}	Normal extrinsic and intrinsic pathways; cleared for spinal anesthesia
Radiographic fracture morphology (AO/OTA)	34-C1 transverse mid-body; g ₀ = 10.0 mm; s ₀ = 3.0 mm*	g _{cutoff} ≤ 3.0 mm; s _{cutoff} ≤ 2.0 mm	3.33 × g _{cutoff} / 1.50 × s _{cutoff}	Complete extensor uncoupling; KL grade II medial osteoarthritis; fibrous interposition

*Values outside the reference interval or above the operative threshold. ADL = activities of daily living; ALP = alkaline phosphatase; AO/OTA = Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association; aPTT = activated partial thromboplastin time; ASA = American Society of Anesthesiologists; g₀ = baseline fracture gap; INR = international normalized ratio; KL = Kellgren–Lawrence; NSAID = non-steroidal anti-inflammatory drug; PT = prothrombin time; R_{cutoff} = ratio to the sufficiency cutoff; R_{LLN} = ratio to the lower limit of normal; R_{thresh} = ratio to the operative threshold; R_{ULN} = ratio to the upper limit of normal; s₀ = baseline articular step-off; TBS = traditional bone-setter.

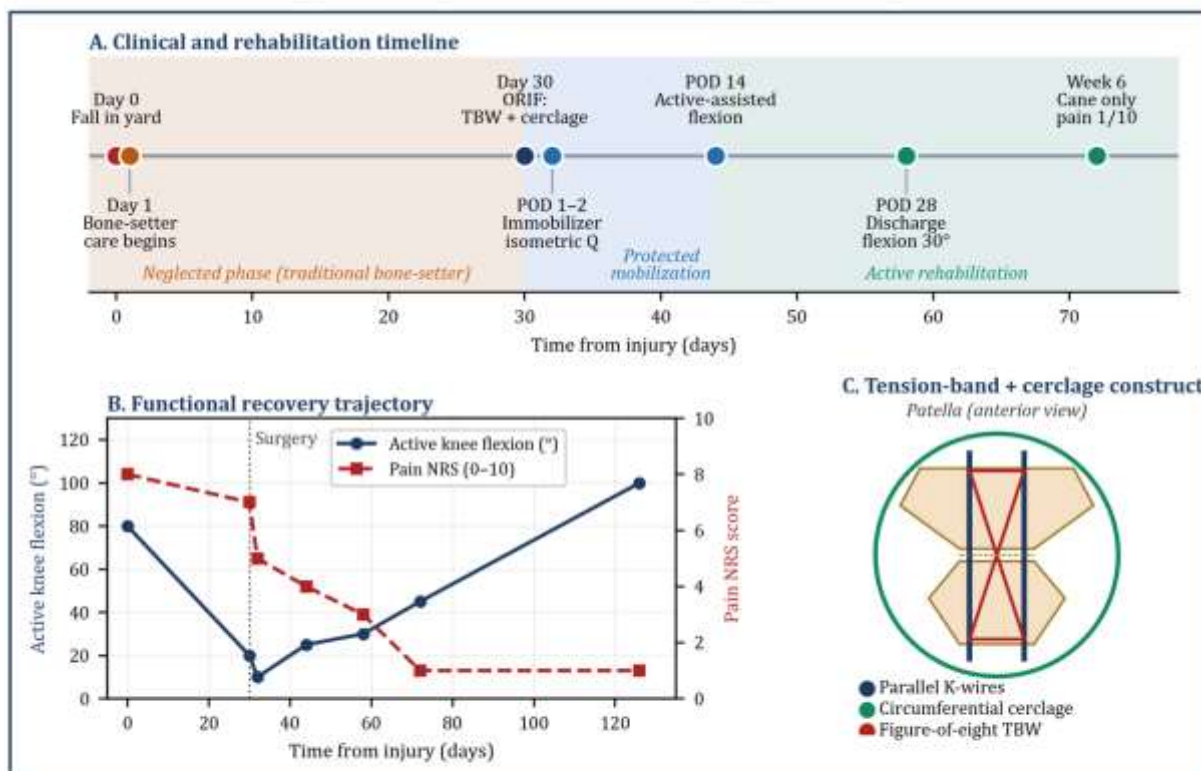
Operative findings and fixation

On T₁ (day 31), single-stage open reduction, removal of the fibrous tissue and internal fixation were performed under spinal anesthesia. Through a 10-cm anterior midline incision, dissection through the prepatellar subcutaneous tissue and bursa exposed a transverse mid-body fracture bridged by a dense, organized, whitish-gray fibrous membrane spanning 10 mm cranio-caudally, with early peripatellar retinacular contracture after 30 days of unopposed quadriceps tone and repeated manipulation. There was no synovial pseudarthrosis cavity, no marginal bone necrosis and no pus. The organized fibrous tissue and immature fibrocartilaginous callus were excised from both fracture surfaces with a curette and rongeur until punctate bleeding appeared from the osteoporotic cancellous bone, preserving the anterior aponeurotic sleeve and the tendon attachments at both poles. With the knee fully extended and the hip flexed, sustained distal traction on the superior pole with a pointed reduction clamp brought the retracted proximal fragment across the 10-mm gap without V-Y quadricepsplasty or peripatellar release.

Palpation of the retropatellar cartilage through the 2-cm medial parapatellar mini-arthrotomy, together with C-arm fluoroscopy, confirmed anatomical reduction: the gap fell from 10 mm to 0 mm and the step-off from 3 mm to 0 mm (both

–100%). Fixation was built in three steps (Figure 1). First, two parallel 1.8-mm stainless-steel K-wires were drilled from the superior to the inferior pole about 5 mm deep to the anterior cortex and parallel to the articular surface, to align the fragments. Second, a 1.0-mm (18-gauge) surgical stainless-steel wire was passed transversely deep to the quadriceps and patellar tendon insertions, immediately anterior to the protruding K-wire ends, through an 18-gauge hollow-needle cannula, crossed in an anterior figure-of-eight and tightened with symmetric medial and lateral twists to compress the fracture evenly^{10,11}. Third, to counter the weaker hold of the K-wires in osteoporotic polar bone and the retracting tension of the extensor mechanism shortened for four weeks, a 1.0-mm stainless-steel cerclage wire was passed around the patella through the parapatellar retinacular–osseous junction and tightened to compress the fragments circumferentially (hoop containment)^{17–19}. The medial and lateral retinacula were repaired with interrupted 1-0 polyglactin 910 sutures. Passive motion from full extension (0°) to 90° of flexion showed stable fixation with no visible gap. All twists and the superior K-wire tips were bent 180°, impacted and buried in the tendon to avoid subcutaneous prominence. The operation took 85 minutes, estimated blood loss was 120 mL, and there were no intraoperative anesthetic or surgical complications.

a Clinical Timeline, Postoperative Range-of-Motion & Pain Trajectory, and Osteosynthesis Construct



b Biomechanical Free-Body & Construct Load-Conversion Analysis (T_0 vs. T_1)

