GEORGIAN BIOMEDICAL NEWS

VOLUME 4 ISSUE 1. JAN-MAR 2026

Comparative Analysis of Metacarpophalangeal Joint Fracture Classifications

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DOI: 10.52340/GBMN.2026.01.01.155

ABSTRACT

Metacarpophalangeal joint fractures are complex injuries involving bone, cartilage, and soft tissue, and therefore require a multidimensional approach. To compare the main classification systems for metacarpophalangeal (MCP) joint fractures and to introduce an extended arthroscopic classification and severity score integrating articular morphology, cartilage integrity, mechanical stability, and associated intra-articular pathology. A narrative review of the literature on MCP and metacarpal head fractures was performed, focusing on the McElfresh & Dobyns classification, the AO/OTA fracture classification, and arthroscopy-based systems. The McElfresh & Dobyns system emphasizes clinical-radiologic stability and is particularly useful for fracture-dislocations. The AO/OTA classification offers universal alphanumeric coding but is relatively coarse for small joints. Arthroscopy allows direct assessment of cartilage lesions, ligamentous integrity, loose bodies, and synovitis. The proposed ACE M classification grades four domains (A0-A3, C0-C3, M0-M3, E0-E3) and yields a concise four-letter profile. The ASS MCP score sums eight components (0-3 points each; total 0-24) and stratifies injuries into four grades, each linked to a specific treatment pathway and prognosis. Low scores (Grade I-II) favor arthroscopic or arthroscopically assisted procedures, whereas high scores (Grade III-IV) usually require combined or open approaches. Based on the literature review, no single system fully captures the complexity of MCP joint fractures. Radiographic stability-oriented (McElfresh & Dobyns), universal (AO/OTA), and arthroscopic (ACE M, ASS MCP) classifications are complementary. The combined use of these systems enables multidimensional description, more precise treatment planning, and more informative reporting in clinical studies.

Keywords: ACE M; AO/OTA; arthroscopy; ASS MCP; fracture classification; McElfresh and Dobyns; metacarpal head fracture; metacarpophalangeal joint.

INTRODUCTION

Metacarpophalangeal (MCP) joint fractures, particularly intra-articular fractures of the metacarpal head, are relatively uncommon but clinically important injuries. They often affect young and active individuals, and inadequate treatment may result in stiffness, pain, loss of grip strength, and early post-traumatic osteoarthritis.

Accurate classification is essential for:

- Standardized description of fracture patterns.
- Effective communication between clinicians.
- Rational choice between conservative and operative treatment.
- Comparison of outcomes in clinical research.

The present paper aims to compare the major classification systems for metacarpophalangeal joint (MCP) fractures and to review the existing literature on fractures of the MCP joint, metacarpal head, and proximal phalanx base, discussing the McElfresh and Dobyns, AO/OTA, and our arthroscopy-based classification systems.

The McElfresh and Dobyns system emphasizes clinical and radiographic stability and is widely used for metacarpophalangeal joint fracture-dislocations.[1] The AO/OTA system provides a universal alphanumeric coding scheme that is used for all skeletal fractures, including cluster fractures.[2] Recently, arthroscopy of the metacarpophalangeal joint has allowed direct visualization of cartilage, ligaments, and intra-articular fragments, leading to the development of arthroscopically based classifications.

Each system accounts for different aspects of the injury, and in practice, a combination of these systems is often required.

Literature searches and publication selection were conducted using electronic databases (e.g., MEDLINE/PubMed) and leading journals in hip surgery and orthopedics. Search terms included combinations of:

- "Metacarpophalangeal joint fracture",
- "Metacarpal head fracture",
- "Fracture-dislocation",
- "Classification",
- "McKelfresh", "Dobbins", "AO/OTA",
- "MCP arthroscopy", "Arthroscopic classification."

The selection of the literature was based on the following criteria:

- Original descriptions or substantive discussions of the McElfresh and Dobbins and AO/OTA classifications that addressed MCP/metacarpal head and proximal phalanx fractures.[1,2]
- Studies or reports describing arthroscopic findings and classification concepts in metacarpophalangeal joint fractures or osteochondral lesions.
- Articles that provided sufficient detail to understand the structure, use, and limitations of the classification;
- Formal quality assessment or meta-analysis was not conducted due to the heterogeneity and conceptual nature of the topic.

ISSN (Online): 2720-8796 ISSN (Print): 2720-7994

REVIEW

The McElfresh and Dobyns system

The clinical-radiological, stability-oriented classification that considers:

- The location and direction of the damaged area of the joint.
- The presence and degree of underpronation or prolapse.
- Joint behavior after closed fixation (fixable vs. non-fixable, stable vs. unstable).
- Distinguish between simple and complex fractures (without displacement). This classification is closely related to the treatment of acute cases and helps determine the need for intraoperative stabilization.[1]

The McElfresh and Dobyns system: (i) emphasizes joint stability and post-alignment behavior; (ii) has a direct impact on decisions regarding emergency and early post-traumatic care; and (iii) is intuitive for traumatologists and vascular surgeons. However, it does not include a specific assessment of cartilage or intra-articular loose bodies, and therefore cannot be considered a universal system.

