

World Journal of *Orthopedics*

World J Orthop 2011 July 18; 2(7): 51-66



A peer-reviewed, online, open-access journal of orthopedics

Editorial Board

2010-2014

The *World Journal of Orthopedics* Editorial Board consists of 245 members, representing a team of worldwide experts in orthopedics. They are from 30 countries, including Argentina (1), Australia (14), Austria (2), Belgium (1), Brazil (3), Canada (5), China (18), Croatia (2), Denmark (1), Egypt (2), Finland (2), France (2), Germany (10), Greece (5), Hungary (1), India (9), Iran (2), Ireland (1), Israel (5), Italy (19), Japan (14), Morocco (1), Netherlands (10), Norway (2), Portugal (1), Serbia (3), Singapore (3), South Korea (12), Spain (4), Sri Lanka (1), Sweden (3), Switzerland (6), Tunisia (3), Turkey (1), Tunisia (1), United Kingdom (6), and United States (69).

PRESIDENT AND EDITOR-IN-CHIEF

Lian-Sheng Ma, Beijing

STRATEGY ASSOCIATE EDITORS-IN-CHIEF

Jenni M Buckley, San Francisco
 Vijay K Goel, Toledo
 James F Griffith, Hong Kong
 Thomas W Kaminski, Newark
 Enrico Pola, Rome
 Masato Takao, Tokyo

GUEST EDITORIAL BOARD MEMBERS

Chih-Hwa Chen, Keelung
 Ruei-Ming Chen, Taipei
 Yen-Jen Chen, Taichung
 Ko-Hsiu Lu, Taichung
 Chen Yuk-Kwan, Kaohsiung

MEMBERS OF THE EDITORIAL BOARD



Argentina

Martin Alejandro Buttaro, Aires



Australia

Gerald J Atkins, Adelaide
 Gregory Ian Bain, Adelaide
 Belinda R Beck, Queensland
 Adam Leigh Bryant, Victoria
 Darren John Beales, Western Australia
 Shanghai Ding, Hobart

Herwig Drobetz, Mackay

Melanie Franklyn, Victoria

Konstantin I Momot, Queensland

George Samuel Murley, Victoria

Michal Elisabeth Schneider-Kolsky, Victoria

Gordon L Slater, Albury

Mark Watsford, Sydney

Cory J Xian, Adelaide



Austria

Florian Kutsch-Lissberg, Vienna
 Klemens Trieb, Wels



Belgium

Olivier Bruyere, Liege



Brazil

Francisco Bandeira Farias, Recife
 Djalma José Fagundes, São Paulo
 Eduardo Magalhães, São Paulo



Canada

Richard E Buckley, Calgary
 Reggie Charles Hamdy, Montreal
 Michael Anthony Hunt, Vancouver
 Richard Kremer, Montreal
 Jackson Mwale, Montreal



China

Yu-Ming Chen, Guangzhou

Yen-Jen Chen, Taiwan

Hong-Bin Fan, Xi'an

Daniel YT Fong, Hong Kong

Li-Xin Guo, Shenyang

Xiong Guo, Xi'an

Xia Guo, Hong Kong

Lui-Tun Hing, Hong Kong

Kai-Fu Huo, Wuhan

Yong Hu, Hong Kong

Jiu-Jenq Lin, Taiwan

Xiang-Hang Luo, Changsha

Marco YC Pang, Hong Kong

Ming Zhang, Hong Kong

Fu-Chan Wei, Taiwan

Ta-Sen Wei, Taiwan

Tak Chuen Wong, Hong Kong

Ricky WK Wong, Hong Kong



Croatia

Tomislav Smoljanovic, Zagreb
 Robert Kolundzic, Zagreb



Denmark

Morten Tange Kristensen, Copenhagen



Egypt

Wael M.T. Koptan, Cairo
 Elsayed Ibraheem Elsayed Massoud, Tahta



Finland

Timo Järvelä, *Tampere*
Yrjö T Konttinen, *Helsinki*



France

Federico Canavese, *Clermont-Ferrand*
Yiou Eric, *Orsay Cedex*



Germany

Annegret Mündermann, *Radolfzell*
Beat Knechtle, *Gallen*
Heinz LOHRER, *Frankfurt Am Main*
Olaf Lorbach, *Homburg*
Stefan Grote, *Munich*
Karsten Knobloch, *Hannover*
Philipp Kobbe, *Aachen*
Volker Schöffl, *Bamberg*
Arndt P Schulz, *Lübeck*
Lars V Baron von Engelhardt, *Bochum*



Greece

George C. Babis, *Attiki*
Marios Georgios Lykissas, *Ioannina*
Lazaros I. Sakkas, *Larissa*
Nikolaos G Papadimitriou, *Thessaloniki*
Konstantinos N Malizos, *Larissa*



Hungary

Andor Sebestyén, *Pécs*



India

Antony Gomes, *Calcutta*
Kunal Sharan, *Lucknow*
Divya Vohora, *New Delhi*
Devdatta Suhas Neogi, *Mumbai*
Mohamed Shafi, *Tamil Nadu State*
Pankaj Kumar, *Andhra Pradesh*
Pramod V. Lokhande, *Pune*
Vidyadhar Srinivasa, *Karnataka*
Vaibhav Bagaria, *Ghaziabad*



Iran

Hossein Negahban, *Ahvaz*
Sayed Javad Mousavi, *Tehran*



Ireland

Joseph S. Butler, *Dublin*



Israel

Alexander Blankstein, *Ramat Hasharon*
Dror Lakstein, *Haifa*
Itzhak Binderman, *Tel Aviv*
Nahum Rosenberg, *Haifa*
Youssef Maher Masharawi, *Tel Aviv*



