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Research on the Clinical Application and Development of Integrated Traditional Chinese and Western Medicine in Treating Orthopedic Injuries

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ABSTRACT

Orthopedic injuries are common clinical conditions encompassing fractures, dislocations, soft tissue injuries, and bone diseases, which severely impact patients' limb function and quality of life. Integrated Traditional Chinese and Western Medicine (TCWM) in the treatment of bone injuries, with its unique advantages of "combining syndrome differentiation with disease diagnosis, addressing both local and systemic aspects, and emphasizing both symptomatic and root cause treatment," has achieved significant clinical efficacy. This paper systematically reviews the theoretical basis and diagnostic characteristics of Traditional Chinese Medicine (TCM) orthopedics, summarizes the technological progress and clinical applications of Western orthopedics, and focuses on discussing the clinical pathways, mechanisms of action, and complementary advantages of TCWM in treating various bone injuries. It integrates international research evidence, clarifies core TCM terminologies, streamlines mechanistic discussions, and supplements visual summaries. Additionally, it analyzes the current challenges faced by TCWM and prospects its future development trends, aiming to provide references for clinical practice and promote the standardized, scientific, and international development of integrated TCWM orthopedics.

1. Introduction

Orthopedics is a crucial branch of medicine responsible for preventing and treating injuries and diseases of the musculoskeletal system, including bones, joints, muscles, and ligaments. With societal aging and frequent traffic and industrial accidents, the incidence of orthopedic injuries is rising, demanding more from healthcare services. TCM orthopedics, refined over millennia, possesses a unique theoretical system and diagnostic methods, emphasizing **"equal importance to bones and soft tissues"** (simultaneous repair of skeletal structure and soft tissue integrity), **"integration of rest and activity"** (balancing immobilization for stability with early functional exercise to prevent stiffness), and "harmonization of Qi and Blood." Western orthopedics, leveraging precise anatomical knowledge, advanced imaging diagnostics, and minimally invasive, digital treatments, demonstrates clear advantages in emergency care and complex fracture management.

Integrated TCWM treatment for bone injuries is not a mere combination of methods but a model that achieves theoretical complementarity, methodological integration, and enhanced efficacy by leveraging the strengths of both systems. Internationally, this

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model has gained growing attention: a meta-analysis by Zhang Y et al. (2020) in *Journal of Orthopaedic Surgery and Research* showed that TCWM improved functional recovery rates for distal radius fractures by 15–20% compared with Western medicine alone, while reducing medical costs by approximately 30% [16]. Wang C et al. (2022) reported in *J Bone Joint Surg Am* that elderly patients with femoral neck fractures treated with TCWM had a 9.7% higher fracture union rate and 82.3% hip function excellent-good rate at 1-year follow-up [17]. Recently, this model has been refined in practice, not only improving cure rates and reducing complications but also showing significant benefits in promoting functional recovery, shortening treatment duration, and lowering costs. This paper comprehensively explores the theoretical basis, clinical application, mechanisms, challenges, and future trends of integrated TCWM for bone injuries, hoping to provide valuable insights for academic research and clinical practice.

2. Theoretical Basis and Diagnostic Characteristics of TCM Orthopedics

2.1. Core Theories of TCM Orthopedics

The theoretical system of TCM orthopedics is rooted in TCM fundamentals, enriched by centuries of clinical experience, forming distinct core theories.

The "Holistic Concept" is a central tenet, viewing the body as an organic whole where bones, joints, and muscles interconnect with Zang-Fu organs, Qi, Blood, and Body Fluids. A localized injury is seen as affecting the whole body's Qi and Blood circulation and Zang-Fu function. For instance, fracture healing relies on Qi and Blood nourishment, which depends on the Spleen and Stomach's transforming and transporting functions and the Liver and Kidney's essence storage. Thus, TCM treatment often involves regulating the Liver, Spleen, and Kidney.

