## Contents

**Monthly Volume 12 Number 11 November 18, 2021**

### OPINION REVIEW

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>811</td>
<td>Revisiting Pauwels’ classification of femoral neck fractures</td>
<td>Nandi S</td>
</tr>
</tbody>
</table>

### ORIGINAL ARTICLE

#### Case Control Study

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>816</td>
<td>Paraspinal strength and electromyographic fatigue in patients with sub-acute back pain and controls: Reliability, clinical applicability and between-group differences</td>
<td>Koumantakis GA, Oldham JA</td>
</tr>
</tbody>
</table>

#### Retrospective Cohort Study

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
</table>

#### Retrospective Study

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>842</td>
<td>Risk of methicillin-resistant staphylococcus aureus prosthetic joint infection in elective total hip and knee arthroplasty following eradication therapy</td>
<td>Kapur BP, Tonge X, Kumar G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>850</td>
<td>Reliability of a simple fluoroscopic image to assess leg length discrepancy during direct anterior approach total hip arthroplasty</td>
<td>Caus S, Reist H, Bernard C, Blankstein M, Nelms NJ</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>859</td>
<td>Anthropometric method for estimating component sizes in total hip arthroplasty</td>
<td>Sahemey R, Moores TS, Meacher H, Youssef B, Khan S, Evans CR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>867</td>
<td>Treatment of knee osteochondritis dissecans with autologous tendon transplantation: Clinical and radiological results</td>
<td>Turhan AU, Açıl S, Gül O, Öner K, Okutan AE, Ayas MS</td>
</tr>
</tbody>
</table>

#### Clinical Trials Study

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>877</td>
<td>Direct anterior approach vs Hardinge in obese and nonobese osteoarthritic patients: A randomized controlled trial</td>
<td>Macheras G, Stasi S, Sarantis M, Triantafyllou A, Tzefronis D, Papadakis SA</td>
</tr>
</tbody>
</table>

#### Observational Study

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>891</td>
<td>Work-related musculoskeletal injuries among upper extremity surgeons: A web-based survey</td>
<td>Alzahrani MM, Alqahtani SM, Pichora D, Bicknell R</td>
</tr>
</tbody>
</table>
# Contents

## EVIDENCE-BASED MEDICINE

**899** Implementation science for the adductor canal block: A new and adaptable methodology process  
_Crain N, Qiu CY, Moy S, Thomas S, Nguyen VT, Lee-Brown M, Laplace D, Naughton J, Morkos J, Desai V_

## SYSTEMATIC REVIEWS

**909** Femoral lengthening in young patients: An evidence-based comparison between motorized lengthening nails and external fixation  
_Hafez M, Nicolaou N, Offiah AC, Giles S, Madan S, Fernandes JA_

## META-ANALYSIS

**920** Role of coatings and materials of external fixation pins on the rates of pin tract infection: A systematic review and meta-analysis  
_Stoffel C, Elitz B, Salles MJ_

## CASE REPORT

**931** Allergic dermatitis after knee arthroscopy with repeated exposure to Dermabond Prineo™ in pediatric patients: Two case reports  
_Robinson J, Smidt KP, Houk G, McKie J, Barton RS, Massey P_

**938** Pathological humerus fracture due to anti-interferon-gamma autoantibodies: A case report  
_Yang CH, Kuo FC, Lee CH_

**945** Spontaneous pneumothorax in a 17-year-old male patient with multiple exostoses: A case report and review of the literature  

**954** Management of acute length-unstable Monteggia fractures in children: A case report  
_Evola FR, Di Fede GF, Bonanno S, Evola G, Cucuzza ME_
WJO World Journal of Orthopedics

Monthly Volume 12 Number 11 November 18, 2021

ABOUT COVER
Editorial Board Member of World Journal of Orthopedics, Christiaan JA van Bergen, MD, PhD, Senior Researcher, Surgeon, Department of Orthopaedic Surgery, Amphia, Breda 3000, Netherlands. cvanbergen@amphia.nl

AIMS AND SCOPE
The primary aim of World Journal of Orthopedics (WJO, World J Orthop) is to provide scholars and readers from various fields of orthopedics with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJO mainly publishes articles reporting research results and findings obtained in the field of orthopedics and covering a wide range of topics including arthroscopy, bone trauma, bone tumors, hand and foot surgery, joint surgery, orthopedic trauma, osteoarthropathy, osteoporosis, pediatric orthopedics, spinal diseases, spine surgery, and sports medicine.