Italy

Alessandro Geraci, *Feltre*
Angelo Cacchio, *L'Aquila*
Costantino Errani, *Bologna*
Claudia Mazzà, *Roma*
Donatella Lippi, *Florence*
Giuseppe M. Campo, *Messina*
Giuseppe Banfi, *Milano*
Patrizia D'Amelio, *Torino*
Marco Crostelli, *Rome*
Marcello Maggio, *Parma*
Marco Giuseppe Angelo Teli, *Bergamo*
Monica Mattioli-Belmonte, *Ancona*
Marco Monticone, *Lissone*
Pasquale De Negri, *Rionero in Vulture*
Andrea Giusti, *Genova*
Alberto Gobbi, *Milan*
Raoul Saggini, *Chieti*
Saverio Affatato, *Bologna*
Tomaso Villa, *Milano*



Japan

Akio Sakamoto, *Fukuoka*
Jun Iwamoto, *Tokyo*
Kanji Mori, *Otsu*
Makoto Makishima, *Tokyo*
Ryuichi Morishita, *Suita*
Shuichi Kaneyama, *Kobe*
Tadahiko Yotsumoto, *Osaka*
Toru Yamaguchi, *Izumo-shi*
Toshimasa Uemura, *Ibaraki*
Hideki Nagashima, *Yonago*
Hisataka Yasuda, *Nagahama*
Yasuhiro Nagano, *Saitama*
Yoichi Aota, *Yokohama*
Yuichi Kasai, *Tsu city*



Morocco

Abdellah El Maghraoui, *Rabat*



Netherlands

Claudine JC Lamoth, *Groningen*
Barend J. Van Royen, *Amsterdam*
Doug King, *Lower Hutt*
Paul C. Jutte, *Groningen*
PE Huijsmans, *Hague*
PM van der Kraan, *Nijmegen*
Michel van den Bekerom, *Amsterdam*
JJ Verlaan, *Utrecht*
Rob G.H.H. Nelissen, *Leiden*
Taco Gosens, *Tilburg*



Norway

Jan Oxholm Gordeladze, *Oslo*
Gunnar Knutsen, *Tromsø*



Portugal

João F Mano, *Guimarães*



Serbia

Radica Dunjic, *Belgrade*
Miroslav Z Milankov, *Novi Sad*
Zoran Vukasinovic, *Belgrade*



Singapore

Anselm Mak, *Singapore*
Dongan Wang, *Singapore*
V Prem Kumar, *Singapore*



South Korea

Dae-Geun Jeon, *Seoul*
Seok Woo Kim, *Gyeonggi*
Sang-Hun Ko, *Ulsan*
Sung-Uk Kuh, *Seoul*
Jaebeom Lee, *Miryang*
Yong Seuk Lee, *Suwon*
Hyun Woo Kim, *Seoul*
Jae Taek Hong, *Suwon*
Jong-Beom Park, *Kyunggi-do*
Kook Jin Chung, *Seoul*
Kyu Hyun Yang, *Seoul*
Sang Ki Lee, *Daejeon*



Spain

Antonio Herrera, *Zaragoza*
Daniel Hernandez Vaquero, *Aviles*
Francisco J Blanco, *A Coruña*
Nuria Vilaboa, *Madrid*



Sri Lanka

Janaka Lenora, *Galle*



Sweden

Jan G Jakobsson, *Stockholm*
Anna Nordström, *Umeå*



Switzerland

Achim Elfering, *Bern*
Benjamin Gantenbein, *Bern*

Nicola A. Maffioletti, *Zurich*
Michael Hirschmann, *Basel*
Elyazid Mouhsine, *Lausanne*
Peter Fennema, *Baar*



Thailand

Boonsin Tangtrakulwanich, *Songkla*
Prachya Kongtawelert, *Chiang Mai*
Sittisak Honsawek, *Bangkok*



Tunisia

Lamia Rezgui-Marhoul, *Tunis*



Turkey

Akmer Mutlu, *Ankara*
Bulent Daglar, *Ankara*
Kemal NAS, *Diyarbakir*
Salih Özgöçmen, *Kayseri*
Serdar Kahraman, *İstanbul*



United Kingdom

Henry DE Atkinson, *London*
Vikas Khanduja, *Cambridge*
Ali Mobasheri, *Sutton Bonington*
Charles Anthony Willis-Owen, *London*
Vikki Wylde, *Bristol*
Tosan Okoro, *Bangor*



United States

Srino Bharam, *New York*
Craig R Bottoni, *Honolulu*
Lavjay Butani, *Sacramento*
Chaoyang Chen, *Detroit*
Ock K Chun, *Storrs*
Christopher J Colloca, *Chandler*
Nabanita S Datta, *Detroit*
Paul E Di Cesare, *Sacramento*
Matthew B Dobbs, *Saint Louis*
Evan F Fkman, *Columbia*
Joel J Gagnier, *Ann Arbor*
Federico P Girardi, *New York*
David L Helfet, *New York*
Johnny Huard, *Pittsburgh*
Stefan Judex, *Stony Brook*
Monroe Laborde, *New Orleans*
Bingyun Li, *Morgantown*
Subburaman Mohan, *Loma Linda*
Arash Momeni, *Palo Alto*
Nader D Nader, *Buffalo*
John Nyland, *Louisville*
Karin Grävare Silbernagel, *Newark*
David H Song, *Chicago*
Nelson F SooHoo, *Los Angeles*
SPA Stawicki, *Columbus*
Ann Marie Swank, *Louisville*
R Shane Tubbs, *Birmingham*
Victoria M Virador, *Bethesda*
Savio LY Woo, *Pittsburgh*
Masayoshi Yamaguchi, *Atlanta*
Feng-Chun Yang, *Indianapolis*
Subhashini Yaturu, *Albany*