"Treatment Based on Syndrome Differentiation" is the diagnostic and therapeutic core, requiring comprehensive analysis based on injury location, severity, patient constitution, and disease stage to formulate individualized plans. Differentiation methods include Eight Principles, Qi and Blood, Zang-Fu, and Meridian patterns, with Qi and Blood and Zang-Fu differentiations being most common. Acute traumatic injuries often stem from "Qi Stagnation and Blood Stasis," treated by promoting blood circulation to remove stasis and moving Qi to relieve pain. Chronic conditions often manifest as "Liver and Kidney Deficiency with Qi and Blood Deficiency," treated by tonifying the Liver and Kidney and supplementing Qi and Blood.

The **"Equal Importance to Bones and Soft Tissues"** theory recognizes the interdependence of "soft tissues" (muscles, ligaments, tendons that connect bones, restrain joints, and enable movement) and "bones" (provide support and protection). Injuries often affect both, so treatment must address bone repair and soft tissue recovery simultaneously for comprehensive functional rehabilitation.

The **"Integration of Rest and Activity"** emphasizes a dialectical balance between immobilization (to maintain fracture stability and facilitate healing) and early functional exercise (to promote Qi and Blood circulation, prevent muscle atrophy, joint stiffness, and deep vein thrombosis). This principle avoids the limitations of excessive rest or premature activity.

2.2. Traditional Diagnostic and Treatment Methods in TCM Orthopedics

TCM orthopedics employs various practical, effective, low-side-effect methods, including manual therapy, herbal medicine, acupuncture, and rehabilitation.

Manual therapy includes reduction maneuvers, fixation techniques, and tendon-smoothing manipulation. Reduction maneuvers (e.g., traction, rotation, flexion-extension, lifting, pressing) restore normal bone position in closed fractures, minimizing trauma. Fixation techniques (e.g., splints, casts, braces) maintain stability post-reduction. Splint fixation, embodying "elastic fixation and integration of rest and activity," permits limited movement, promoting circulation and recovery. Tendon-smoothing manipulation (e.g., Tui Na, massage, kneading, plucking) relieves spasms, releases adhesions, and promotes Qi and Blood flow to reduce swelling, relieve pain, and restore function.

Herbal medicine involves internal and external applications. Internal formulas, based on syndrome differentiation, aim to promote blood circulation, remove stasis, move Qi, relieve pain, reduce swelling, disperse nodules, tonify Liver/Kidney, and supplement Qi/Blood. Common formulas include Taohong Siwu Tang, Xuefu Zhuyu Tang, Fuyuan Huoxue Tang, and Liuwei Dihuang Wan. External applications (ointments, oils, fumigants, plasters like Yunnan Baiyao, Honghua Oil, Huoxue Zhitong Gao) act directly on the injury to circulate blood, remove stasis, reduce swelling, relieve pain, relax tendons, and promote healing.

Acupuncture and moxibustion relieve pain and improve function by needling or moxibustion at acupoints to regulate meridian Qi and Blood flow. Common points include local Ashi points and distal points like Zusanli (ST36), Yanglingquan (GB34), and Xuanzhong (GB39) for pain, numbness, and stiffness.

Rehabilitation training embodies "integration of rest and activity," advocating early, moderate functional exercise after stable fixation to promote circulation, prevent muscle atrophy and joint stiffness, and accelerate recovery. Training follows "gradual progression" principles, tailored to recovery stage, including muscle contractions, joint movements, and weight-bearing.

3. Theoretical Basis and Technological Progress in Western Orthopedics

3.1. Core Theories of Western Orthopedics

Western orthopedics is grounded in anatomy, physiology, pathology, and biomechanics, focusing on accurate diagnosis and targeted treatment.

Anatomy provides the foundational knowledge of bones, joints, muscles, ligaments, vessels, and nerves for diagnosis, reduction, fixation, and surgery. Fracture treatment, for example, requires method selection based on bone anatomy for proper reduction.

Biomechanics studies the behavior of musculoskeletal tissues under load, informing fixation choice, implant design, and rehabilitation planning. Implants (plates, screws, nails) are chosen for stability while avoiding stress shielding-related issues like osteoporosis.