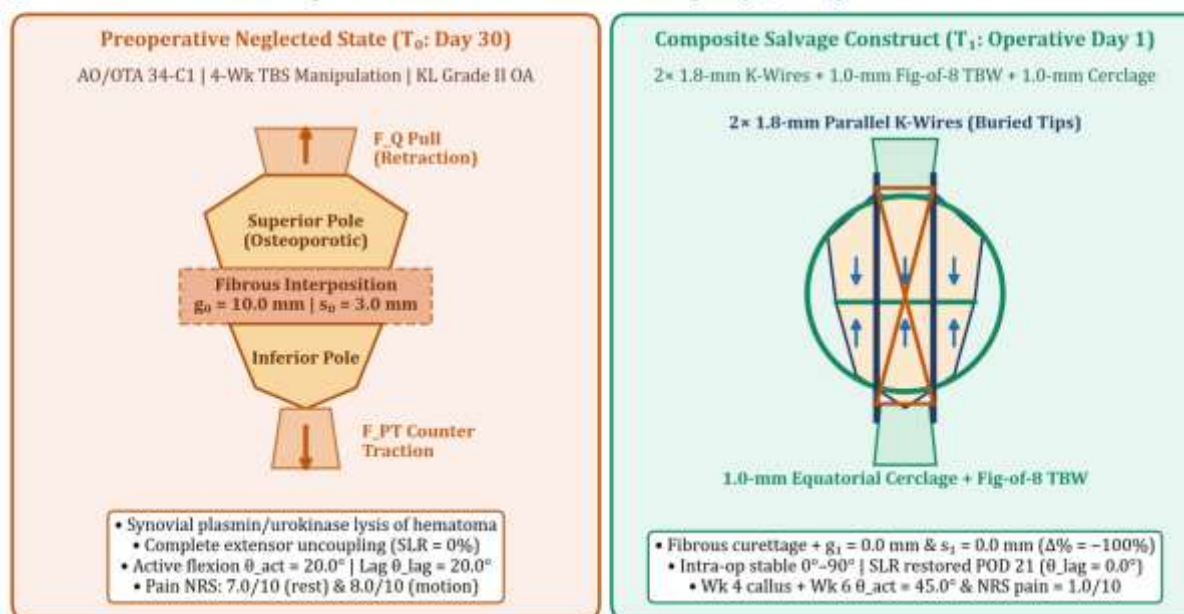


Figure 1. Clinical timeline, recovery and construct. (a) Clinical and rehabilitation timeline (A), active knee flexion and pain (NRS) from injury (B; values as recorded in the original figure), and schematic of the tension-band plus circumferential cerclage construct (C). (b) Schematic of the neglected fracture at T_0 (day 30 after injury, after four weeks of traditional bone-setter manipulation: AO/OTA 34-C1 mid-body fracture with a 10-mm gap and 3-mm articular step-off, organized fibrous interposition, proximal quadriceps retraction F_Q and background Kellgren–Lawrence grade II osteoarthritis) and of the construct at T_1 (fibrous curettage; anatomical reduction with gap and step-off 0 mm; two parallel 1.8-mm K-wires, an anterior 1.0-mm figure-of-eight wire and a 1.0-mm circumferential cerclage). F_{PT} = patellar tendon force; K-wire = Kirschner wire; KL = Kellgren–Lawrence; NRS = Numerical Rating Scale; OA = osteoarthritis; ORIF = open reduction and internal fixation; POD = postoperative day; SLR = straight-leg raise; TBS = traditional bone-setter; TBW = tension band wiring.

Table 3 compares the construct used here with standalone parallel K-wire TBW and standalone circumferential cerclage^{11,17-19,37,38}. A circumferential wire used alone lies near the neutral bending axis of the patella rather than on the anterior tensile cortex, so it resists anterior opening poorly and allows posterior articular gapping during flexion. Standalone

parallel K-wire TBW depends on the purchase of the K-wires in the polar bone, which is weaker in osteoporotic patellae¹⁴⁻¹⁶. Adding the circumferential wire to the K-wires and the anterior figure-of-eight wire distributes load across both planes and contains the osteoporotic poles around the K-wires; in a finite-element and cadaveric comparisons, a tension band with an

added cerclage displaced less or failed at a higher load than a tension band alone^{20,38}. In this patient no gap opened during

passive flexion from 0° to 90° at surgery, and early anterior cortical callus was present by week 4 despite the 30-day delay.

Table 3. Implant configuration and operative details of the construct used, compared with standalone parallel K-wire TBW and standalone circumferential cerclage.

Parameter	Standalone parallel K-wire TBW	Standalone circumferential cerclage	Composite TBW + circumferential cerclage (present case)	Mechanical and clinical rationale in a neglected osteoporotic patella
Primary axial and tensile fixation elements	2 × 1.8-mm longitudinal K-wires + 1.0-mm anterior figure-of-eight SS wire	Single 1.0-mm peripatellar circumferential SS wire loop	2 × 1.8-mm parallel K-wires + 1.0-mm figure-of-eight TBW + 1.0-mm circumferential cerclage	Load sharing in two planes: axial K-wire alignment + anterior tension-to-compression conversion + radial hoop containment
Soft-tissue and retinacular tension relief	Relies on K-wire purchase at the poles and suture repair	Circumferential soft-tissue constriction only	Circumferential 1.0-mm cerclage + interrupted absorbable retinacular repair	Offloads the 30-day quadriceps retraction and peripatellar fibrosis without V-Y quadricepsplasty
Implant prominence mitigation	Standard single or double twist; implant removal in 56.7%–76% after TBW ^{12,13}	Peripatellar knot irritation	Double parallel twists + deep bending and burial of wire ends in the tendons	No palpable subcutaneous knot or prepatellar skin breakdown during 6 weeks
Operative details (present case, T ₁)	—	—	Spinal 12.5 mg bupivacaine 0.5% + 25 µg fentanyl; 10-cm incision; 85 min; EBL 120 mL	Single-stage procedure with standard secondary-hospital instruments; no transfusion

The mechanical descriptions are qualitative: distraction resistance, construct stiffness, articular compression and fracture-gap opening were not measured in this patient. EBL = estimated blood loss; K-wire = Kirschner wire; SS = stainless steel; TBW = tension band wiring.

Postoperative course and rehabilitation

Table 2 and Figures 2 and 3 show the postoperative course from T₁ to the week-6 visit (T₆, day 72, POD 42), with rehabilitation targets to week 12 (day 114, POD 84). After surgery the knee was kept in a hinged long-leg immobilizer locked in full extension, with elevation and intermittent cryotherapy. The patient received subcutaneous enoxaparin 40 mg once daily for venous thromboembolism prophylaxis, intravenous cefazolin 1 g every 8 hours for 24 hours, oral cholecalciferol 1,000 IU and elemental calcium 1,000 mg daily, and scheduled non-opioid analgesia (intravenous paracetamol 1 g four times daily and intravenous ketorolac 30 mg three times daily for 48 hours, changed on POD 3 to oral celecoxib 200 mg twice daily). Resting pain fell from 7/10 at admission (T₀) to 5/10 on POD 1 (–28.6%) and 3/10 on POD 3 (T₂; –57.1%; an average fall of 1.33 points per day), and pain on motion fell from 8/10 to 6/10 on POD 1 and 5/10 on POD 3 (–37.5%). Isometric quadriceps sets and active ankle pumps began on POD 1, and partial weight-bearing

with two crutches and the knee locked in extension began on POD 2.

On POD 12 the incision had healed by primary intention without erythema, hematoma or suture abscess, and all sutures were removed. On POD 14 (T₃, day 44), physiotherapist-supervised active-assisted flexion was started within a protected 0°–30° arc, to protect the curetted osteoporotic fracture interface while preventing intra-articular adhesions^{39,40}. At T₃, active flexion was 25° (+25% from 20° at T₀), passive flexion 35° within the protected rehabilitation range, the active extension lag 5° (–75%), resting pain 2.5/10 (–64.3%) and pain on motion 4/10 (–50%). By POD 21 (T₄, day 51), with progressive gait training and quadriceps re-education, she could perform an unassisted straight-leg raise against gravity (absent at T₀), the extension lag had resolved (0° vs 20° at T₀; –100%; an average of –0.95° per day over 21 days), and active flexion was 28° (+40%).

Table 2. Serial clinical, radiographic, range-of-motion and functional findings from injury (T_{-30d}) and admission (T₀) through surgery (T₁) to the week-6 visit (T₆).