Hiroki Yokota, *Troy*
Charalampos Zalavras, *Los Angeles*
Chunfeng Zhao, *Rochester*
Anil Bhave, *Baltimore*
John Elias, *Akron*
Clark Dickin, *Muncie*
John S Early, *Dallas*
James S Harrop, *Philadelphia*
Adam H. Hsieh, *Maryland*
Aditya V Maheshwari, *New York*
Zong-Ming Li, *Cleveland*
Richard M Lovering, *Baltimore*
Lyle Joseph Micheli, *Boston*
Ming Pei, *Morgantown*
Juan A Pretell - Mazzini, *Philadelphia*
David M Selkowitz, *Pomona*
Hassan Serhan, *Raynham*
Subhashini Yaturu, *Albany*
Sorin Siegler, *Pennsylvania*
Aaron David Sciascia, *Lexington*
Jeffrey C Wang, *Santa Monica*
David Andrew Spiegel, *Philadelphia*
Inna Belfer, *Pittsburgh*
Angie Botto-van Bemden, *Lauderdale*
Quan-Jun Cui, *Virginia*
Scott D Daffner, *Morgantown*
B Sonny Bal, *Columbia*
Beril Gok, *Baltimore*
Ashraf S Gorgey, *Richmond*
Kee D Kim, *Sacramento*
Brian Michael Haus, *Boston*
Dror Paley, *Pittsburgh*
Bing Wang, *Pittsburgh*
Wen-Bao Wang, *New York*
Li-Qun Zhang, *Chicago*
Nigel Zheng, *Charlotte*



EDITORIAL	51	Diagnosing syndesmotic instability in ankle fractures <i>van den Bekerom MPJ</i>
REVIEW	57	Ultrasound-assisted musculoskeletal procedures: A practical overview of current literature <i>Royall NA, Farrin E, Bahner DP, Stawicki SPA</i>

Contents

World Journal of Orthopedics
Volume 2 Number 7 July 18, 2011

ACKNOWLEDGMENTS	I	Acknowledgments to reviewers of <i>World Journal of Orthopedics</i>
------------------------	---	---

APPENDIX	I	Meetings
-----------------	---	----------

	I-V	Instructions to authors
--	-----	-------------------------

ABOUT COVER	Royall NA, Farrin E, Bahner DP, Stawicki SPA. Ultrasoundassisted musculoskeletal procedures: A practical overview of current literature.
--------------------	--

World J Orthop 2011; 2(7): 57-66

<http://www.wjgnet.com/2218-5836/full/v2/i7/57.htm>

AIM AND SCOPE

World Journal of Orthopedics (*World J Orthop*, *WJO*, online ISSN 2218-5836, DOI: 10.5312) is a monthly peer-reviewed, online, open-access, journal supported by an editorial board consisting of 122 experts in orthopedics from 30 countries.

The aim of *WJO* is to report rapidly new theories, methods and techniques for prevention, diagnosis, treatment, rehabilitation and nursing in the field of orthopedics. *WJO* covers diagnostic imaging, arthroscopy, evidence-based medicine, epidemiology, nursing, sports medicine, therapy of bone and spinal diseases, bone trauma, osteoarthropathy, bone tumors and osteoporosis, minimally invasive therapy, traditional medicine, and integrated Chinese and Western medicine. The journal also publishes original articles and reviews that report the results of applied and basic research in fields related to orthopedics, such as immunology, physiopathology, cell biology, pharmacology, medical genetics, and pharmacology of Chinese herbs.

FLYLEAF	I-II	Editorial Board
----------------	------	-----------------

EDITORS FOR THIS ISSUE

Responsible Assistant Editor: *Le Zhang*
Responsible Electronic Editor: *Xiao-Mei Zheng*
Proofing Editor-in-Chief: *Lian-Sheng Ma*

Responsible Science Editor: *Hong Sun*
Proofing Editorial Office Director: *Hong Sun*

NAME OF JOURNAL

World Journal of Orthopedics

LAUNCH DATE

November 18, 2010

SPONSOR

Beijing Baishideng BioMed Scientific Co., Ltd.
Room 903, Building D, Ocean International Center,
No. 62 Dongsihuan Zhonglu, Chaoyang District,
Beijing 100025, China
Telephone: +86-10-8538-1892
Fax: +86-10-8538-1893
E-mail: baishideng@wjgnet.com
<http://www.wjgnet.com>

EDITING

Editorial Board of *World Journal of Orthopedics*
Room 903, Building D, Ocean International Center,
No. 62 Dongsihuan Zhonglu, Chaoyang District,
Beijing 100025, China
Telephone: +86-10-5908-0036
Fax: +86-10-8538-1893
E-mail: wjo@wjgnet.com
<http://www.wjgnet.com>

PUBLISHING

Baishideng Publishing Group Co., Limited
Room 1701, 17/F, Heman Building,
No.90 Jaffe Road, Wanchai, Hong Kong, China
Fax: +852-3115-8812

Telephone: +852-5804-2046
E-mail: baishideng@wjgnet.com
<http://www.wjgnet.com>

SUBSCRIPTION

Beijing Baishideng BioMed Scientific Co., Ltd.
Room 903, Building D, Ocean International Center,
No. 62 Dongsihuan Zhonglu, Chaoyang District,
Beijing 100025, China
Telephone: +86-10-8538-1892
Fax: +86-10-8538-1893
E-mail: baishideng@wjgnet.com
<http://www.wjgnet.com>

