

Unit 1: Fundamentals of Injury Mechanisms

PAPER 8 — Injury Prevention

Unit 1: Fundamentals of Injury Mechanisms

(Causes of MSK injuries • Movement biomechanics • Risk factors in martial & therapeutic contexts • Acute vs. chronic • Warm-up & cooldown)

1) Understanding common causes of musculoskeletal injuries

Most injuries happen when **tissue demand exceeds tissue capacity**. Capacity is built by genetics, nutrition, sleep, prior training, and recovery; demand spikes with harder/longer/faster work or poor technique. In practice, five patterns account for most problems:

- Load spikes: abrupt jumps in training volume or intensity (new stance drills, extra weapon practice, longer treatments without conditioning) outpace tendon/ligament adaptation.
- **Technique faults**: valgus knees in deep lunges, spinal hinging instead of hip hinging, punching with a rotated wrist, or therapists pressing vertically from the thumb instead of stacking joints.
- Under-recovery: poor sleep, low iron/protein, dehydration, or stress reduce collagen turnover and motor control.
- Environment & equipment: hard/slippery floors, cold rooms (stiff tissues), worn footwear, cluttered spaces.
- **Medical/constitutional factors**: hypermobility, prior injury, metabolic conditions—these don't doom you, but they raise the bar for preparation and monitoring.

Think of injury risk as a **stack**: when several modest risks coincide (cold room + heavy session + new drill + little sleep), the same movement that was fine yesterday can injure today.

2) Biomechanics of movement and postural stress

Levers and lines of force explain why some positions hurt more than others. The farther a load is from a joint, the higher the torque. Deep stances increase knee and hip moments; overhead motions elevate shoulder demand; spinal load rises when the trunk leans while the core is lax.

Key ideas for safe mechanics:

- Neutral zones, then excursion: establish rib-cage-pelvis alignment before reaching into extremes.
- **Hip hinge** > **spinal hinge**: fold at hips with a long spine for lifting, striking from the ground, or leaning during bodywork.
- Knee tracking: knees align over 2nd-3rd toe; avoid collapsing inward under fatigue.
- Scapular mechanics: upward rotation + posterior tilt create space for overhead strikes and staff work.
- Ankle dorsiflexion: limited dorsiflexion pushes stress to the knee and low back; mobilize ankles to save knees.
- **Breath & pressure**: diaphragmatic breathing and gentle abdominal brace create intra-abdominal pressure that shares spinal load ("can inside the torso").
- **Eccentric control**: most strains occur when decelerating (landing, catching, lowering). Train slow, controlled eccentrics.

Postural stress is $time \times load$. Ten minutes of sub-optimal posture is tolerable; hours become tendinopathy. Micro-breaks reset the clock.

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3) Risk factors in traditional martial and therapeutic practices

Kalaripayattu practice

- Low, long stances (vadivu): knee valgus, ankle collapse, and hip adduction under fatigue → patellofemoral and adductor strains.
- High kicks & spins: hamstring/adductor strains, lumbar rotation stress if core/hip timing is late.
- Weapons forms: shoulder impingement if scapulae don't upwardly rotate; wrist tendons if grip is too rigid.
- Barefoot on hard floors: plantar fascia and Achilles overload without progressive conditioning.

Kalari Uzhichil (therapeutic) practice

- **Therapist overuse**: thumbs/wrists pressed vertically, long reaches across the table, static trunk flexion → CMC arthritis, lateral epicondylitis, low-back fatigue.
- Heat hazards: steaming or bolus too hot; stacked heat over chest/abdomen; slippery floors from oils.
- Marma zones: excessive depth/pressure over heart, umbilicus, pelvic and carotid areas.
- **Clinic factors**: poor table height, cold room (stiff clients, strained therapist), inadequate towel management (slip risk).

Mitigation is simple: **progressive loading**, **mechanics coaching**, **ergonomics** (stacked joints, neutral wrists, table at mid-thigh to wrist-crease height), and **temperature control**.

4) Difference between acute and chronic injuries

Acute injuries are sudden (sprain, strain, contusion). They feature sharp pain, swelling, warmth, and functional loss. Early care: protect, relative rest, compression, elevation, gentle pain-free motion, and medical review for severe loss of function or deformity.

Chronic/overuse injuries develop slowly (tendinopathy, bursitis, stress reaction). Pain is dull/aching, worse with repeated load, better with warm-up, and may flare after activity. Management blends **load reduction**, **technique correction**, **graded strength (especially eccentrics)**, mobility where limited, and **sleep/nutrition** improvements.

Healing timelines vary: muscle (2-4 weeks), tendon (6-12+), ligament (8-12+), bone stress (6-8+). Pain can calm before tissue is strong—**progress gradually even when pain is gone**.