INDEXING/ABSTRACTING
The WJO is now abstracted and indexed in PubMed, PubMed Central, Emerging Sources Citation Index (Web of Science), Scopus, China National Knowledge Infrastructure (CNKI), China Science and Technology Journal Database (CSTJ), and Superstar Journals Database. The 2021 edition of Journal Citation Reports® cites the 2020 Journal Citation Indicator (JCI) for WJO as 0.66. The WJO’s CiteScore for 2020 is 3.2 and Scopus CiteScore rank 2020: Orthopedics and Sports Medicine is 87/262.

RESPONSIBLE EDITORS FOR THIS ISSUE
Production Editor: Lin-YuTong Wang; Production Department Director: Xiang Le; Editorial Office Director: Jin-Lei Wang.

NAME OF JOURNAL
World Journal of Orthopedics

ISSN
ISSN 2218-5836 (online)

LAUNCH DATE
November 18, 2010

FREQUENCY
Monthly

EDITORS-IN-CHIEF
Massimiliano Leigheb

EDITORIAL BOARD MEMBERS
http://www.wjgnet.com/2218-5836/editorialboard.htm

PUBLICATION DATE
November 18, 2021

COPYRIGHT
© 2021 Baishideng Publishing Group Inc

INSTRUCTIONS TO AUTHORS
https://www.wjgnet.com/bpg/gerinfo/204

GUIDELINES FOR ETHICS DOCUMENTS
https://www.wjgnet.com/bpg/gerinfo/287

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH
https://www.wjgnet.com/bpg/gerinfo/240

PUBLICATION ETHICS
https://www.wjgnet.com/bpg/gerinfo/288

PUBLICATION MISCONDUCT
https://www.wjgnet.com/bpg/gerinfo/208

ARTICLE PROCESSING CHARGE
https://www.wjgnet.com/bpg/gerinfo/242

STEPS FOR SUBMITTING MANUSCRIPTS
https://www.wjgnet.com/bpg/gerinfo/239

ONLINE SUBMISSION
https://www.f6publishing.com

© 2021 Baishideng Publishing Group Inc. All rights reserved. 7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
E-mail: bpgoffice@wjgnet.com https://www.wjgnet.com

World Journal of Orthopedics

Monthly Volume 12 Number 11 November 18, 2021

ABOUT COVER
Editorial Board Member of World Journal of Orthopedics, Christiaan JA van Bergen, MD, PhD, Senior Researcher, Surgeon, Department of Orthopaedic Surgery, Amphia, Breda 3000, Netherlands. cvanbergen@amphia.nl

AIMS AND SCOPE
The primary aim of World Journal of Orthopedics (WJO, World J Orthop) is to provide scholars and readers from various fields of orthopedics with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJO mainly publishes articles reporting research results and findings obtained in the field of orthopedics and covering a wide range of topics including arthroscopy, bone trauma, bone tumors, hand and foot surgery, joint surgery, orthopedic trauma, osteoarthropathy, osteoporosis, pediatric orthopedics, spinal diseases, spine surgery, and sports medicine.

INDEXING/ABSTRACTING
The WJO is now abstracted and indexed in PubMed, PubMed Central, Emerging Sources Citation Index (Web of Science), Scopus, China National Knowledge Infrastructure (CNKI), China Science and Technology Journal Database (CSTJ), and Superstar Journals Database. The 2021 edition of Journal Citation Reports® cites the 2020 Journal Citation Indicator (JCI) for WJO as 0.66. The WJO’s CiteScore for 2020 is 3.2 and Scopus CiteScore rank 2020: Orthopedics and Sports Medicine is 87/262.