PUBLICATION DATE

July 18, 2011

ISSN

ISSN 2218-5836 (online)

PRESIDENT AND EDITOR-IN-CHIEF

Lian-Sheng Ma, Beijing

STRATEGY ASSOCIATE EDITORS-IN-CHIEF

Enrico Pola, Rome
Masato Takao, Tokyo
James F Griffith, Hong Kong
Thomas W Kaminski, Newark
Jenni M Buckley, San Francisco
Vijay K Goel, Toledo

EDITORIAL OFFICE

Hong Sun, Director
World Journal of Orthopedics
Room 903, Building D, Ocean International Center,
No. 62 Dongsihuan Zhonglu, Chaoyang District,
Beijing 100025, China
Telephone: +86-10-5908-1630
Fax: +86-10-8538-1893
E-mail: wjo@wjgnet.com
<http://www.wjgnet.com>

COPYRIGHT

© 2011 Baishideng. Articles published by this Open-Access journal are distributed under the terms of the Creative Commons Attribution Non-commercial License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non commercial and is otherwise in compliance with the license.

SPECIAL STATEMENT

All articles published in this journal represent the viewpoints of the authors except where indicated otherwise.

INSTRUCTIONS TO AUTHORS

Full instructions are available online at http://www.wjgnet.com/2218-5836/g_info_20100722172650.htm.

ONLINE SUBMISSION

<http://www.wjgnet.com/2218-5836office>



Diagnosing syndesmotic instability in ankle fractures

Michel PJ van den Bekerom

Michel PJ van den Bekerom, Academic Medical Center, Department of Orthopaedic Surgery, Orthopaedic Research Center Amsterdam, 1105 AZ Amsterdam, The Netherlands

Author contributions: van den Bekerom MPJ contributed solely to the paper.

Correspondence to: Michel PJ van den Bekerom, MD, Academic Medical Center, Department of Orthopaedic Surgery, Orthopaedic Research Center Amsterdam, Meibergdreef 15, PO Box 22660, 1105 AZ Amsterdam, The Netherlands. bekerom@gmail.com

Telephone: +31-20-5669111 Fax: +31-20-566 9117

Received: March 29, 2011 Revised: June 14, 2011

Accepted: June 21, 2011

Published online: July 18, 2011

Abstract

The precise diagnosis of distal tibiofibular syndesmotic ligament injury is challenging and a distinction should be made between syndesmotic ligament disruption and real syndesmotic instability. This article summarizes the available evidence in the light of the author's opinion. Pre-operative radiographic assessment, standard radiographs, computed tomography scanning and magnetic resonance imaging are of limited value in detecting syndesmotic instability in acute ankle fractures but can be helpful in planning. Intra-operative stress testing, in the sagittal, coronal or exorotation direction, is more reliable in the diagnosis of syndesmotic instability of rotational ankle fractures. The Hook or Cotton test is more reliable than the exorotation stress test. The lateral view is more reliable than the AP mortise view because of the larger displacement in this direction. When the Hook test is used the force should be applied in the sagittal direction. A force of 100 N applied to the fibula seems to be appropriate. In the case of an unstable joint requiring syndesmotic stabilisation, the tibiofibular clear space would exceed 5 mm on the lateral stress test. When the surgeon is able to perform an ankle arthroscopy this technique is useful to detect syndes-

motic injury and can guide anatomic reduction of the syndesmosis. Many guidelines formulated in this article are based on biomechanical and cadaveric studies and clinical correlation has to be established.

© 2011 Baishideng. All rights reserved.

Key words: Ankle fracture; Syndesmosis; Ligament; Instability; Operative treatment; Stabilisation

Peer reviewers: Masato Takao, MD, PhD, Professor, Department of Orthopaedic Surgery, Teikyo University School of Medicine, 2-11-1, Kaga, Itabashi, Tokyo, 173-8605, Japan; Shaohung Hung, MD, PhD, Department of Orthopedic Surgery, Fooyin University Hospital, No.5 Chun-Sun Rd. Tungkang PingTung 928, Taiwan, China; Alessandro Geraci, PhD, Department of Orthopedic and Traumatology Unit, University of Palermo – Santa Maria del Prato Hospital, Feltre, Via Montegrappa 18/c, 32032, Feltre (BL), Italy; Karin Grävare Silbernagel, PT, ATC, PhD, Mechanical Engineering, Biomechanics and Movements Science, University of Delaware, Spencer Laboratory, Newark, DE 19716, United States

van den Bekerom MPJ. Diagnosing syndesmotic instability in ankle fractures. *World J Orthop* 2011; 2(7): 51-56 Available from: URL: <http://www.wjgnet.com/2218-5836/full/v2/i7/51.htm> DOI: <http://dx.doi.org/10.5312/wjo.v2.i7.51>

INTRODUCTION

A syndesmosis is a fibrous articulation in which the opposing joint surfaces are united by ligaments^[1]. The distal tibiofibular syndesmosis consists of a complex of ligaments that provides stability to this joint. The anterior and posterior tibiofibular ligaments together with the interosseous ligament form the syndesmosis. The inferior transverse tibiofibular ligament is sometimes considered a fourth ligament but is rather a continuation of the posterior tibiofibular ligament^[2].