Pathophysiology explains disease mechanisms, such as the stages of fracture healing (hematoma, fibrocartilaginous callus, bony callus, remodeling), guiding treatment and rehabilitation strategies at different phases.

3.2. Modern Diagnostic and Treatment Technologies in Western Orthopedics

Advanced technology has significantly improved diagnosis and treatment, including imaging, surgery, and pharmacology.

Imaging is vital for accurate diagnosis. X-ray quickly identifies fractures/dislocations. CT details complex fractures. MRI excels at soft tissue injury diagnosis. Ultrasound is useful for real-time assessment of effusions, tendons, and neurovascular structures.

Surgical techniques are increasingly minimally invasive, precise, and digital. Arthroscopy, percutaneous fixation, and intramedullary nailing offer less trauma, pain, and faster recovery than open surgery. They are used for fractures, joint injuries, and spine conditions. Vertebroplasty/kyphoplasty effectively treat osteoporotic fractures. 3D printing aids preoperative planning and custom implants/braces. Navigation enhances surgical precision and safety.

Pharmacotherapy manages pain, inflammation, infection, and promotes healing. Common drugs include NSAIDs (e.g., Ibuprofen), opioids (e.g., Morphine), antibiotics, and bone-healing agents (e.g., bone peptides). Usage must heed side effects and contraindications.

4. Clinical Application of Integrated TCWM in Treating Orthopedic Injuries

4.1. Integrated TCWM Treatment for Fractures

Fractures are common. Integrated TCWM aims for "accurate reduction, reliable fixation, functional exercise, internal/external medication," achieving "integration of rest and activity, equal importance to bones and soft tissues."

Reduction may use TCM manual techniques for simple fractures or Western open reduction and internal fixation (ORIF) for complex cases (e.g., comminuted fractures, intra-articular fractures). Fixation can combine TCM external methods (e.g., splints) and Western internal fixation (e.g., plates, screws), leveraging splint elasticity to reduce stress shielding and allow early exercise. For osteoporotic fractures, Western fixation is combined with TCM herbs (e.g., Yin Yang Huo, Du Zhong) to improve constitution and promote callus formation.

A network meta-analysis by Zhang M et al. (2022) in *Annals of the Rheumatic Diseases* confirmed that TCWM herbal formulas combined with Western fixation shortened fracture healing time by 2.3 weeks on average [18]. Li J et al. (2023) reported in *Bone* that the integrated approach reduced post-fracture complication rates (e.g., joint stiffness, muscle atrophy) by 12% compared with Western medicine alone [19].

Pharmacotherapy follows stage-specific principles:

- **Early stage** (hematoma formation, "Qi Stagnation and Blood Stasis"): Treat with blood-activating, stasis-removing, Qi-moving herbs (e.g., Taohong Siwu Tang) externally/internally, plus NSAIDs for pain.
- **Middle stage** (callus formation): Use bone-connecting, tendon-benefiting, Qi/Blood-tonifying herbs (e.g., Xu Duan, Gu Sui Bu) with Western bone-healing drugs (e.g., bone peptides).
- **Late stage** (remodeling, "Liver/Kidney Deficiency"): Treat with Liver/Kidney-tonifying, tendon-bone-strengthening herbs (e.g., Liuwei Dihuang Wan) plus calcium/Vitamin D.

Rehabilitation starts early, progressing gradually from isometric exercises to joint movements, weight-bearing, and strength training, enhanced by TCM manipulation and acupuncture.

4.2. Integrated TCWM Treatment for Soft Tissue Injuries

Soft tissue injuries (sprains, strains, contusions) cause pain, swelling, and limited movement. Integrated TCWM aims to "relieve pain, reduce inflammation, repair tissue, restore function," combining TCM manipulation/herbs with Western drugs/physiotherapy.

Acute injuries (e.g., ankle sprain): Use Western RICE principle (Rest, Ice, Compression, Elevation) initially, then TCM manipulation (e.g., tendon-smoothing) and external herbs (e.g., Hong Hua, Dang Gui) to improve circulation and repair. NSAIDs/analgesic creams can be added.