RESPONSIBLE EDITORS FOR THIS ISSUE
Production Editor: Lin-YuTong Wang; Production Department Director: Xiang Le; Editorial Office Director: Jin-Lei Wang.

NAME OF JOURNAL
World Journal of Orthopedics

ISSN
ISSN 2218-5836 (online)

LAUNCH DATE
November 18, 2010

FREQUENCY
Monthly

EDITORS-IN-CHIEF
Massimiliano Leigheb

EDITORIAL BOARD MEMBERS
http://www.wjgnet.com/2218-5836/editorialboard.htm

PUBLICATION DATE
November 18, 2021

COPYRIGHT
© 2021 Baishideng Publishing Group Inc

INSTRUCTIONS TO AUTHORS
https://www.wjgnet.com/bpg/gerinfo/204

GUIDELINES FOR ETHICS DOCUMENTS
https://www.wjgnet.com/bpg/gerinfo/287

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH
https://www.wjgnet.com/bpg/gerinfo/240

PUBLICATION ETHICS
https://www.wjgnet.com/bpg/gerinfo/288

PUBLICATION MISCONDUCT
https://www.wjgnet.com/bpg/gerinfo/208

ARTICLE PROCESSING CHARGE
https://www.wjgnet.com/bpg/gerinfo/242

STEPS FOR SUBMITTING MANUSCRIPTS
https://www.wjgnet.com/bpg/gerinfo/239

ONLINE SUBMISSION
https://www.f6publishing.com

© 2021 Baishideng Publishing Group Inc. All rights reserved. 7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
E-mail: bpgoffice@wjgnet.com https://www.wjgnet.com

World Journal of Orthopedics

Monthly Volume 12 Number 11 November 18, 2021

ABOUT COVER
Editorial Board Member of World Journal of Orthopedics, Christiaan JA van Bergen, MD, PhD, Senior Researcher, Surgeon, Department of Orthopaedic Surgery, Amphia, Breda 3000, Netherlands. cvanbergen@amphia.nl

AIMS AND SCOPE
The primary aim of World Journal of Orthopedics (WJO, World J Orthop) is to provide scholars and readers from various fields of orthopedics with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJO mainly publishes articles reporting research results and findings obtained in the field of orthopedics and covering a wide range of topics including arthroscopy, bone trauma, bone tumors, hand and foot surgery, joint surgery, orthopedic trauma, osteoarthropathy, osteoporosis, pediatric orthopedics, spinal diseases, spine surgery, and sports medicine.

INDEXING/ABSTRACTING
The WJO is now abstracted and indexed in PubMed, PubMed Central, Emerging Sources Citation Index (Web of Science), Scopus, China National Knowledge Infrastructure (CNKI), China Science and Technology Journal Database (CSTJ), and Superstar Journals Database. The 2021 edition of Journal Citation Reports® cites the 2020 Journal Citation Indicator (JCI) for WJO as 0.66. The WJO’s CiteScore for 2020 is 3.2 and Scopus CiteScore rank 2020: Orthopedics and Sports Medicine is 87/262.

RESPONSIBLE EDITORS FOR THIS ISSUE
Production Editor: Lin-YuTong Wang; Production Department Director: Xiang Le; Editorial Office Director: Jin-Lei Wang.

NAME OF JOURNAL
World Journal of Orthopedics

ISSN
ISSN 2218-5836 (online)

LAUNCH DATE
November 18, 2010

FREQUENCY
Monthly

EDITORS-IN-CHIEF
Massimiliano Leigheb

EDITORIAL BOARD MEMBERS
http://www.wjgnet.com/2218-5836/editorialboard.htm

PUBLICATION DATE
November 18, 2021

COPYRIGHT
© 2021 Baishideng Publishing Group Inc

INSTRUCTIONS TO AUTHORS
https://www.wjgnet.com/bpg/gerinfo/204

GUIDELINES FOR ETHICS DOCUMENTS
https://www.wjgnet.com/bpg/gerinfo/287

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH
https://www.wjgnet.com/bpg/gerinfo/240