Syndesmotic injuries are most commonly associated

with Weber C/pronation external rotation or pronation abduction^[3] and less frequently with Weber B/supination external rotation (SER)^[4] ankle fractures. Syndesmotic injury can also occur in isolation mostly due to an exorotation trauma or in association with damage to the lateral ankle ligaments after traumatic supination^[5,6]. There could be subsequent mortise instability and this should be treated with syndesmotic stabilisation to prevent long-term complications of syndesmotic diastasis. Ramsey *et al*^[7] reported that, when the talus moves 1mm laterally, the contact area in the tibiotalar articulation is decreased by 42%. A complete disruption of syndesmosis with a disruption of the deltoid ligament causes a 40% decrease in the tibiotalar contact area and a 36% increase in the tibiotalar contact pressures^[8]. Immediate reconstruction of the unstable syndesmosis is indicated, because a delay could expedite the development of degenerative arthritis.

To date, the need for distal tibiofibular syndesmotic fixation is not fully clear despite the abundance of literature concerning the treatment of ankle fractures and isolated syndesmotic injuries^[9]. The syndesmotic screw or other stabilising techniques are all effective in stabilising the distal tibiofibular syndesmosis to allow ligamentous healing or to allow a fibrous union^[10]. Despite the numerous biomechanical and clinical studies concerning ankle fractures, there are no consistent recommendations regarding the technical aspects of placement in syndesmotic screw fixation^[11].

The placement of a syndesmotic screw may require an additional operation for removal of the screw and both operations are not without complications. Late repairs are satisfactory but result in less favorable outcomes than properly treated acute injuries^[12]. It is not easy to regain complete stability by means of these secondary procedures^[12]. Because of these conflicting factors it is important to clearly identify the patients who will require (temporary) distal tibiofibular syndesmotic stabilisation. The precise diagnosis of syndesmosis disruption is challenging and a distinction should be made between syndesmotic ligament disruption and real syndesmotic instability. History and physical examination are not completely reliable indicators because of symptoms due to the ankle fracture itself.

PRE-OPERATIVE ASSESSMENT

Radiographic measurements such as tibiofibular overlap, tibiofibular clear space, medial and superior clear space are of little value in detecting syndesmotic injury^[13,14], probably because all these parameters depend on the rotation of the ankle^[13,15]. Even additional quantitative measurement of all syndesmotic parameters with repeated radiographs of the ankle can only be used only as

a guide in the diagnosis and management of syndesmotic injuries and not solely relied upon for treatment decisions^[13,14].

Although Maisonneuve ankle fractures always require syndesmotic stabilisation^[16], there is no correlation between the level of the fibula fracture and the need for syndesmotic stabilisation^[17-19]. This is possibly because the level of the fibular fracture does not correlate reliably with the integrity or extent of the interosseous membrane tears and the status of the strongest posterior syndesmotic ligament in operative ankle fractures^[14].

Based on a cadaver study, Boden *et al*^[20] proposed that syndesmotic fixation is unnecessary if rigid medial malleolar fixation can be achieved or, in the case of deltoid disruption, the fibular fracture is 3 to 4.5 cm proximal to the ankle joint. Recently we observed that the Boden criteria may be helpful in planning, but may have some limitations as a predictor of syndesmotic instability in distal pronation-external rotation ankle fractures^[19].

Even the Lauge-Hansen classification is not able to predict syndesmotic instability. This system can be used only as a guide in the diagnosis and management of ankle fractures and not solely relied upon for decisions on treatments such as syndesmotic stabilisation^[21].

Computed tomography scanning^[22], ultrasound^[23] and magnetic resonance imaging (MRI)^[24,25] could be valuable in detecting syndesmotic disruption in patients with chronic or isolated syndesmotic injuries but their usefulness in predicting instability in acute ankle fractures is not proven. Vogl *et al*^[26] and Oae *et al*^[27] concluded that magnetic resonance imaging of the syndesmotic complex is a highly sensitive and specific tool for the evaluation of syndesmotic injury^[26] and even syndesmotic disruption^[27].

MRI does not provide a dynamic assessment of the distal tibiofibular syndesmosis, so although a rupture of one or more of the ligaments can be identified, instability cannot be diagnosed but only suspected with a MRI scan. Another disadvantage is that the MRI is expensive and often not readily and rapidly available^[28].

Pre-operative assessment is less valuable in detecting syndesmotic instability in acute ankle fractures but can be helpful in planning.

INTRA-OPERATIVE ASSESSMENT

Jenkinson *et al*^[29] concluded that fluoroscopic stress examination of rotational ankle fractures significantly increases the rate of detection of syndesmotic instability when compared to preoperative evaluation based on standard radiography and biomechanical criteria.

The external rotation test used as a manual stress or a gravity stress test is widely recognized as a clinical tool for the diagnosis of deltoid ligament incompetence in SER ankle fractures^[30]. The role of stress radiography in