Variable	T _{-30d} (day 0, fall)	T ₀ (day 30, admission)	T ₁ (POD 1, ORIF)	T ₂ (POD 3, immobil.)	T ₃ (POD 14, rehab start)	T ₄ (POD 21, crutch gait)	T ₅ (POD 28, wk 4 discharge)	T ₆ (POD 42, wk 6 F/U)	Δ% T ₅ vs T ₀ / T ₆ vs T ₀	Average change per day
Fracture gap g (mm)	8	10	0	0	0	0	0	0	–100% / –100%	–10 mm intra-op
Articular step-off s (mm)	2.5	3	0	0	0	0	0	0	–100% / –100%	–3 mm intra-op
Active knee flexion θ _{act} (°)	15	20	0 (locked)	10	25	28	30	45 ^a	+50% / +125%	+0.36°/d (T ₀ –T ₅); +1.07°/d (T ₅ –T ₆)
Passive knee flexion θ _{pas} (°)	45	60	90 (intra-op)	30 (brace)	35	40	45	65	–25% (protected) / +8.3%	+1.07°/d (T ₃ –T ₆)
Active extension lag θ _{lag} (°)	25	20	0 (brace)	10	5	0	0	0	–100% / –100%	–0.95°/d (resolved POD 21)
Active straight-leg raise (SLR)	Absent	Absent	Immobilized	Isometric	Assisted (50%)	Full	Full	Full	Restored	Full against gravity by POD 21
Pain NRS at rest (0–10)	8	7	5	3	2.5	2	2	1	–71.4% / –85.7%	–0.18/d (T ₀ –T ₅); –0.14/d (T ₀ –T ₆)
Pain NRS on motion (0–10)	9	8	6	5	4	3.5	3	1	–62.5% / –87.5%	–0.18/d (T ₀ –T ₅); –0.17/d (T ₀ –T ₆)
Böstman patellar score (0–30)	6 (unsatisfactory)	8 (unsatisfactory)	—	12	16	19	21 (good)	25 (good) ^a	+162.5% / +212.5%	+0.46/d (T ₀ –T ₅); +0.40/d (T ₀ –T ₆)
Lysholm knee score (0–100)	18	24	—	35	48	58	66	78 ^a	+175% / +225%	+1.50/d (T ₀ –T ₅); +1.29/d (T ₀ –T ₆)
Radiographic healing and implant stability	Unreduced acute	Fibrous gap; no callus	Anatomical; 0 mm gap	Maintained	Maintained; sutures out POD 12	Maintained; no migration	Early anterior cortical callus	Consolidating callus; cane indoors	100% hardware retention	No K-wire loosening or breakage

Relative change Δ% = [(T_n – T₀)/T₀] × 100%; average change per day = (later value – earlier value)/days between the two time points. ^aWeek-12 targets: active flexion 100°, Böstman score 28, Lysholm score 90. F/U = follow-up; immobil. = immobilization; NRS = Numerical Rating Scale; ORIF = open reduction and internal fixation; POD = postoperative day; SLR = straight-leg raise; wk = week.

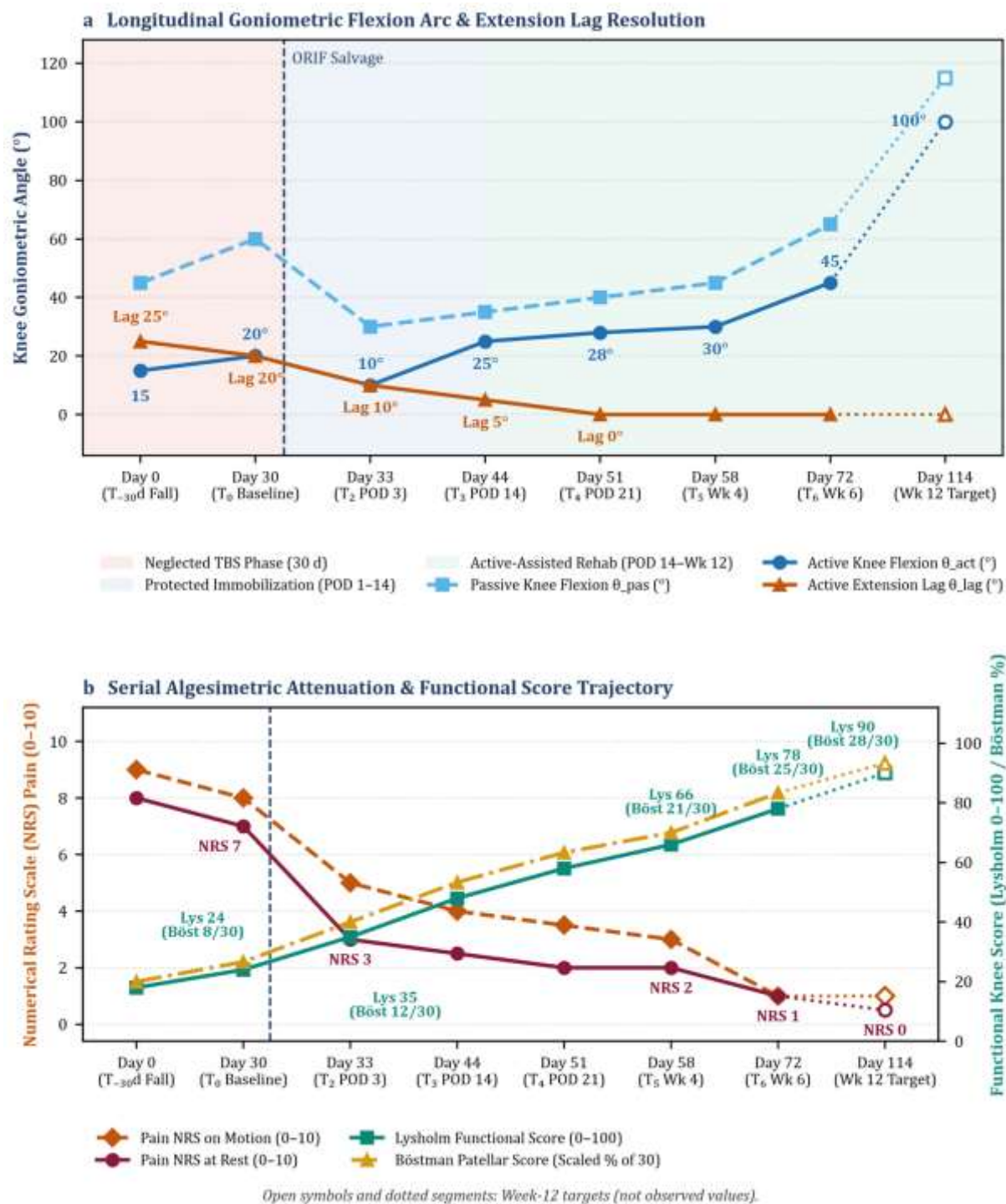


Figure 2. Range of motion, pain and function from injury (T_{-30d}) to week 6 (T_6). (a) Active knee flexion (θ_{act} , circles), passive flexion (θ_{pas} , squares) and active extension lag (θ_{lag} , triangles) during the 30-day bone-setter phase, protected immobilization (POD 1–14) and active-assisted rehabilitation (from POD 14); the 20° lag resolved by POD 21 (T_4), and active flexion reached 30° at week 4 (T_5) and 45° at week 6 (T_6). (b) Pain at rest and on motion (NRS, left axis), and the Lysholm score (0–100) and Böstman score (percentage of the 30-point maximum) (right axis). Open symbols and dotted segments show week-12 targets, not observed values. NRS = Numerical Rating Scale; ORIF = open reduction and internal fixation; POD = postoperative day; TBS = traditional bone-setter.

At week 4 (T_5 , POD 28, day 58), she was discharged after a 28-day hospital stay, extended mainly by the distance to her rural home so that physiotherapy could be supervised. Active flexion was 30° and pain-free (+50% from T_0 ; an average gain of 0.36° per day over the first 28 postoperative days), and active extension was full (lag 0°; –100%). Resting pain had fallen to 2/10 (–71.4%; –0.18 points per day) and pain on motion to 3/10 (–62.5%; –0.18 points per day). Anteroposterior and lateral radiographs at T_5 confirmed that the anatomical reduction was maintained (gap and step-off 0 mm), with no K-wire back-out or

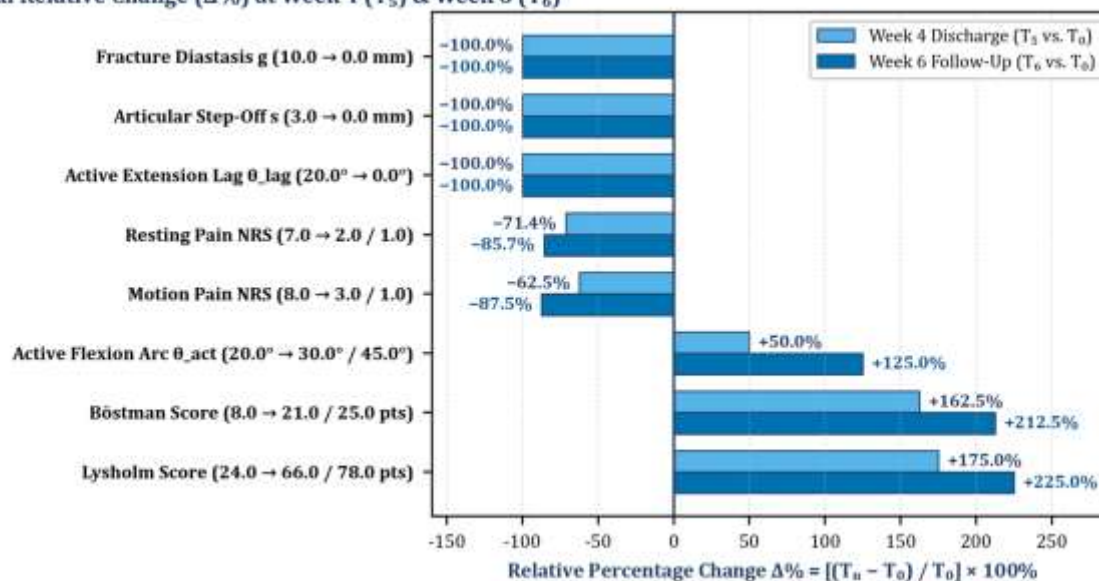
wire breakage, and showed early mineralized bridging callus across the anterior cortex. The Böstman score improved from 8/30 (unsatisfactory) at T_0 to 21/30 (good; +162.5%; +0.46 points per day) and the Lysholm score from 24/100 to 66/100 (+175%; +1.50 points per day).