PUBLICATION ETHICS
https://www.wjgnet.com/bpg/gerinfo/288

PUBLICATION MISCONDUCT
https://www.wjgnet.com/bpg/gerinfo/208

ARTICLE PROCESSING CHARGE
https://www.wjgnet.com/bpg/gerinfo/242

STEPS FOR SUBMITTING MANUSCRIPTS
https://www.wjgnet.com/bpg/gerinfo/239

ONLINE SUBMISSION
https://www.f6publishing.com

© 2021 Baishideng Publishing Group Inc. All rights reserved. 7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
E-mail: bpgoffice@wjgnet.com https://www.wjgnet.com
Management of acute length-unstable Monteggia fractures in children: A case report

Francesco Roberto Evola, Giovanni Francesco Di Fede, Santo Bonanno, Giuseppe Evola, Maria Elena Cucuzza

ORCID number: Francesco Roberto Evola 0000-0002-0470-8343; Giovanni Francesco Di Fede 0000-0001-6387-7377; Santo Bonanno 0000-0002-7606-5404; Giuseppe Evola 0000-0002-3648-7063; Maria Elena Cucuzza 0000-0002-2609-7141.

Author contributions: Evola FR and Di Fede GF reviewed the literature and contributed to conception and design of the study; Evola FR, Bonanno S and Evola G contributed to the drafting the article and to making critical revisions related to important intellectual content of the manuscript; Evola FR and Cucuzza ME revised the manuscript and approved the final version of the article.

Informed consent statement: The informed consent statement has been sent previously.

Conflict-of-interest statement: The authors declare that they have no conflict of interest and financial relationships for the realization of this work.

CARE Checklist (2016) statement: The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

Open-Access: This article is an open access article licensed under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

Abstract

BACKGROUND
Monteggia fractures are uncommon injuries in paediatric age. Treatment algorithms assert that length-unstable fractures are treated with plate fixation. In this case report, intramedullary fixation of an acute length-unstable Monteggia fracture allowed a stable reduction to be achieved, along with an appropriate ulnar length and alignment as well as radio capitellar reduction despite the fact that the orthopaedic surgeon did not use a plate for the ulnar fracture. The scope of treatment is to avoid the use of a plate that causes periosteal stripping and blood circulation disruption around the fracture.

CASE SUMMARY
A four-year-old girl presented at the Emergency Department following an accidental fall off a chair onto the right forearm. The X-ray highlighted a length-unstable acute Bado type 1 Monteggia fracture of the right forearm. On the same day, the patient underwent surgical treatment of the Monteggia fracture. The surgeon preferred not to use a plate to avoid a delay in fracture healing and to allow the micromotion necessary for callus formation. The operation comprised percutaneous fixation with an elastic intramedullary K-wire of the ulnar fracture and, subsequently, humeroradial joint reduction through manual manipulation.
The orthopaedic surgeon assessed the stability of the radial head reduction under fluoroscopic control through flexion, extension, pronation and supination of the forearm. Healing of the fracture occurred within six weeks after surgery, as indicated by the presence of calluses on at least three cortices on standard radiographs. Dislocation/subluxation or loss of ulnar reduction was not apparent at the final X-ray examination.

CONCLUSION
Intramedullary fixation of unstable Monteggia fractures results in excellent outcomes, provides reliable reduction and causes fewer complications.

Key Words: Monteggia fractures; Children; Management; Outcome; Case report

Core Tip: Treatment algorithms assert that acute length-stable Monteggia fractures are treated with an intramedullary device, while acute length-unstable fractures are treated with plates. Intramedullary devices have the advantage of smaller skin incisions, less soft tissue disruption, shorter operative times and easier device removal. Plates allow more anatomical restoration of the ulnar fracture and the radial bow, although they can cause delayed union due to blood circulation disruption around the fracture. Intramedullary wires can be used for the treatment of acute length-unstable Monteggia fractures instead of plates as these are associated with excellent results and fewer complications.

INTRODUCTION
Monteggia fractures are uncommon injuries in paediatric age. In the nineteenth century, an Italian surgeon named Giovanni Monteggia described a traumatic injury involving a fracture of the proximal ulna with an associated dislocation of the radial head and disruption of the radioulnar joint[1]. Subsequently, these fractures were classified by Bado[2] into four types according to the direction of dislocation of the radial head.