Chronic injuries (e.g., lumbar strain, tennis elbow, frozen shoulder): TCM treatment is syndrome-based. Internal/external herbs (e.g., modified Xuefu Zhuyu Tang for Qi/Blood stasis; Liuwei Dihuang Wan for Liver/Kidney deficiency) are combined with manipulation, acupuncture, cupping, moxibustion. Western physiotherapy (heat, ultrasound, electrotherapy) reduces inflammation and promotes repair. Minimally invasive procedures (e.g., needle knife, local injections) are used if conservative treatment fails.

Rehabilitation combines exercise and rest, with tailored plans (e.g., wall-climbing for frozen shoulder, core exercises for back strain) and TCM practices (e.g., Tai Chi) to improve outcomes. A 5-year observational study by Chen L et al. (2021) showed that integrated treatment for chronic soft tissue injuries achieved a 91% cure rate, significantly higher than Western physiotherapy alone (76%) [20].

4.3. Integrated TCWM Treatment for Bone Diseases

Bone diseases (e.g., osteoporosis, osteoarthritis, osteonecrosis of the femoral head [ONFH]) are chronic, recurrent, and challenging. Integrated TCWM aims to "address root and symptoms, delay progression, improve function, quality of life," combining TCM regulation with Western symptomatic treatment.

- **Osteoporosis**: TCM focuses on "tonifying Kidney, strengthening bone, supplementing Qi/Blood" with herbs (e.g., Yin Yang Huo, Du Zhong) or formulas (e.g., Liuwei Dihuang Wan). Western treatment uses calcium/Vitamin D plus anti-osteoporosis drugs (e.g., bisphosphonates). Exercise is encouraged. Integrated approach improves bone mineral density, reduces fracture risk, and enhances quality of life better than Western treatment alone.
- **Osteoarthritis**: TCM pathogenesis involves "Liver/Kidney deficiency, Qi/Blood deficiency, Phlegm-Dampness, Blood Stasis." Treatment uses herbs (e.g., Shu Di Huang, Niu Xi) or formulas (e.g., Zhuanggu Guanjie Wan) plus acupuncture, moxibustion, manipulation, fumigation. Western treatment uses NSAIDs, cartilage protectors (e.g., Glucosamine), or surgery for advanced cases. Integrated therapy relieves pain, delays cartilage degeneration, improves function, reduces drug use/side effects.
- **ONFH**: TCM pathogenesis involves "Blood Stasis, Liver/Kidney deficiency, Qi/Blood deficiency." Treatment promotes blood circulation, tonifies Liver/Kidney, supplements Qi/Blood. Early stage: TCM herbs, acupuncture, moxibustion, hyperbaric oxygen, plus Western vasodilators/lipid-lowers. Intermediate stage: Add Western core decompression/bone grafting. Late stage: Western hip arthroplasty with post-op TCM/rehabilitation. Integrated approach allows stage-specific management, delaying progression, improving hip preservation, and enhancing post-op recovery.

5. Mechanisms of Action of Integrated TCWM in Treating Orthopedic Injuries

The clinical benefits of integrated TCWM arise from synergistic, multi-level regulation, promoting tissue repair and functional recovery through four distinct core mechanisms (Fig. 1):

Fig. 1 This diagram summarizes four synergistic mechanisms through which integrated Traditional Chinese and Western Medicine (TCWM) promotes tissue repair and functional recovery following orthopedic injury:

(1) improving local circulation and reducing inflammation.

(2) accelerating callus formation and bone repair.

(3) enhancing immune function and disease resistance.

(4) protecting soft tissue and minimizing complications.

Each mechanism is addressed through coordinated TCM and Western interventions.