After discharge she followed an outpatient physiotherapy program aimed at 60° of active flexion by week 8 and 90°–100° by week 12. At week 6 (T_6 , POD 42, day 72), she had changed from two axillary crutches to walking indoors with a single cane and reported full adherence to daily range-of-motion exercises

and to calcium and cholecalciferol supplements. Active flexion had increased to 45° (+125% from T₀; a faster gain of 1.07° per day between T₅ and T₆) and passive flexion to 65° (+8.3% above the pain-limited preoperative value), and active extension remained full. Resting pain and pain on motion had both fallen to 1/10, cumulative reductions of 85.7% and 87.5% from admission (Figure 3a). The Böstman score was 25/30

(+212.5%) and the Lysholm score 78/100 (+225%). Figure 3b shows that the two preoperative values above surgical thresholds at T₀, the fracture gap (3.33 times the cutoff) and the articular step-off (1.50 times), fell to zero after fixation, and that cholecalciferol was started for the vitamin D insufficiency (0.70 times the sufficiency threshold).

a Serial Relative Change (Δ%) at Week 4 (T₅) & Week 6 (T₆)



b Baseline Preoperative Threshold Ratios (R_{ULN} & R_{cutoff})

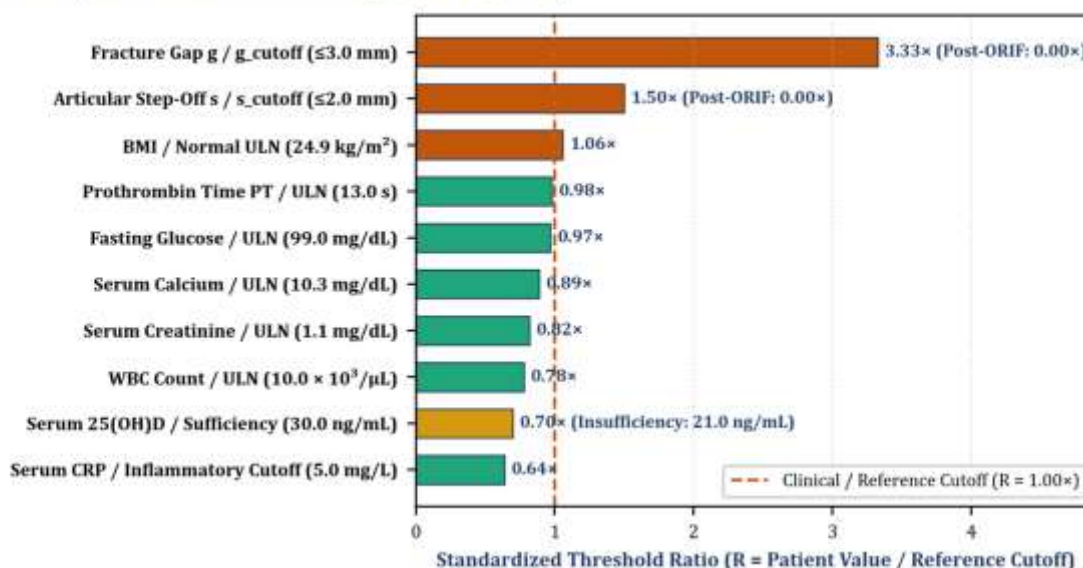


Figure 3. Relative changes and preoperative threshold ratios. (a) Relative change from admission ($\Delta\% = [(T_n - T_0)/T_0] \times 100\%$) at week 4 (T₅, light bars) and week 6 (T₆, dark bars). (b) Preoperative values at T₀ as ratios to the operative cutoff or reference limit ($R = X_t/X_{cutoff}$); the dashed line marks $R = 1.00$. 25(OH)D = 25-hydroxyvitamin D; BMI = body mass index; CRP = C-reactive protein; NRS = Numerical Rating Scale; ORIF = open reduction and internal fixation; ULN = upper limit of normal; WBC = white blood cell.

Complications and safety

Table 4 summarizes perioperative safety and secondary fracture prevention. After four weeks of bone-setter manipulation and non-rigid herbal binding, the fracture was found displaced by 10 mm, with organized fibrous interposition and lateral skin abrasions. No drug-related adverse event

occurred during the perioperative regimen (hyperbaric bupivacaine, intrathecal fentanyl, cefazolin, paracetamol, ketorolac, celecoxib, enoxaparin, cholecalciferol and calcium); there was no post-spinal hypotension, nephrotoxicity, gastrointestinal ulceration or bleeding, or coagulopathy. No postoperative surgical complication occurred through day 72, so no Clavien–Dindo grade applied.

Table 4. Perioperative safety and secondary fracture prevention.

Assessment domain	Exposure or intervention	Classification	Evidence from the case course	Comment
Perioperative drug-related adverse events	Multimodal regimen (bupivacaine 12.5 mg, fentanyl 25 µg, cefazolin, paracetamol, ketorolac, celecoxib, enoxaparin, cholecalciferol + Ca ²⁺)	None observed	No post-spinal hypotension, nephrotoxicity (Cr 0.9 mg/dL), gastrointestinal bleeding, surgical site infection or venous thromboembolism across 42 postoperative days	Regimen tolerated in an ASA II older patient with hypertension
Postoperative surgical complications (Clavien–Dindo, grades I–V)	Single-stage open reduction, fibrous curettage and TBW + circumferential cerclage	None (no grade applicable)	Primary wound healing with suture removal on POD 12; no wound dehiscence, hardware migration, wire breakage or neurovascular deficit through week 6	Uncomplicated recovery after midline dissection with deep burial of wire ends
Fragility and metabolic risk	Postmenopausal (~15 years); low-energy fall; 25(OH)D 21.0 ng/mL; KL grade II knee OA	Secondary fragility-fracture risk	Low-energy fall from standing height producing an AO/OTA 34-C1 fracture; 25(OH)D 30% below the 30 ng/mL cutoff; cholecalciferol 1,000 IU/day + calcium 1,000 mg/day started; outpatient DXA referral	Referral to fracture liaison care and DXA

ASA = American Society of Anesthesiologists; Cr = serum creatinine; DXA = dual-energy X-ray absorptiometry; KL = Kellgren–Lawrence; OA = osteoarthritis; POD = postoperative day; TBW = tension band wiring.

Comparison with published series

Table 5 and Figure 4 compare the present case with eight studies published between 2021 and 2026 on acute, geriatric and neglected patellar fractures (1,937 patients in total, as reported in the sources)^{2,11,17–19,21,22,36}. Among acute fractures, Kachare et al.¹⁷ (n = 38) reported union in all patients by 16 weeks after circumferential cerclage with a figure-of-eight wire without K-wires, with flexion of 124°; Li et al.¹⁸ (n = 31, aged 65 years or older) reported healing at a mean of 2.9 months and flexion of 130° after modified cerclage wiring; Qiu et al.¹⁹ (n = 37) reported union in all patients after cannulated-screw tension-band fixation with suture cerclage; and Bickel et al.³⁶ (n = 63) reported 1-year Lysholm scores of about 90 after locked plating or cerclage compression wiring, with implant complications in 35% after wiring. Selçuk et al.¹¹ reported failure in 9 of 32 transverse fractures (28.1%) fixed with TBW, mostly cerclage

slippage or breakage and more often with a single knot. Among neglected fractures, Harna et al.²¹ (n = 10; 7–13 months after injury, all first treated by bone-setters) achieved union in all patients at a mean of 5 months with TBW, cerclage or Krackow suture, used iliac crest graft in some patients and did not need V-Y plasty, and Patterson et al.²² (n = 5; 2.2–15 months) used a modified quadricepsplasty, tension-band plating and tibial autograft, with union within 3 months and a mean active flexion of 98°. Kapilow et al.² reported 30-day outcomes in 1,721 surgically treated patients older than 65 years (unplanned reoperation 2.7%). At 30 days after injury, the present case lay between these groups: single-stage curettage with K-wire TBW and a circumferential cerclage achieved anatomical reduction, resolved the extension lag by week 3, showed early cortical callus at week 4 and reached 45° of active flexion at week 6 (target 100° at week 12), without quadriceps lengthening or autologous bone grafting.