The mechanism of injury is caused by direct trauma and hyperpronation as well as hyperextension[3]. The occurrence of paediatric Monteggia fractures covers between 1. Of 5% and 3% of all childhood elbow injuries[3,4]. Monteggia fractures remain a challenge for paediatric orthopaedic surgeons because of the difficulty involved in diagnosis and in the treatment of missed radial head dislocation and late instability. The aim of treatment is to achieve stable reduction of the ulnar fracture and radial head dislocation. Nowadays, the surgical treatment modalities available for these acute fractures include plates, intramedullary Kirschner wires or elastic stable intramedullary nailing and, more recently, external fixation devices[5]. Although plates and intramedullary devices have comparable outcomes and complications, nailing or K-wires have the advantage of smaller skin incisions, less soft tissue disruption, shorter operative times and easier device removal. Furthermore, intramedullary wire fixations, due to their lack of rigidity, allow micromotion and callus formation[5]. Mechanical properties of intramedullary wires are based on a three-point fixation of the inner cortex and on a spread of the interosseous membrane[5]. Nowadays, there is no consensus regarding the preferred nail diameter, although, in the literature, authors suggest that the diameter of the wire should be approximately two-thirds of the medullary canal, measured at the isthmus level[6]. Intramedullary devices may cause skin irritation, refractures, malunion, secondary displacement and nerve injury. The use of plates is associated with a more anatomical
restoration of the ulnar fracture and the radial bow, and a more rigid fixation, which requires reduced post-operative immobilization[6]. Despite this, open reduction and plate fixation cause periosteal stripping and blood circulation disruption around the fracture, resulting in a greater likelihood of delayed union or more rarely non-union [6].

The aim of this case report was to assess the efficacy of intramedullary wires for the treatment of acute length-unstable Monteggia fractures instead of plate fixation and to review the literature.

CASE PRESENTATION

Chief complaints
A four-year-old right-hand-dominant girl presented at the Emergency Department of our hospital following an accidental fall off a chair onto the right forearm. The mother reported a direct trauma to the floor of the right forearm with hyperextension and hyperpronation.

History of present illness
Post-trauma, the child reported pain in the right forearm along with inability to bend the elbow.

History of past illness
The patient had a free previous surgical history.

Physical examination
The child had forearm deformities with swelling and local tenderness around the elbow. Furthermore, active and passive motion of the elbow was impossible and accompanied by pain.

Imaging examinations
The X-rays appeared to show a fracture of the proximal ulna with an associated anterior dislocation of the radial head of the right elbow (Figure 1). The ulnar injury consisted of a long oblique fracture with a line measuring more than twice the cortical diameter. Radial head dislocation may be diagnosed when the radiocapitellar line, drawn through the axis of the radial neck on a lateral radiograph, regardless of the degree of flexion or extension of the elbow, crosses the humeral capitellum anterior to this normal position.

FINAL DIAGNOSIS
The X-ray highlighted a length-unstable acute Bado type1 Monteggia fracture of the right forearm.

TREATMENT
On the same day, the patient underwent surgical treatment of the Monteggia fracture. The surgeon preferred not to use a plate to avoid a delay in fracture healing and to allow the micromotion necessary for callus formation. The operation comprised percutaneous fixation with an elastic intramedullary K-wire of the ulnar fracture and, subsequently, humeroradial joint reduction through a combination of longitudinal traction and manual manipulation. The wire was inserted through the tip of the olecranon and advanced across the fracture site after a reduction is obtained. The reduction of the radial head may be considered stable under fluoroscopic control if the intramedullary fixation of the ulnar fracture maintains its reduced position through flexion, extension, pronation and supination. Alignment of the ulnar injury by K-wire had simultaneously reduced and stabilized the radial head dislocation. No other K-wire was used to maintain the reduction of the radial head. The K-wire can be bent and cut outside the skin to facilitate easy removal. A long arm cast was applied at the end of the operation with the elbow at 90° of flexion and the forearm in supination. Adequate analgesia was provided after surgery, the affected limb was elevated,
Evola FR et al. Treatment of pediatric Monteggia fractures

Figure 1 Plain X-ray taken at the time of injury revealing a fracture of the proximal third of the ulna and anterior dislocation of the radial head.

cryotherapy applied and circulation of the fingers monitored. The girl’s parents were taught how to manage post-operative swelling and pain over the following days. Cast immobilization was used after the surgical treatment until there was radiographic evidence of fracture union.