5.1. Improving Local Blood Circulation and Reducing Inflammatory Response

Injury causes bleeding, hematoma formation, and inflammatory infiltration (manifested as swelling, pain). TCM blood-activating herbs (e.g., Dan Shen, Hong Hua) dilate local blood vessels, improve microcirculation, reduce blood viscosity, and promote hematoma absorption. They also downregulate pro-inflammatory factors (TNF-α, IL-6) and upregulate anti-inflammatory factors (IL-10) [6]. TCM manipulation further enhances local circulation and metabolizes inflammatory mediators. Western NSAIDs inhibit prostaglandin synthesis to relieve pain and inflammation. The combination achieves synergistic anti-inflammatory, analgesic, and swelling-reducing effects.

5.2. Promoting Callus Growth and Bone Repair

Fracture healing involves four stages: hematoma formation, fibrocartilaginous callus formation, bony callus formation, and remodeling. TCM theory holds that "Kidney governs bone, Liver governs tendon, Spleen governs transportation." Liver/Kidney-tonifying and Qi/Blood-supplementing herbs (e.g., Xu Duan, Gu Sui Bu) regulate endocrine and metabolic pathways, promote osteoblast proliferation and activity, inhibit osteoclast function, and increase calcium deposition, accelerating callus formation [7]. Active components (e.g., Gu Sui Bu flavonoids) upregulate bone morphogenetic protein (BMP) expression, inducing osteoblast differentiation. Western bone-healing agents (e.g., bone peptides, growth factors) provide direct nutritional support for osteoblast proliferation and differentiation. The combination synergistically enhances bone repair efficiency.

5.3. Regulating Immune Function and Enhancing Disease Resistance

Injury-induced stress responses can disrupt immune homeostasis, increasing infection risk. TCM's holistic approach posits that Qi/Blood deficiency and Zang-Fu dysfunction weaken immunity. TCM herbs (e.g., Huang Qi, Dang Shen) regulate Liver/Spleen/Kidney function, supplement Qi/Blood, and modulate immune cells (T cells, B cells, macrophages) to restore immune balance [8]. Acupuncture regulates meridian Qi and Blood to improve immune status. Western antibiotics prevent/treat infection when necessary. The combination may reduce antibiotic dosage and duration, lowering the risk of bacterial resistance.

5.4. Protecting Soft Tissue Function and Reducing Complications

Injuries often involve concurrent soft tissue damage, with risks of muscle atrophy, joint stiffness, and deep vein thrombosis (DVT). TCM's principles of “equal importance to bones and soft tissues” and “integration of rest and activity” guide soft tissue protection: manipulation and acupuncture relieve muscle spasms and release adhesions, while early rehabilitation helps maintain local circulation, muscle strength, and joint mobility. Western physiotherapy modalities (e.g., ultrasound, infrared radiation) improve soft tissue perfusion,

reduce inflammation, and promote repair; anticoagulants (e.g., low-molecular-weight heparin) are used to prevent DVT. The integrated TCWM approach comprehensively reduces postoperative complications and promotes recovery.

6. Challenges in Integrated TCWM Treatment for Orthopedic Injuries

Despite increasing clinical success, the integration of Traditional Chinese and Western Medicine (TCWM) in orthopedic treatment continues to face several persistent and systemic challenges.

6.1. Insufficient Theoretical Integration

TCM emphasizes holism, syndrome differentiation, experiential knowledge, and individualized care, while Western medicine is grounded in anatomy, biomechanics, empirical validation, and standardized protocols. These foundational differences hinder the formation of a unified theoretical framework. Core TCM concepts such as *Qi* and *Meridians* still lack clear, evidence-based scientific interpretations. Moreover, syndrome differentiation remains largely qualitative, limiting reproducibility and academic consensus.

6.2. Deficiencies in Clinical Research Quality

Many existing TCWM studies are limited by small sample sizes, single-center designs, and the absence of multicenter randomized controlled trials (RCTs). Methodological issues—including inconsistent outcome measures, inadequate blinding, and short follow-up duration reduce the strength of clinical evidence. Furthermore, individualized TCM interventions (e.g., specific manipulation techniques or herbal prescriptions) often lack standardization, making results difficult to replicate or generalize.