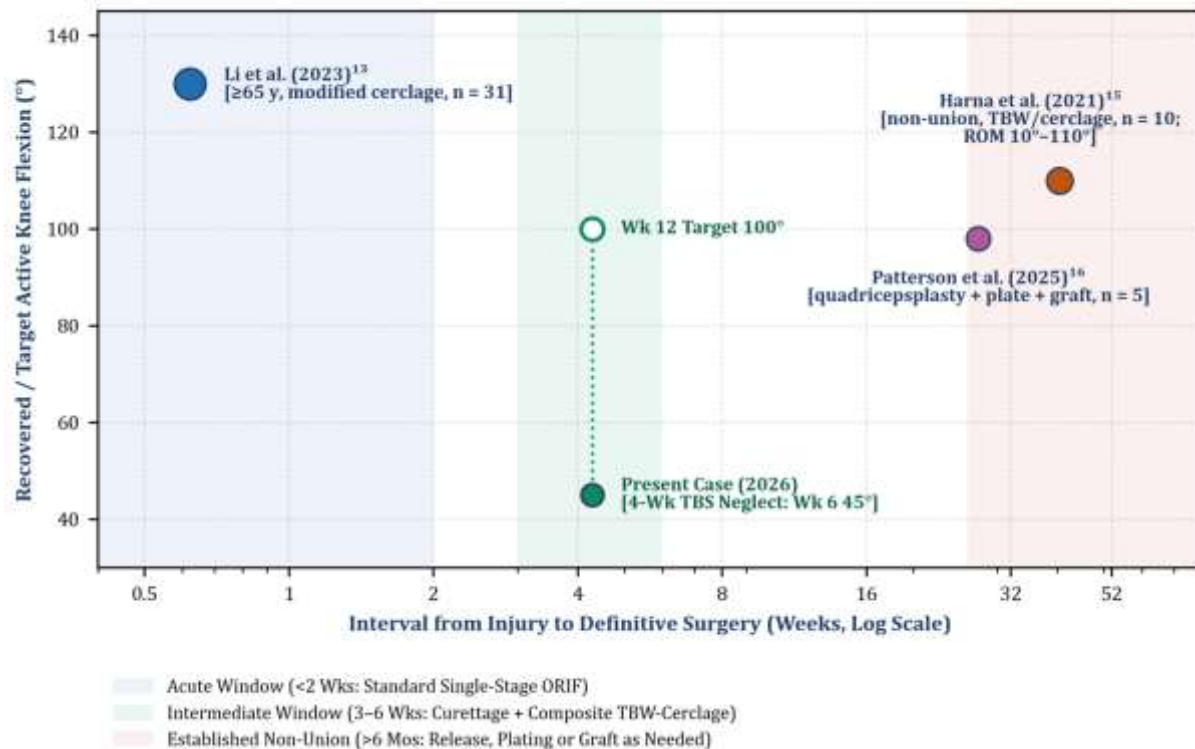


Figure 4. Delay to surgery and active knee flexion in published series and the present case. Each point shows the mean delay from injury to surgery (weeks, log scale) and the flexion reported in the source article (Harna et al.: upper end of the reported 10°–110° range); marker size increases with sample size. For the present case, the filled marker is the observed value at week 6 and the open marker the week-12

target. Kachare et al., Bickel et al., Qiu et al., Selçuk et al. and Kapilow et al. report no delay–flexion pair and are not plotted (Table 5). ORIF = open reduction and internal fixation; TBS = traditional bone-setter; TBW = tension band wiring.

Table 5. The present case compared with published studies of acute, geriatric and neglected patellar fractures (2021–2026), as reported in the source articles.

Author and year	Design and sample	Patients and delay	Fracture type	Fixation and soft-tissue protocol	Union and function	Complications and key point
Harna et al. (2021) ²¹	Case series (n = 10)	Age 32–58 years; 7–13 months (mean 9.3) after injury; all first treated by bone-setters	Neglected patellar non-unions (transverse, comminuted, inferior pole)	TBW (K-wires or cancellous screws), cerclage or Krackow suture; iliac crest graft in 2–3	Union in all at a mean of 5 months; ROM 10°–110° at 12 months	One stitch abscess; V-Y plasty not needed
Kapilow et al. (2021) ²	ACS-NSQIP registry review (n = 1,721)	Age > 65 years (mean 74.9); 79.2% women	Surgically treated patellar fractures	Not reported	30-day outcomes only	Unplanned reoperation 2.7%, readmission 3.4%, surgical site infection 1.1%
Li et al. (2023) ¹⁸	Retrospective series (n = 31)	Age ≥ 65 years (mean 73.7); surgery at mean 4.4 days	Displaced fractures, 87% comminuted	Modified cerclage wiring (three steel wires including figure-of-eight)	Healing at 2.9 months; flexion 130°; Böstman 28.6	No complications or non-union
Kachare et al. (2023) ¹⁷	Retrospective series (n = 38)	Mean age 45 years; road-traffic injuries	OTA 34-C fractures	Circumferential cerclage + figure-of-eight wire without K-wires	Union in all by 16 weeks (mean 2.9 months); flexion 124°; Böstman 28.5	One superficial infection, one broken wire
Bickel et al. (2024) ³⁶	Retrospective cohort (n = 63)	Mean age 52.8 years; surgery at about 3 days	AO type C patellar fractures	Locked plating (n = 23) vs cerclage compression wiring (n = 40)	1-year Lysholm 89.8 vs 90.6; union rate not reported	Implant complications 35% after wiring; reoperation 8.7% vs 27.5%
Selçuk et al. (2025) ¹¹	Retrospective cohort 2013–2022 (n = 32)	Mean age 50 years; 75% men; mostly high-energy	AO/OTA 34-C1 transverse	Classic TBW	Functional outcome not reported	Failure 28.1% (6 cerclage slippages, 3 breakages); single knot 66.7% vs double 19.2%
Patterson et al. (2025) ²²	Case series (n = 5)	Mean age 48 years; 2.2–15.0 months (mean 6.3) after injury	Chronic displaced transverse non-union without extensor function	Modified quadricepsplasty + 2.7-mm tension band plate + tibial autograft	Union in all within 3 months; mean active flexion 98°	No infection or implant problems
Qiu et al. (2026) ¹⁹	Retrospective study (n = 37)	Fractures older than 3 weeks excluded	Displaced patellar fractures by morphology	Cannulated-screw tension band + suture cerclage	Union in all; flexion arc not reported	Anterior discomfort in 2; no infection or loosening
Present case (2026)	Case report (n = 1)	66-year-old woman; 30 days (4 weeks) after traditional bone-setting	Neglected AO/OTA 34-C1 transverse fracture (10-mm gap, 3-mm step-off) + KL II OA + 25(OH)D 21.0 ng/mL	Single-stage fibrous curettage + 2 × 1.8-mm K-wires + 1.0-mm figure-of-eight TBW + 1.0-mm circumferential cerclage (no quadricepsplasty)	Gap and step-off 0 mm; active SLR restored POD 21; flexion 30° at week 4 and 45° at week 6; NRS 1/10; early callus at week 4	No complications; single-stage fixation at a four-week delay without quadriceps lengthening or bone grafting

ACS-NSQIP = American College of Surgeons National Surgical Quality Improvement Program; AO/OTA = Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association; K-wire = Kirschner wire; KL = Kellgren–Lawrence; NRS = Numerical Rating Scale; OA = osteoarthritis; POD = postoperative day; ROM = range of motion; SLR = straight-leg raise; TBW = tension band wiring.