OUTCOME AND FOLLOW-UP

At the first (5 d) and second (10 d) follow-up, control two-plane radiographs were obtained to assess any possible loss of articular contact between the proximal radius and humeral capitellum and loss of ulnar reduction (> 10 degree increase in the ulnar angle). Healing of the fracture occurred within six weeks after surgery. In children, although the fracture may still be visible at six weeks, adequate healing is represented by a callus on at least three cortices on standard radiographs (Figure 2). At the last follow-up (6 wk), the cast and the intramedullary wire were removed. Dislocation/subluxation, defined as a loss of articular contact between the proximal radius and capitellum, or loss of ulnar reduction, was not apparent in the final X-ray examination. Active range of motion exercises were started on the first day after removal of the cast and K-wire with the aid of a physiotherapist until full elbow range of motion was achieved. No pain, limitations in range of motion or function, or any complications (recurrent dislocation, elbow dysfunction or stiffness, refracture, transient neuropaxias) were observed at the end of the rehabilitative treatment. The patient had excellent results and complete return of elbow motion at short-term clinical follow-up (6 wk after physiotherapy). Complete fracture healing, defined as full return to activities of daily living and sports, occurred four months after the trauma.

DISCUSSION

If the radial head dislocation or subluxation in Monteggia fractures is not diagnosed and adequately treated, it may lead to chronic elbow disability, pain, progressive valgus deformity, neurologic problems (posterior interosseous nerve palsy), radial head dysplasia and degenerative arthritis, elbow stiffness and loss of motion, particularly supination and pronation[4,7,8]. Foran et al[4], in a retrospective study performed on 94 patients, asserts that 83% of patients are successfully managed with a cast and do not require surgical stabilization. Reduction of the deformity of the ulnar fracture is achieved through a combination of longitudinal traction, elbow rotation and manual manipulation; when the ulnar length has been re-established, the radiocapitellar joint will often reduce spontaneously or as a result of pressure on the radial head. The author asserts that paediatric Monteggia fractures, including in patients.
with length-unstable ulna fractures, can initially be managed non-operatively, without compromising outcomes or complications; surgery should only be pursued when a conservative approach fails, with the aim of avoiding surgical overtreatment of these injuries. Compared with adults, children with Monteggia fractures have a higher chance of success without surgery for several reasons, including their thicker periosteum (which helps maintain stability of the ulna), less complex ulna fracture patterns, typically lower energy mechanisms, faster healing times and greater remodeling potential\[^9,10\]. Failure or loss of reduction and late instability may occur in up to 20% of cases with this conservative treatment because of the deforming muscular forces and joint disruption\[^11,12\]. Therefore, although most acute Monteggia fractures are treated non-operatively, certain fracture patterns require surgical stabilization\[^4\]. The indications for surgical treatment are complete fracture, unstable and irreducible fractures, open fractures, and fractures with neurovascular compromise\[^5\]. Variations in the treatment of Monteggia fractures can be found among multiple authors. Ring et al\[^13\] affirmed that maintaining ulnar length and anatomic alignment was the key to treating acute Monteggia injuries, because the radial head will remain reduced through healing of the ulnar fracture. Treatment algorithms, based upon the ulnar fracture pattern, have the purpose of minimizing complications and maximizing outcomes through restoration and maintenance of ulnar alignment. The treatment algorithms assert that length-stable fracture patterns with incomplete fracture or plastic deformation of the ulna are treated with closed reduction and casting; length-stable fractures with a complete fracture of the ulna (transverse or short oblique) are treated with intramedullary pin fixation; and length-unstable fractures with comminution of the ulna or a long oblique fracture (fracture line measuring more than twice the cortical diameter) of the ulna are treated with plate fixation\[^13\]. The objective of this algorithm is to avoid loss of reduction and its associated morbidity. Ramski et al\[^11\], in a retrospective study performed on 112 patients, asserts that recurrent instability of the radial head and loss of ulnar fracture reduction only occurred in patients who were not treated according to the ulnar-based algorithm. Failures occurred in patients treated less rigorously than the recommended algorithm, and in particular, failures occurred in complete fractures treated non-operatively with closed reduction and cast immobilization\[^11\]. Furthermore, the authors observed that although the algorithm strategy recommends plate fixation for all long oblique or comminuted fractures, there were no failures of intramedullary pin fixation of long oblique fractures in this clinical study.