Table 1 Arthroscopic assessment of distal tibiofibular syndesmotic stability

Study, yr	Patients	Test
Takao <i>et al</i> ^[39] , 2001	38 Weber B fractures, 26 males, 40 yr	Arthroscopic anatomical examination of anterior tibiofibular ligament, the posterior tibiofibular ligament, and the transverse tibiofibular ligament. The interosseous ligament and membrane were not assessed Syndesmotic disruptions were diagnosed in 16 of 38 patients (42%) by AP radiography, in 21 of 38 patients (55%) by mortise radiography, and in 33 of 38 patients (87%) by ankle arthroscopy > 2 mm movement in between the tibia and fibula during arthroscopy
Sri-Ram <i>et al</i> ^[37] , 2005	1 Maisonneuve ankle fracture, image intensifier showed no syndesmotic diastasis	≥ 2 mm displacement of lateral malleolus in coronal or sagittal plane.
Lui <i>et al</i> ^[38] , 2005	53 Weber B and C fractures, 35 yr, without radiographic evidence of frank syndesmosis diastasis	Displacement of anterior border of the lateral malleolus at least 2 mm more than displacement of the posterior border of the lateral malleolus 16 cases had positive intraoperative stress radiographs; 35 cases had positive arthroscopic findings of syndesmosis diastasis, including various combinations of coronal, sagittal, and rotational planes of instability Distal tibiofibular joint instability was detected by a squeeze test under fluoroscopy or by residual, arthroscopically observed diastasis of the joint Persistent instability of the distal tibiofibular joint, which was detected under fluoroscopy and arthroscopy in 8 patients
Ono <i>et al</i> ^[40] , 2004	105 ankle fractures, 59 males, 46 yr	Arthroscopic anatomical assessment of AITFL and the PITFL, transverse ligament, interosseous ligament and membrane were not assessed
Takao <i>et al</i> ^[36] , 2003	52 acute ankle injuries, 31 males, 35 yr	The accuracy of AP radiography, mortise radiography and MRI was compared with arthroscopy for the diagnosis of a tear of the tibiofibular syndesmosis
Hintermann <i>et al</i> ^[41] , 2002	148 chronic ankle instabilities, 38 males, 34 yr	Arthroscopic anatomical assessment of AITFL, PITFL, and the transverse ligament

the diagnosis of distal tibiofibular syndesmotic instability is less clear^[28], although recent data have suggested that many surgeons (69%) use the intra-operative lateral stress test to assess syndesmotic stability^[31].

The absence of distal tibiofibular diastasis on static radiographs is not sufficient to exclude syndesmotic instability in patients with ankle injuries.

Intra-operative stress testing, in sagittal, coronal or exorotation direction, is essential in the diagnosis and treatment of rotational ankle fractures.

Which test?

On the basis of a biomechanical cadaveric study, Stoffel *et al*^[28] concluded that use of the lateral (bone hook) stress test or Cotton test^[32] and examination of the tibiofibular clear space on stress radiographs intra-operatively is more reliable, because of the greater displacement when performing this test, than the exorotation stress test.

The "Hook" or "Cotton" test is more reliable than the exorotation stress test.

Which direction?

Several authors^[28,33,34] have concluded that assessment of sagittal plane movement appears to be a more sensitive test of inferior tibiofibular instability than assessment of movement in coronal plane^[33]. Coronal plane instability as observed on an AP mortise view only occurs where the deltoid ligament or the whole interosseous membrane is also divided^[33]. Candal-Couto *et al*^[33] used the Hook test

in both directions and Xenos *et al*^[34] used the exorotation test.

The lateral view is more reliable than the AP mortise view because of the greater displacement in this direction. When the Hook test is used the force should be applied in the sagittal direction.

How much force?

Most studies do not report the level or type of force used in tests to detect syndesmotic instability^[28]. Boden *et al*^[20] used a combined pronation-external rotation force of 440 N, whereas Stoffel *et al*^[28] used an external rotation load of 150 N resulting in an external moment of 7.5 Nm. The tibiofibular clear space is relatively independent of external rotation force and there may be no benefit in using an external rotation moment of more than 7.5 Nm^[28]. In this study a lateral force of 100 N was applied to the ankle mortise and forces of > 100 N did not show any substantial increase in displacement^[28].

Based on these data, application of a force of 100 N seems appropriate.

How much displacement?

Currently available literature does not provide clear guidelines for the amount of displacement or degree of diastasis required for performing syndesmotic stabilisation.

Jenkinson *et al*^[29] used a 1-mm increase in tibiofibular clear space on an external rotation stress radiograph as an indication for syndesmotic stabilisation. However,

this may probably lead to overtreatment of many ankle fractures^[28]. Leeds *et al*^[35] suggested 2 mm as an unacceptable increase in the tibiofibular clear space. In addition, Stoffel *et al*^[28] showed that syndesmotic injuries correlate with relatively small increases in the measurements on stress radiographs. The ability of the surgeon to manually detect these small increases in intra-operative tibiofibular clear space has been questioned^[29].

Stoffel *et al*^[28] formulated guidelines for clinical practice. The superior clear space in a normal ankle joint is approximately 3 to 4 mm, which is also the maximum tibiofibular clear space value indicating a stable ankle joint. In the case of an unstable joint requiring syndesmotic stabilisation, the tibiofibular clear space would exceed 5 mm on the lateral stress test^[28].

Clinical studies are now required to determine the acceptable degree of displacement of the distal tibiofibular syndesmosis after ankle fracture fixation. In the case of an unstable distal tibiofibular syndesmosis requiring stabilisation, the tibiofibular clear space would exceed 5 mm on the lateral stress test.

ARTROSCOPY

Recent publications^[36-41] (Table 1) state that ankle arthroscopy is a more sensitive method than intraoperative stress radiography^[36-38]. Moreover, ankle arthroscopy can aid analysis of different patterns of syndesmosis diastasis and also guide anatomic reduction of the syndesmosis^[37]. However, there are some limitations of these studies as it is not known how much diastasis the syndesmosis allows and whether the physiologic laxity is similar in the anterior and posterior part of the syndesmosis. It is known that the distance between the tibia and fibula is variable over the joint line. The central part contains the tibiofibular syndesmotic recess whose dimensions are not known. I agree with Takao *et al*^[36,39] that arthroscopy is very valuable for the accurate diagnosis of a tear of the tibiofibular syndesmosis. However, the observation of a ruptured anterior syndesmotic ligament during arthroscopy does not mean that there is syndesmotic instability because the interosseous ligament and the interosseous membrane cannot reliably be assessed during ankle arthroscopy. In most SER IV ankle fractures the anterior and posterior syndesmotic ligaments are ruptured but syndesmotic instability is rare^[42]. Ankle arthroscopy is useful for identifying ruptures of the syndesmotic ligaments intraoperative, although the test is more invasive and not all surgeons have the expertise to perform an ankle arthroscopy.