4. Discussion

Bone fragility, bone-setter delay and the pathophysiological cascade

This case illustrates how postmenopausal bone fragility, intra-articular biology during prolonged bone-setter treatment and the mechanics of tension-band constructs interact^{1,5,21–23,26}. As summarized in the five-tier pathophysiological and surgical decision cascade in Figure 5, the course began (Tier I) with the patient's age (66 years), about 15 years of postmenopausal estrogen deficiency, vitamin D insufficiency (25(OH)D 21.0 ng/mL; 30% below the 30 ng/mL threshold), a BMI of 26.3 kg/m² and pre-existing ipsilateral KL grade II medial knee osteoarthritis. Rosillo et al.⁵ found lower areal bone density at the hip and deficits in trabecular density, trabecular number and bone stiffness on high-resolution peripheral quantitative computed tomography (HR-pQCT) and dual-energy X-ray absorptiometry (DXA) in women aged 65 years or older with patellar fracture compared with women without fracture, supporting the view that many patellar fractures in older women are fragility fractures^{5,41,42}. Estrogen withdrawal accelerates osteoclast-mediated perforation of the trabecular lattice in the anterior and polar cancellous bone of the patella, and vitamin D insufficiency impairs intestinal calcium absorption and osteoid mineralization, reducing the tensile and bending strength of the bone. Pre-existing KL grade II osteoarthritis may also increase patellofemoral friction and alter trochlear contact mechanics, concentrating three-point bending across the middle of the patella when the patient fell

forward onto her flexed knee while carrying a load (Tier IC of Figure 5).

After the fracture on day 0, 30 days of bone-setter care set off the cascade shown in Tier II of Figure 5. In rural districts of Indonesia, Sub-Saharan Africa and South Asia, traditional bone-setters remain part of community care-seeking because of cultural familiarity, flexible payment, fear of hospital surgery or amputation, and geographic proximity^{26–30}. Systematic reviews and clinical reports by Garikapati et al.²⁶, Endeshaw et al.²⁷, Touray et al.²⁸, Meirizal et al.²⁹, Adesina et al.³⁰ and Lingaiah et al.³¹ describe serious complications of manipulation without immobilization and of tight herbal bindings. Because the deep surface of the patella is intra-articular, the fracture cleft is bathed in synovial fluid containing uPA, plasminogen and matrix metalloproteinases, which can dissolve the fibrin-platelet clot that forms the provisional scaffold for bone (Tier IIB)^{21,22}. At the same time, unopposed quadriceps tone and daily manual massage subjected the gap to repeated tensile and shear strain (Tier IIC). According to Perren's strain theory, direct bone healing requires interfragmentary strain below about 2%, callus forms at about 2%–10%, and higher strain hinders bone formation and favors fibrous tissue^{24,25}; strain was not measured in this patient. Under these conditions, local mesenchymal progenitor cells formed fibrous tissue that filled the 10-mm gap, producing the dense, organized membrane found at surgery (T₁) and leaving the extensor mechanism uncoupled (extension lag 20°, no straight-leg raise; Tier III of Figure 5).

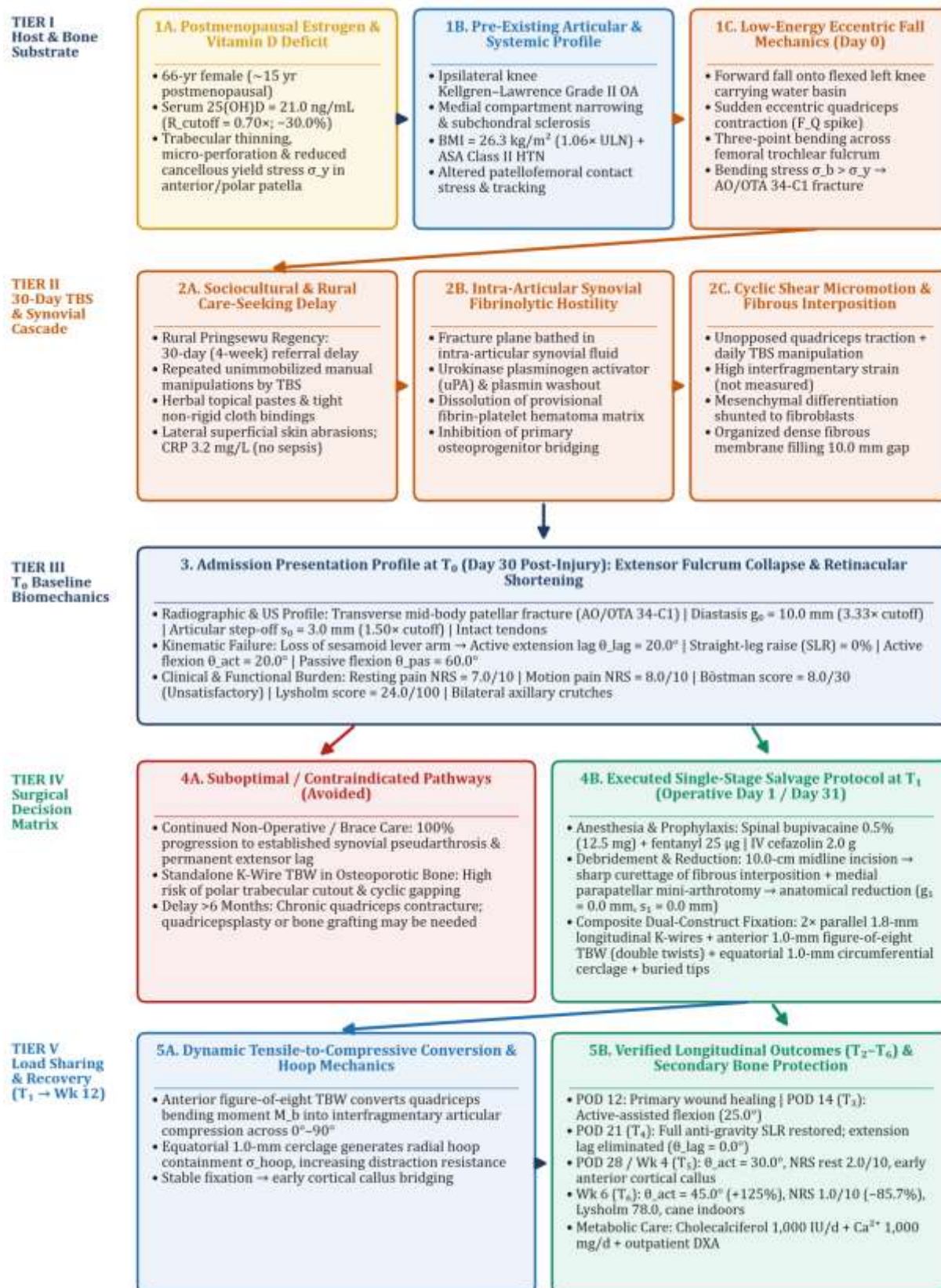


Figure 5. Five-tier pathophysiological and surgical decision cascade in the neglected patellar fracture. Tier I, host bone and joint (66-year-old woman about 15 years after menopause; 25(OH)D 21.0 ng/mL; KL grade II medial osteoarthritis; forward fall onto a flexed knee). Tier II, 30 days of traditional bone-setter manipulation, synovial fibrinolysis of the fracture hematoma and high interfragmentary strain leading to fibrous interposition. Tier III, findings at admission (T₀). Tier IV, treatment pathways avoided and the single-stage procedure performed. Tier V, tension-band conversion and circumferential containment, and recovery milestones to week 6 with bone-health measures. Mechanical quantities were not measured. ASA = American Society of Anesthesiologists; DXA = dual-energy X-ray absorptiometry; HTN = hypertension; KL = Kellgren–Lawrence; OA = osteoarthritis; SLR = straight-leg raise; TBS = traditional bone-setter; TBW = tension band wiring; US = ultrasonography.