AO/OTA classification

The AO/OTA system provides a global alphanumeric classification scheme for fractures of the entire skeleton, including clusters. When classifying fractures of the MCF joint, they are coded as:

- By bone and segment (metacarpal head, diaphysis, base);
- Depending on the extent of damage to the articular surface (extraarticular, partially intra-articular, fully intra-articular).
- By complexity (simple, wedge-shaped, complex/comminuted). Thus, metacarpal head fractures are assigned a specific code indicating the bone, segment, and type of joint involvement.[2]

The present system is a universal standard and suitable for registries, epidemiological studies, and multicenter trials. The AO/OTA system enables comparison of the fractures in other areas. However, it has the following drawbacks: (i) the coding categories are relatively broad and not targeted at small funds; (ii) it does not reflect minor injuries to the articular surface or cartilage; and finally, (iii) it does not directly include a soft tissue stability assessment scheme.

Advanced arthroscopic classification (ACE-M):

The classification is based on four domains:

- Domain A - articular surface (A0-A3).
- Domain C - Cartilage integrity (C0-C3).
- Domain M - Mechanical stability (M0-M3).
- Domain E - Extraarticular data (E0-E3).

Each domain is scored from 0 (no relevant pathology) to 3 (most severe pathology).

Domain A - Articular surface:

- A0: Extraarticular; no intraarticular extension, unchanged surface, no step.
- A1: Minimal intra-articular damage (<25% surface), single fragment, <2 mm misalignment, stable configuration.
- A2: Moderate intra-articular injury (25-50% surface area), 2-3 fragments, 2-4 mm misalignment, potentially unstable fracture.
- A3: Extensive intra-articular injury (>50% surface area), ≥3 fragments or comminuted, ≥4 mm misalignment, substantially unstable;

Domain C - Cartilage integrity;

- C0: Intact cartilage, smooth articular surface, no defects.
- C1: Superficial damage to the articular cartilage (Outerbridge I-II), softening or fibrillation, without full-thickness damage.
- C2: Deep chondral damage to the articular cartilage (Outerbridge III), partial thickness tears in the cartilage, exposed subchondral bone.
- C3: Severe chondromalacia (Outerbridge IV), full-thickness loss of cartilage with large exposed bone defects.

Domain M - Mechanical stability

- M0: Stable joint; collateral ligaments and volar plate intact; no subluxation.
- M1: Partial instability; ligament sprain or partial tear; correctable subluxation.
- M2: Unstable joint; complete ligament tear or volar plate avulsion; persistent subluxation.
- M3: Dislocated joint; complete disruption of the joint, dislocation difficult to correct without manipulation or open intervention; multiple soft tissue injuries.

Domain E - Additional data

- E0: No changes; clean joint, without loose bodies and synovitis.
- E1: Minor changes; mild synovitis, small cartilage fragments, minimal hemarthrosis.
- E2: Significant changes; moderate-severe synovitis, multiple loose bodies (>3), large osteochondral fragments.
- E3: Major changes; capsule tear, extensor mechanism damage, neurovascular involvement.

The MCF joint fracture is summarized by a four-letter code (e.g., A2-C2-M1-E2), which provides a concise, qualitative description directly related to arthroscopic findings.

The Arthroscopic Severity Assessment Scale (ASS-MCP)

This scale converts qualitative arthroscopic data into a numerical severity index. Eight components are scored on a scale of 0 to 3 (0=none, 3=most severe), yielding a total score of 0 to 24.4 (Tab.1).[5,6]

The interpretation of the total ASS-MCP score is as following:

- Grade I (0-6 points; minimum):

ISSN (Online): 2720-8796 ISSN (Print): 2720-7994

- Arthroscopic debridement ± percutaneous fixation.
- Excellent prognosis; return to activity ≈in 6-8 weeks.

- Grade II (7-12 points; moderate):
  - Arthroscopic-assisted repositioning and internal fixation.
  - Good to excellent prognosis; recovery ≈10-12 weeks.
- Grade III (13-18 points; severe):
  - Combined arthroscopic and mini-open approach; joint restoration as needed.
  - Satisfactory-good prognosis; return ≈14-16 weeks.
- Grade IV (19-24 points; critical):
  - Open reduction and internal fixation, with possible consideration of arthroplasty.
  - Cautious prognosis; return >16 weeks, high risk of residual symptoms.