5) Role of warm-up and cooldown in prevention

A smart warm-up raises temperature, switches on the right muscles, rehearses ranges, and "primes" the nervous system.

Warm-up (10-15 min; RAMP model):

- Raise: light skipping/shadow moves to elevate temperature and heart rate.
- Activate: core, glutes, mid-back (dead bug, glute bridge, scap push-ups).
- Mobilize: dynamic ankle, hip, thoracic flows; knee tracking drills.
- Potentiate: 2-3 short, crisp technique reps at session intensity (not fatigue).

Cooldown (5-10 min):

• Gentle locomotion to clear metabolites; **nasal breathing** (4-in/6-out) to shift to parasympathetic; **positional mobility** (calf, hip flexor, pec door stretch); skin temperature back to baseline before leaving.

Therapists also warm up: 3-5 minutes of wrist/elbow circles, scap sets, hip hinge drills, and two slow diaphragmatic breaths before first client; micro-breaks between clients.

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Summary Tables

A) Common injury causes & how to mitigate

| Cause | Examples | Mitigation |
|------------------|--|---|
| Load spikes | Doubling stance reps, extra weapon class, longer treatment day | 10-20% weekly progression; deload weeks |
| Technique faults | Knee valgus, spinal hinge, rigid wrist | Coaching, mirrors/video, cue "knees track 2nd toe," "hinge at hips," neutral wrist |
| Under-recovery | <6-7 h sleep, low protein/iron, dehydration, stress | Sleep routine, 1.6-2.2 g/kg protein (athletes), fluids/electrolytes, stress hygiene |
| Environment | Hard/cold floors, clutter, poor lighting | Mats or floor prep, room at comfortable warmth, clear pathway |
| Prior injury | Old ankle sprain, shoulder impingement | Targeted strength/balance, ankle/shoulder prep in warm-up |

B) Movement faults → quick corrections

| Fault | Why it loads tissue | Fix (one cue) |
|----------------------------------|---------------------------------|---|
| Knees collapse inward in lunge | Increases patellofemoral stress | "Press knee out to 2nd-3rd toe" |
| Rounded low back when lifting | Shear on discs/ligaments | "Chest long, hinge from hips" |
| Overhead arm without scap motion | Rotator cuff pinch | "Reach then rotate—elbow to ceiling, shoulder blade up" |
| Short ankle dorsiflexion | Compensatory knee/hip load | "Knee to wall" ankle drills pre-session |
| Breath holding | Loses trunk pressure & control | "Exhale through effort, keep ribs soft" |

C) Risk in martial & therapeutic practice

| Context | Specific risk | Prevention |
|------------------------|--|---|
| Low stances | Knee valgus, adductor strain | Ankle/hip mobility; glute activation; limit depth under fatigue |
| High kicks/spins | Hamstring/lumbar strain | Eccentric hamstring work; core timing; gradual height |
| Weapons forms | Shoulder impingement; wrist tendinopathy | Scap upward rotation drills; neutral wrist grip |
| Therapist thumbs/wrist | s CMC pain, lateral elbow pain | Stack joints, use forearm/palm, adjust table height |
| Heat modalities | Burns, syncope | Temp checks, rotate boluses, no heat on high-risk marmas |
| Slippery floors | Falls | Towel discipline, footwear policy, spill SOP |

D) Acute vs. chronic snapshot

| Feature | Acute | Chronic/Overuse |
|--------------|---|--|
| Onset | Sudden | Gradual |
| Pain | Sharp → ache | Dull, morning stiffness, warms up |
| Signs | Swelling, redness, loss of function | Thickened tendon, crepitus |
| First steps | Protect, relative rest, compression, elevation, medical check if severe | Reduce/modify load, technique fix, eccentric strength, sleep/nutrition |
| Refer now if | Deformity, "giving way," night pain, neuro signs, fever | Persistent worsening >2-3 weeks despite load modification |

E) Warm-up & cooldown checklists

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| Phase | Do | Duration |
|-----------------|---|----------|
| Warm-up — Raise | Light cardio/shadow moves | 2-3 min |
| Activate | Core/glute/scap sets | 3-4 min |
| Mobilize | Ankles/hips/T-spine dynamic flows | 3-5 min |
| Potentiate | 2-3 crisp reps of key skills | 1-3 min |
| Cooldown | Walk/breathe 4-in/6-out, gentle stretches | 5-10 min |

Key take-aways

- 1. Injuries are **capacity-demand mismatches**; adjust one or both.
- 2. Good mechanics = hinge at hips, align knees, breathe and brace, control eccentrics
- 3. In Kalari and Kalari Uzhichil, reduce risk with **progression, ergonomics, temperature control, and marma safety**.
- 4. Distinguish **acute vs. chronic**—each needs a different first step.
- 5. A short, structured **warm-up and cooldown** is the cheapest insurance you can buy.

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