Timing, reduction and choice of construct

In this patient, 30 days (about four weeks) after injury, the fracture was between the acute stage and an established non-union and could still be reduced without lengthening the extensor mechanism (Tier IV of Figure 5; Figure 4). In patellar non-unions treated months after injury—7–13 months in the series of Harna et al.²¹ and 2.2–15 months in that of Patterson et al.²²—the proximal fragment is retracted by several centimeters, and the quadriceps and peripatellar capsule become contracted^{21,22}. Prolonged retraction also leads to loss of serial sarcomeres, fatty infiltration and myostatic contracture of the quadriceps⁴³. In such late cases traction alone may not bring the fragments together, and surgeons have used V-Y or modified quadricepsplasty, fractional (pie-crusting) lengthening, preoperative skeletal traction or bone grafting^{21,22,32,33}, which may weaken active extension and prolong immobilization. By contrast, in our patient at four weeks, once the organized fibrous membrane had been excised to bleeding cancellous bone and the knee placed in full extension, the quadriceps–retinacular unit was compliant enough for tension-free anatomical apposition (gap and step-off 0 mm) with a pointed reduction clamp alone. This case suggests that patients referred three to five weeks after bone-setter manipulation may still be candidates for single-stage reduction and fixation after open removal of the fibrous tissue, rather than staged traction or extensor-lengthening procedures.

Anatomical reduction of a four-week neglected osteoporotic patella is useful only if the fixation can resist the higher distraction forces of a shortened extensor mechanism anchored in weak bone (Tier IV–V of Figure 5)^{11,17–19,36–38,44}. Garner et al.³⁷ found in cadavers (donor mean age 76 years) that cannulated screws with an anterior tension band failed earlier under cyclic loading than multiplanar mesh plating; Xiang et al.³⁸ found in a finite-element model that a tension band alone displaced more than a tension band with an added cerclage; Prasad et al.³⁵ reported loss of reduction in 20% of fractures fixed with cannulated-screw TBW and in none fixed with K-wire TBW; and Selçuk et al.¹¹ reported failure in 28.1% of transverse fractures fixed with TBW, mainly cerclage slippage or breakage. Loss of K-wire purchase in demineralized polar bone as the knee flexes beyond 30°–45° is a plausible mechanism of failure in osteoporotic patellae, but these studies did not test it directly. Anterior fixed-angle locking plates, multiplanar mesh plates^{36,37,44,45} and cannulated-screw tension-band constructs^{19,35,38} provide robust fixation, and a randomized trial comparing TBW with locking plates is under way⁴⁶. Augmentation with cerclage wires, sutures, anchors or plates has also been described for comminuted and inferior-pole fractures, including osteoporotic ones^{47–52}. However, fixed-angle patellar plates are often unavailable or unaffordable in rural secondary-level Indonesian hospitals under the reimbursement limits of the national health insurance scheme (Jaminan Kesehatan Nasional, JKN), and large (4.0-mm) cannulated screws may split a small osteoporotic patella with osteoarthritis or create stress risers. Two parallel 1.8-mm K-wires, an anterior 1.0-mm figure-of-eight wire and a 1.0-mm circumferential cerclage use widely available, inexpensive stainless-steel implants to reinforce the fixation¹⁸. The circumferential wire acted as a peripheral containment band that limited K-wire toggling and shared tensile load with the repaired medial and lateral retinacula, which allowed active-assisted flexion from POD 14 and a full straight-leg raise by POD 21 without radiographic loss of reduction. Suture-based alternatives to metallic cerclage and tension-band wires have given

comparable clinical results in transverse fractures, although stainless-steel wire is stronger^{53–55}.

Prevention of surgical site infection, symptomatic hardware and further fragility fractures is equally important in older patients^{12–14,56–58}. Qi et al.⁵⁶ identified higher BMI, a delay of more than 6 days from injury to surgery, diabetes, low hematocrit and low albumin as risk factors for surgical site infection after patellar fracture surgery in patients aged 60 years or older. In our patient, despite four weeks of non-sterile herbal applications and massage, a normal preoperative CRP (3.2 mg/L; 0.64 times the upper limit), cefazolin prophylaxis, careful full-thickness flap handling and an 85-minute operation were followed by primary wound healing by POD 12, without complication. Because hardware irritation and wire breakage are leading causes of reoperation after patellar fixation^{12–14,57,58}, particularly where deep knee flexion and kneeling are needed for daily prayer and floor sitting, as in Indonesia, we used symmetric double figure-of-eight twists and bent and buried all K-wire and wire ends in the polar tendons, avoiding subcutaneous knots^{10,14,57,58}. Finally, a patellar fracture in an older woman is a sentinel fragility fracture that signals a higher risk of later hip or vertebral fractures^{5,59,60}, and knee osteoarthritis may later progress to arthroplasty²³, in which osteoporosis increases the risk of intraoperative fracture⁶¹. We therefore combined fixation with treatment of the vitamin D insufficiency (cholecalciferol 1,000 IU/day and elemental calcium 1,000 mg/day), fall-prevention counseling and outpatient DXA referral, as a model of secondary fracture prevention in a resource-limited setting⁶².

Mechanics of tension-band conversion and circumferential containment

Fixation of a patellar fracture in a postmenopausal woman can also be considered in terms of the stresses acting across the patellofemoral joint during active flexion^{1,37,38}. As the knee flexes through an angle θ (about 15° in early stance and 60°–90° during stair descent or rising from a low seat), the patella is drawn into the femoral trochlear groove and loaded in three-point bending by the quadriceps tendon proximally (F_Q) and the patellar ligament distally (F_{PT}), balanced by the patellofemoral joint reaction force ($F_{PF} = 2 F_Q \cos[(180^\circ - \theta_{PF})/2]$)³⁸. In an unfixed or inadequately fixed AO/OTA 34-C1 fracture, this bending moment produces maximal tensile stress at the anterior aponeurotic cortex ($\sigma_t = M_{bc}/I$, where c is the distance from the neutral axis to the anterior cortex and I the area moment of inertia), so that the superior and inferior poles hinge open anteriorly and a wedge-shaped gap forms^{10,11,37}.

Pauwels' tension-band wiring counteracts this bending moment by placing an anterior figure-of-eight stainless-steel wire on the tensile surface of the patella, with two parallel longitudinal 1.8-mm K-wires acting as intraosseous axial neutralization pins^{1,10,11}. As the knee flexes and the anterior cortex tends to open, the figure-of-eight wire resists elongation in proportion to its axial stiffness (EA/L , where $E \approx 193$ GPa for 316L surgical stainless steel and $A = 0.785$ mm² for a 1.0-mm wire) and converts the eccentric quadriceps pull into compression across the deep retropatellar cartilage¹¹. The efficiency of a standalone figure-of-eight construct depends on how well the polar cancellous bone holds the K-wires¹⁶. In young, dense bone the polar trabecular struts resist the anterior-superior shear exerted at the K-wire entry points; in postmenopausal osteoporotic bone, as in this patient (about 15 years after menopause, with a 25(OH)D level of 21.0 ng/mL), loss of horizontal trabecular connectivity may lower the bearing capacity of the cancellous bone below the contact pressure of

the 1.8-mm K-wires, so that the wires cut through the polar bone and the fracture opens cyclically during flexion (Table 3)^{5,14}.

Adding a circumferential 1.0-mm cerclage around the periphery of the patella changes this stress distribution in two complementary ways^{18,19,55}. First, the tensioned circumferential wire applies a continuous radial compressive (hoop) force around the whole circumference of the patella, proportional to the wire tension, which compacts the osteoporotic cancellous bone around the K-wire shafts, increases their effective pullout and bending resistance and limits wire migration^{18,19}. Second, because the cerclage passes deep to the quadriceps and patellar tendon insertions at the bone-tendon junction, it acts as a second tension loop in a coronal plane behind the anterior figure-of-eight wire and shares the distraction load during active flexion²⁰. In a finite-element comparison, a tension band combined with cerclage displaced less than a tension band alone³⁸. In this patient no gap opened during passive flexion to 90° at surgery, and early bridging callus was present by week 4 (Table 2; Figure 1).

Synovial biology and the four-week window

This case also illustrates the course by which an untreated intra-articular patellar fracture can progress from an acute hemorrhagic cleft to organized fibrous interposition and, later, to an established synovial pseudarthrosis²¹. Unlike diaphyseal fractures of the femur or tibia, in which an intact muscle envelope and vascular periosteum contain the fracture hematoma and endochondral ossification begins quickly, the posterior two-thirds of the patella is covered by avascular hyaline cartilage and communicates directly with the suprapatellar pouch and the tibiofemoral joint^{1,9,21}. After an AO/OTA 34-C1 fracture, synovial fluid continuously bathes the trabecular fracture surfaces, exposing them to urokinase-type and tissue-type plasminogen activators (uPA, tPA), plasmin and matrix metalloproteinases (MMP-1, MMP-3 and MMP-13)^{21,22}. These proteolytic cascades degrade the provisional fibrin-fibronectin clot between the fragments and may wash osteoinductive platelet-derived growth factor (PDGF), transforming growth factor- β 1 (TGF- β 1) and bone morphogenetic proteins (BMP-2 and BMP-7) into the joint (Tier IIB of Figure 5)^{21,22}.