The advantage of this technique is that it provides assessment of different planes of instability and assists anatomic reduction of the syndesmosis. Syndesmotic stabilisation without direct visualization has a high percentage of malreduction^[43]. Even surgeons with arthroscopic

experience state that intraoperative radiography still plays an important role in assessing fracture reduction as well as proper restoration of fibular length and longitudinal orientation of the syndesmosis^[38]. Future research is required into the amount of displacement of the fibula in relation to the tibia, necessary to detect syndesmotic instability. When the surgeon is able to perform an ankle arthroscopy this technique is useful to detect syndesmotic injury and guide anatomic reduction of the syndesmosis.

DISCUSSION

General radiographic criteria for syndesmotic fixation are of low value compared with the intraoperative impression of the syndesmotic stability in all operated ankles. Preoperative planning is essential but not sufficient to determine the necessity for syndesmotic fixation. The pre-operative assessments can be used only as a guide in the diagnosis and management of syndesmotic instability associated with ankle fractures and cannot be solely relied on for treatment of these injuries. Other factors influencing the choice of fixation include the presence of posterior malleolus fractures, deltoid ligament injuries, and subluxation of the fibula^[2,44]. The decision to stabilize the distal tibiofibular syndesmosis should be made based on intra-operative (stress testing of arthroscopic) findings.

There is a lack of published information, particularly in relation to the performance of intra-operative stress testing of syndesmotic stability. So far, there are no clear answers to the questions: which test?, which direction?, how much force?, how much displacement? Many of the guidelines outlined in this article are based on biomechanical and cadaveric studies and clinical correlation has to be established.

Whenever the surgeon is in doubt about syndesmotic instability, I believe stabilisation of the distal tibiofibular joint should be performed because of the problems caused by chronic syndesmotic instability^[9,12].

REFERENCES

- 1 Wuest TK. Injuries to the Distal Lower Extremity Syndesmosis. *J Am Acad Orthop Surg* 1997; **5**: 172-181
- 2 Ebraheim NA, Taser F, Shafiq Q, Yeasting RA. Anatomical evaluation and clinical importance of the tibiofibular syndesmosis ligaments. *Surg Radiol Anat* 2006; **28**: 142-149
- 3 Riegels-Nielsen P, Christensen J, Greiff J. The stability of the tibio-fibular syndesmosis following rigid internal fixation for type C malleolar fractures: an experimental and clinical study. *Injury* 1983; **14**: 357-360
- 4 Heim D, Schmidlin V, Ziviello O. Do type B malleolar fractures need a positioning screw? *Injury* 2002; **33**: 729-734
- 5 Boytim MJ, Fischer DA, Neumann L. Syndesmotic ankle sprains. *Am J Sports Med* 1991; **19**: 294-298
- 6 Hopkinson WJ, St Pierre P, Ryan JB, Wheeler JH. Syndesmosis sprains of the ankle. *Foot Ankle* 1990; **10**: 325-330