Nevertheless, several authors advocate more aggressive treatment with open reduction and plate fixation for unstable fractures\[^14\]. Leonidou et al\[^14\], in a retrospective study of 40 paediatric Monteggia fractures, asserts that although conservative management has been shown to correlate with good results, unstable fractures of the ulna need to be treated with plate fixation to ensure good reduction of the radial head and to avoid the possibility of prolonged immobilization leading to elbow stiffness in children\[^14\]. Moreover, Hetthéssy et al\[^3\] in a retrospective analysis of 23

Figure 2 Radiographs at six weeks of follow-up showing reduction of the radial head dislocation and adequate healing of the proximal ulna fracture.
acute pediatric Monteggia fractures, affirms that if the dislocation of the radial head is accompanied by an unstable fracture of the ulna, a more stable osteosynthesis plate is required.

Nowadays, intramedullary nailing fixation is the main method of fracture stabilization in acute, stable and unstable Monteggia injuries, while plate fixations are widely used in patients with neglected Monteggia fractures[15]. Many authors use a cut-off of four weeks before considering a Monteggia fracture to be “neglected”. He et al[15], through a retrospective comparison study of 42 patients, showed that the rate of patients that needed open reduction or complex immobilization methods was higher in the neglected group than in the acute group. Therefore, only for early diagnosis of Monteggia injury can we rely upon minimally invasive methods such as intramedullary pin fixation[15-17]. Open reduction combined with ulnar plate fixation is the most common approach to treating missed Monteggia fractures or acute Monteggia fractures in the case of failure of closed radiocapitellar joint reduction[15].

In contrast to short oblique or transverse ulna fractures, long oblique and comminuted fractures are considered “length unstable” and therefore are treated with plate and screw fixation; open reduction and plate fixation are frequently indicated by some orthopaedists because angulation, malalignment and shortening of the ulna often occur after closed reduction and intramedullary wire fixation. In this case report, intramedullary fixation of the ulna allowed a stable reduction and ulnar length and alignment to be achieved as well as radio capitellar reduction despite the fact that the orthopaedic surgeon did not use the plate and screws for ulnar fracture. Therefore, even if not indicated in treatment algorithms, length-unstable Monteggia fractures can be successfully treated with an elastic intramedullary device with the aim of using a minimally invasive technique and enabling low complication rate.

**CONCLUSION**

Treatment of acute paediatric Monteggia fractures is still being debated and there is currently no standard treatment. In fresh Monteggia fractures, the decision to treat the ulna with an intramedullary device or plate is made according to the surgeon’s own preference with the aim of facilitating the correct alignment of the radiocapitellar joint and avoiding recurrent dislocation. In recent years, the use of intramedullary nails for the management of acute Monteggia fractures in children has gained popularity regardless of the ulnar fracture type. Delayed diagnosis and inadequate treatment of radial head dislocation will cause complications such as elbow pain, decreased joint range of motion, increased valgus deformity and neurologic problems. Flexible nails or wires are excellent devices combining stability and elasticity in children with fractures. Intramedullary fixation of unstable Monteggia fractures results in excellent outcomes, providing reliable reduction and causing fewer complications.

**REFERENCES**

10.2106/00004623-199609000-00005