6.3. Imperfect Talent Training Systems

There is a critical shortage of clinicians trained in both TCM and Western orthopedics. Medical education remains largely segregated, with limited interdisciplinary coursework or integrated clinical rotations. As a result, many practitioners lack the necessary cross-disciplinary competencies to implement TCWM effectively in real-world settings.

6.4. Lagging Standardization

TCM clinical practices, including bone-setting manipulation and herbal treatments, are still highly reliant on practitioner experience. The absence of unified operating procedures and treatment guidelines leads to wide variability in practice and therapeutic outcomes. Without standardized protocols for common conditions, the risk of misapplication or ineffective integration increases.

6.5. Weak Research Translation Capability

A significant gap remains between basic research findings and clinical or industrial applications. Progress in TCM herbal formulation development is slow, with traditional dosage forms (e.g., decoctions, plasters) often lacking convenience, rapid onset, or quality consistency. Device innovation—such as intelligent orthopedic manipulators or precision acupuncture tools—lags behind. Additionally, limited funding and insufficient interdisciplinary collaboration further constrain translational research and industrial integration.

7. Development Trends of Integrated TCWM in Treating Orthopedic Injuries

Future development of integrated Traditional Chinese and Western Medicine (TCWM) in orthopedics will emphasize **standardization**, **scientific validation**, and **internationalization**, addressing current limitations and enhancing global impact.

7.1. Theoretical Innovation and Integration

Modern biological sciences—such as molecular biology, genomics, and metabolomics—offer valuable tools for reinterpreting foundational TCM concepts. For instance, *Qi* may be conceptualized as a regulatory network of signaling molecules. Integration of TCM principles (holism, syndrome differentiation) with Western pathophysiological frameworks will support the construction of a unified diagnostic and therapeutic system that addresses both local and systemic factors.

7.2. Precision and Standardization of Clinical Research

High-quality clinical evidence is essential. Future efforts should focus on large-scale, multi-center randomized controlled trials (RCTs) with standardized protocols to rigorously evaluate the efficacy and safety of integrated treatments. In addition, real-world studies and big data analytics should be employed to refine patient stratification, determine optimal intervention timing, and validate individualized TCWM strategies in diverse clinical settings.

7.3. Reform of Talent Training Models

Interdisciplinary education must be prioritized to cultivate clinicians proficient in both TCM and Western orthopedics. Curricula should integrate foundational and clinical content from both systems. Dual-mentorship models—pairing TCM and Western supervisors—can improve clinical training. Continuing medical education (CME) programs and competency-based assessments should emphasize innovation, evidence-based thinking, and integrative clinical decision-making.

7.4. Promotion of Standardization

Standard operating procedures (SOPs) should be established for commonly used TCM techniques, including manipulation and herbal therapies, with clearly defined steps, dosages, and indications. Clinical pathways and consensus-based guidelines for integrative orthopedic treatment should be developed and disseminated. Quality control frameworks must be enhanced to ensure consistent therapeutic outcomes.

7.5. Deepening Research Translation and Industrial Integration

Bridging basic research and clinical application remains critical. Advanced pharmaceutical technologies should be leveraged to modernize TCM formulations (e.g., tablets, capsules, injectable forms) with improved stability and bioavailability. The development of specialized TCWM devices—such as intelligent reduction instruments, precision acupuncture systems, and rehabilitation platforms—should be accelerated. Close collaboration among academia, industry, and healthcare providers will facilitate efficient translation of research into scalable clinical products.

7.6. Strengthening International Exchange and Cooperation

To expand global influence, TCWM must engage in robust academic exchanges and cooperative research initiatives. Active participation in international standard-setting for integrative orthopedic care will enhance legitimacy. Introducing and adapting advanced technologies and methodologies from global partners can further enrich TCWM practices and foster broader recognition and acceptance worldwide.