TABLE 1. Arthroscopic Severity Assessment Scale for the metacarpophalangeal Joint (ASS-MCP)

Component	0 Points	1 Point	2 Points	3 Points
Joint deformity	Without	<2 mm	2–4 mm	>4 mm
Number of fragments	1	2	3	>3 - crushed
Cartilage damage	Without	Superficial	Partial thickness	Full thickness
Ligament injury	Without changes	Strain	Partial tear	Complete rupture
Joint stability	Stable	Mild laxity	Moderate laxity	Unstable/ Dislocated
Free bodies	Without	1–2 Minor	3–5 or big	>5 or stuck
Synovitis	Without	Mild	Moderate	Severe
Capsule integrity	Without changes	Minor tear	Large tear	Complete disruption

Explanations: The scale is a scoring system that quantitatively reflects the degree of intra-articular damage and the prognosis, which then determines the method of intervention.

In practice, both the ACE-M code and the ASS-MCP score are used to characterize each lesion and inform treatment decisions.[7]

The given review confirms that no single classification system fully describes or covers all aspects of metacarpophalangeal joint (MCP) fractures and ligament injuries. Each existing system has specific advantages, but also has disadvantages.

The McElfresh and Dobyns system focuses on joint stability and post-alignment behavior, making it particularly valuable in emergencies, especially for fracture-dislocations. The AO/OTA classification provides a uniform coding scheme indispensable for registries and extensive multicenter studies, though it lacks detail for small joint pathology.

Arthroscopy enables direct visualization of the articular surface, cartilage, ligaments, loose bodies, and synovitis. The proposed ACE-M classification systematically groups four main criteria, each covering different lesion characteristics that are crucial for prognosis but are often not visible on radiographs. The ASS-MCP score converts the given characteristics into a numerical index that stratifies lesions into four grades, each associated with treatment tactics.

Hence, the arthroscopic ACE-M + ASS-MCP scoring system is not intended to replace existing classifications, but to supplement their shortcomings:

- The McElfresh and Dobyns systems are still helpful for preoperative radiographic and clinical evaluation.
- AO/OTA ensures compatibility with international fracture registries.
- ACE-M and ASS-MCP improve intraoperative decision making and may improve prognostic accuracy, particularly in centers routinely performing MCP arthroscopy.

The major drawback of this work is its narrative (non-systematic) design and the conceptual nature of the new arthroscopic system. Formal reliability testing and prospective validation of the ACE-M and ASS-MCP with respect to clinical and radiographic outcomes remain needed.

Table 2 compares classification systems for MCP joint fractures.

TABLE 2. Comparative characteristics of classification systems for MCP joint fractures

Classificacation	McElfresh and Dobyns	AO/OTA (carpals/metacarpals)	Arthroscopic (ACE M + ASS MCP)
Primary Focus	Clinical-radiological stability and error	Universal alphanumeric coding (bone, segment, type, complexity)	Direct intra-articular data and assessment of injury severity
Main Purpose	Acute management of MCP fractures/ fracture-dislocations	Standardized documentation and research	Intraoperative evaluation, treatment management, and prognosis
Anatomy	MCP fractures and fracture-dislocations	All fractures, including carpals/metacarpals	Articular surface and soft tissues of the MCP joint
Method	Radiographs + clinical examination	Radiographs ± CT	Arthroscopy ± radiographs/CT/MRI
Key elements	Displacement, reduction behavior, stability	Bone, segment, extra/partial/complete articular, simple/wedge/complex	A: articular extent; C: cartilage; M: stability; E: extra-articular pathology; numeric ASS-MCP score
Stability	Central feature	Limited	Direct (M domain, ligament injury, joint stability)
Cartilage/soft tissue	Not specific	Not included	Detailed chondral and ligamentous assessment
Best use	Early treatment strategy in a trauma setting	Registries, large studies	Arthroscopy-capable centers, operative planning, and outcome studies

CONCLUSIONS

Metacarpophalangeal joint fractures are complex injuries involving bone, cartilage, and soft tissue, and therefore require a multidimensional approach to classification.

Georgian Biomedical News
ISSN (Online): 2720-8796 ISSN (Print): 2720-7994

Clinical-radiological systems (McElfresh and Dobyns) assess stability and guide treatment of acute cases.

Universal coding systems (AO/OTA) facilitate documentation and research.

The proposed arthroscopic ACE-M classification and ASS-MCP score allow for a structured assessment of intra-articular damage, mechanical stability, and associated pathology, which is linked to a practical treatment algorithm.

The combined use of these systems could enhance communication between surgeons, improve surgical planning, and increase the quality of research on metacarpophalangeal joint fractures.

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ISSN (Online): 2720-8796 ISSN (Print): 2720-7994