When this synovial washout is combined with 30 days of bone-setter manipulation—repeated manual knee bending, vigorous friction massage and no rigid extension splint—the strain across the 10-mm gap is likely to remain high (Tier IIC of Figure 5)^{25,30}; it was not measured. In mechanobiological models, high tensile and shear strain combined with low hydrostatic pressure suppresses the osteogenic transcription factors Runx2 and Osterix in local mesenchymal cells and favors fibrous tissue rich in type I and III collagen²⁵, consistent with the dense, rubbery fibrous membrane excised at T₁. At surgery on day 31, the polar cancellous bone showed no eburnation or sclerotic capping of the medullary spaces, and the proximal fragment could be reduced, suggesting that irreversible quadriceps contracture had not yet developed.

Skeletal muscle and parapatellar retinacular collagen held in a shortened position adapt in two phases. During the first 3 to 5 weeks, loss of length is mediated mainly by reversible series-elastic compliance, dehydration of the hyaluronic acid ground substance and early cross-linking of immature type III collagen; beyond 6 to 12 weeks, muscle fibers lose serial sarcomeres and the endomysial and perimysial type I collagen remodels into a fixed myostatic contracture^{21,22,55}. Such a contracture cannot be stretched acutely without tearing the myotendinous junction or fracturing the osteoporotic superior pole, which is why

Patterson et al.²² used a modified quadricepsplasty in non-unions treated 2.2–15 months after injury (V-Y plasty was not needed in the series of Harna et al.²¹; Table 5 and Figure 4). At four weeks in our patient, curettage of the fibrous membrane to bleeding bone, hip flexion and sustained clamp traction overcame the reversible shortening of the quadriceps-retinacular unit and allowed anatomical reduction without compromising the extensor muscle-tendon unit.

Osteoarthritis, rehabilitation and fracture liaison care

Pre-existing ipsilateral KL grade II osteoarthritis in this 66-year-old patient added a biomechanical and rehabilitation challenge and required careful calibration of postoperative mobilization²³. In a knee with KL grade II medial tibiofemoral and patellofemoral degeneration (cartilage fibrillation, mild joint-space narrowing, subchondral sclerosis and marginal osteophytes), cast immobilization beyond 2–3 weeks can accelerate proteoglycan loss in the remaining cartilage and promote dense adhesions in the suprapatellar pouch and the medial and lateral gutters^{40,63}. Conversely, aggressive deep flexion (> 60°–90°) during the first 14 postoperative days exposes the newly curetted osteoporotic fracture interface to high shear before bony bridging has begun^{11,18,54}.

The three-phase rehabilitation program—Phase I, protected extension immobilization with daily isometric quadriceps co-contractions and ankle pumps (POD 1–14); Phase II, physiotherapist-supervised active-assisted flexion within a 0°–30° arc with progressive weight-bearing on crutches (POD 14–28); and Phase III, outpatient progression of active flexion toward 45° at week 6, 60° at week 8 and 100° at week 12—was designed to balance healing of the osteoporotic fracture against preservation of the osteoarthritic joint (Table 2; Figure 2)^{19,39}. Isometric quadriceps contractions with the knee in full extension load the fracture in axial compression along the K-wires and limit atrophy of the vastus medialis obliquus without bending the middle of the patella^{1,10,54}. With this program the patient regained a full straight-leg raise and lost the 20° extension lag by POD 21 (–100%; –0.95° per day), had early anterior cortical callus and 30° of pain-free flexion at week-4 discharge (T₅), and tripled her rate of flexion gain to 1.07° per day between weeks 4 and 6, reaching 45° of active flexion, resting pain of 1/10, a Böstman score of 25/30 and a Lysholm score of 78/100 at T₆ (Table 2; Figure 3a).

At the health-system level, this case supports linking rural musculoskeletal trauma outreach with secondary fracture liaison services in Indonesia and comparable LMICs^{5,26–31}. Studies from LMICs show that patients consult traditional bone-setters because of social acceptance and peer pressure, lower cost, proximity, trust, reluctance toward surgical implants and fear of amputation in hospital^{26–28,64,65}; whether unfamiliarity with coverage under Indonesia's JKN contributes has not been studied. Collaborative, non-punitive referral links between district hospitals and community leaders—teaching traditional practitioners to recognize warning signs of intra-articular injury, such as inability to perform a straight-leg raise or a palpable patellar gap, and to refer such patients promptly for radiography—may reduce the number of neglected fractures^{26–28}. Because a low-energy patellar fracture in a postmenopausal woman with low vitamin D (25(OH)D 21.0 ng/mL) is a sentinel sign of skeletal fragility^{2,5}, starting cholecalciferol (1,000 IU/day) and elemental calcium (1,000 mg/day) with outpatient DXA screening and fall-hazard modification is recommended to reduce the risk of later hip or vertebral fragility fractures (Tier V of Figure 5)⁶².

Limitations

This report has limitations. It describes a single patient, so the outcome cannot be generalized to other patients or delays. Follow-up ended at six weeks: union and the final range of motion were not yet established, and the week-12 values are targets rather than outcomes; radiographic consolidation and return to previous activities after patellar fixation usually take several months^{66,67}. The day-0 values were obtained retrospectively, the radiographs are not shown, osteoporosis was not confirmed by DXA, and the mechanical behavior of the construct was not measured, so the comparison of fixation configurations relies on published studies.

5. Conclusion

This case shows that a displaced transverse patellar fracture (AO/OTA 34-C1) neglected for one month after unsuccessful traditional bone-setter manipulation, in a postmenopausal woman with vitamin D insufficiency, could be treated in a single stage with open curettage of the fibrous tissue and parallel K-wire TBW with an additional circumferential cerclage. At 30 days after injury, removal of the organized fibrous membrane exposed bleeding cancellous surfaces and allowed tension-free anatomical reduction (gap and step-off 0 mm; -100%) without V-Y quadricepsplasty or autologous bone grafting. Adding a 1.0-mm circumferential cerclage to the parallel 1.8-mm K-wires and the anterior 1.0-mm figure-of-eight wire combined circumferential (hoop) compression with the tension-band effect, and the reduction was maintained throughout phased rehabilitation. The extension lag of 20° resolved and a full straight-leg raise returned by POD 21, early anterior cortical callus was seen at week 4, and by week 6 active flexion had increased by 125% to 45°, resting pain had fallen by 85.7% to 1/10, and the Lysholm score had increased by 225% to 78/100, without surgical or drug-related complications. Combining low-cost reinforced fixation with vitamin D and calcium treatment and community referral education may be a practical option for fractures delayed by bone-setter treatment in secondary-care hospitals in developing regions; longer follow-up and more cases are needed.

6. Declarations

Ethics Approval and Consent to Participate

Ethical approval for this case report was granted by the Ethics Committee CMHC Research Center Indonesia (protocol No. 2026/0421), in accordance with the institutional policy of Pringsewu Regional General Hospital and the Declaration of Helsinki (2013 revision). Written informed consent was obtained from the patient and her family guardian before surgery and before inclusion in this report.

Consent for Publication

Written informed consent for anonymized publication of all clinical data, laboratory values, radiographic findings and schematic figures was obtained directly from the patient. All figures comply with the ICMJE recommendations on patient privacy and anonymization.

Availability of Data and Materials

All clinical, goniometric, laboratory and radiographic data generated and analyzed for this report are included in the article (Tables 1–5 and Figures 1–5).

Artificial Intelligence Use Statement

None.

Author Contribution Statement

R.A.W.: Conceptualization, Investigation (clinical and goniometric data collection), Formal analysis, Visualization, Writing – original draft. R.A.: Investigation (surgery), Validation (radiographic assessment), Supervision, Writing – review & editing. Both authors read and approved the final manuscript.

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None.

Conflict of Interest / Competing Interests

The authors declare that they have no competing interests.

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