8. Conclusion

Integrated Traditional Chinese and Western Medicine (TCWM) orthopedics synthesizes the holistic and individualized strengths of Traditional Chinese Medicine—including syndrome differentiation, the dual emphasis on bones and soft tissues, and the integration of rest and activity—with the precision diagnostics, minimally invasive techniques, and standardized rehabilitation protocols of Western medicine. This integrative approach has shown notable clinical efficacy in the management of fractures, soft tissue injuries, and chronic bone diseases. It offers benefits such as improved healing rates, functional outcomes, reduced complication rates, and cost-effectiveness. Its value is increasingly supported by international evidence, including meta-analyses, randomized controlled trials, and long-term observational studies.

However, several challenges remain, including the lack of unified theoretical integration, variability in clinical research quality, insufficient interdisciplinary training, inconsistent standardization of practices, and underdeveloped translational pathways. Addressing these issues will require systematic efforts focused on theoretical innovation, evidence-based clinical validation, interdisciplinary education reform, treatment standardization, technology-driven research translation, and enhanced international collaboration.

As medical science and technology continue to advance and global interest in integrative medicine grows, TCWM is poised to evolve further—offering more effective, culturally inclusive, and sustainable solutions in the field of orthopedic care.

Author Contribution

Jiarui He was solely responsible for the conception, drafting, and revision of this manuscript.

Compliance with Ethical Standards

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Competing Interest declaration

The author declare that, to their knowledge, they have no financial, personal, or professional relationships that could be construed as a potential competing interest regarding the work described in this manuscript.

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Appendices

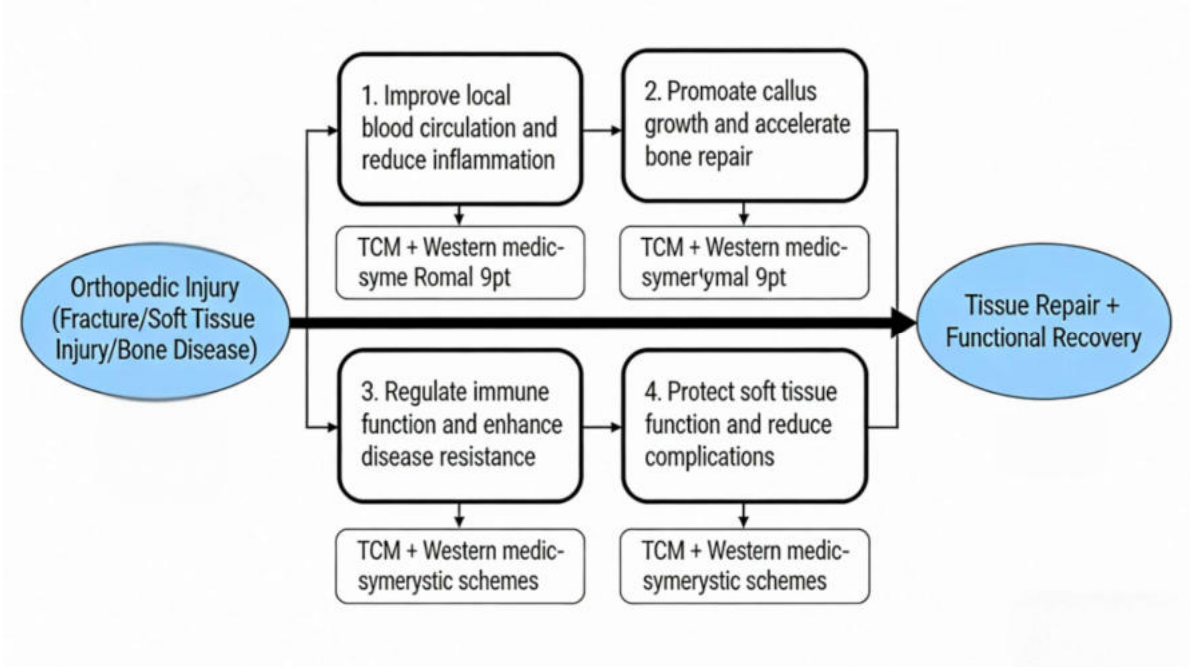


Fig. 1. Mechanisms of Action of Integrated Traditional Chinese and Western Medicine (TCWM) in Treating Orthopedic Injuries