- 7 **Ramsey PL**, Hamilton W. Changes in tibiotalar area of contact caused by lateral talar shift. *J Bone Joint Surg Am* 1976; **58**: 356-357
- 8 **Burns WC**, Prakash K, Adelaar R, Beaudoin A, Krause W. Tibiotalar joint dynamics: indications for the syndesmotic screw--a cadaver study. *Foot Ankle* 1993; **14**: 153-158
- 9 **van den Bekerom MP**, Lamme B, Hogervorst M, Bolhuis HW. Which ankle fractures require syndesmotic stabilization? *J Foot Ankle Surg* 2007; **46**: 456-463
- 10 **van den Bekerom MP**, Raven EE. Current concepts review: operative techniques for stabilizing the distal tibiofibular syndesmosis. *Foot Ankle Int* 2007; **28**: 1302-1308
- 11 **van den Bekerom MP**, Hogervorst M, Bolhuis HW, van Dijk CN. Operative aspects of the syndesmotic screw: review of current concepts. *Injury* 2008; **39**: 491-498
- 12 **van den Bekerom MP**, de Leeuw PA, van Dijk CN. Delayed operative treatment of syndesmotic instability. Current concepts review. *Injury* 2009; **40**: 1137-1142
- 13 **Beumer A**, van Hemert WL, Niesing R, Entius CA, Ginali AZ, Mulder PG, Swierstra BA. Radiographic measurement of the distal tibiofibular syndesmosis has limited use. *Clin Orthop Relat Res* 2004; **227**-234
- 14 **Nielson JH**, Gardner MJ, Peterson MG, Sallis JG, Potter HG, Helfet DL, Lorich DG. Radiographic measurements do not predict syndesmotic injury in ankle fractures: an MRI study. *Clin Orthop Relat Res* 2005; **216**-221
- 15 **Pneumaticos SG**, Noble PC, Chatzioannou SN, Trevino SG. The effects of rotation on radiographic evaluation of the tibiofibular syndesmosis. *Foot Ankle Int* 2002; **23**: 107-111
- 16 **Stufkens SA**, van den Bekerom MP, Doornberg JN, van Dijk CN, Kloen P. Evidence-based treatment of malleonieuve fractures. *J Foot Ankle Surg* 2011; **50**: 62-67
- 17 **Nielson JH**, Sallis JG, Potter HG, Helfet DL, Lorich DG. Correlation of interosseous membrane tears to the level of the fibular fracture. *J Orthop Trauma* 2004; **18**: 68-74
- 18 **Ebraheim NA**, Elgafy H, Padanilam T. Syndesmotic disruption in low fibular fractures associated with deltoid ligament injury. *Clin Orthop Relat Res* 2003; **260**-267
- 19 **van den Bekerom MP**, Haverkamp D, Kerkhoffs GM, van Dijk CN. Syndesmotic stabilization in pronation external rotation ankle fractures. *Clin Orthop Relat Res* 2010; **468**: 991-995
- 20 **Boden SD**, Labropoulos PA, McCowin P, Lestini WF, Hurwitz SR. Mechanical considerations for the syndesmosis screw. A cadaver study. *J Bone Joint Surg Am* 1989; **71**: 1548-1555
- 21 **Gardner MJ**, Demetrakopoulos D, Briggs SM, Helfet DL, Lorich DG. The ability of the Lauge-Hansen classification to predict ligament injury and mechanism in ankle fractures: an MRI study. *J Orthop Trauma* 2006; **20**: 267-272
- 22 **Ebraheim NA**, Lu J, Yang H, Mekhail AO, Yeasting RA. Radiographic and CT evaluation of tibiofibular syndesmotic diastasis: a cadaver study. *Foot Ankle Int* 1997; **18**: 693-698
- 23 **Mei-Dan O**, Kots E, Barchilon V, Massarwe S, Nyska M, Mann G. A dynamic ultrasound examination for the diagnosis of ankle syndesmotic injury in professional athletes: a preliminary study. *Am J Sports Med* 2009; **37**: 1009-1016
- 24 **Hermans JJ**, Wentink N, Kleinrensink GJ, Beumer A. MR-plastination-arthrography: a new technique used to study the distal tibiofibular syndesmosis. *Skeletal Radiol* 2009; **38**: 697-701
- 25 **Muratli HH**, Biçimoğlu A, Celebi L, Boyacigil S, Damgaci L, Tabak AY. Magnetic resonance arthrographic evaluation of syndesmotic diastasis in ankle fractures. *Arch Orthop Trauma Surg* 2005; **125**: 222-227
- 26 **Vogl TJ**, Hochmuth K, Diebold T, Lubrich J, Hofmann R, Stöckle U, Söllner O, Bisson S, Südkamp N, Maeurer J, Haas N, Felix R. Magnetic resonance imaging in the diagnosis of acute injured distal tibiofibular syndesmosis. *Invest Radiol* 1997; **32**: 401-409
- 27 **Oae K**, Takao M, Naito K, Uchio Y, Kono T, Ishida J, Ochi M. Injury of the tibiofibular syndesmosis: value of MR imaging for diagnosis. *Radiology* 2003; **227**: 155-161
- 28 **Stoffel K**, Wysocki D, Baddour E, Nicholls R, Yates P. Comparison of two intraoperative assessment methods for injuries to the ankle syndesmosis. A cadaveric study. *J Bone Joint Surg Am* 2009; **91**: 2646-2652
- 29 **Jenkinson RJ**, Sanders DW, Macleod MD, Domonkos A, Lydestdadt J. Intraoperative diagnosis of syndesmosis injuries in external rotation ankle fractures. *J Orthop Trauma* 2005; **19**: 604-609
- 30 **van den Bekerom MP**, Mutsaerts EL, van Dijk CN. Evaluation of the integrity of the deltoid ligament in supination external rotation ankle fractures: a systematic review of the literature. *Arch Orthop Trauma Surg* 2009; **129**: 227-235
- 31 **Monga P**, Kumar A, Simons A, Panikker V. Management of distal tibio-fibular syndesmotic injuries: a snapshot of current practice. *Acta Orthop Belg* 2008; **74**: 365-369
- 32 **Cotton FJ**. Fractures and Joint Dislocations. Philadelphia, PA: WB Saunders, 1910: 549
- 33 **Candal-Couto JJ**, Burrow D, Bromage S, Briggs PJ. Instability of the tibio-fibular syndesmosis: have we been pulling in the wrong direction? *Injury* 2004; **35**: 814-818
- 34 **Xenos JS**, Hopkinson WJ, Mulligan ME, Olson EJ, Popovic NA. The tibiofibular syndesmosis. Evaluation of the ligamentous structures, methods of fixation, and radiographic assessment. *J Bone Joint Surg Am* 1995; **77**: 847-856
- 35 **Leeds HC**, Ehrlich MG. Instability of the distal tibiofibular syndesmosis after bimalleolar and trimalleolar ankle fractures. *J Bone Joint Surg Am* 1984; **66**: 490-503
- 36 **Takao M**, Ochi M, Oae K, Naito K, Uchio Y. Diagnosis of a tear of the tibiofibular syndesmosis. The role of arthroscopy of the ankle. *J Bone Joint Surg Br* 2003; **85**: 324-329
- 37 **Sri-Ram K**, Robinson AH. Arthroscopic assessment of the syndesmosis following ankle fracture. *Injury* 2005; **36**: 675-678
- 38 **Lui TH**, Ip K, Chow HT. Comparison of radiologic and arthroscopic diagnoses of distal tibiofibular syndesmosis disruption in acute ankle fracture. *Arthroscopy* 2005; **21**: 1370
- 39 **Takao M**, Ochi M, Naito K, Iwata A, Kawasaki K, Tobita M, Miyamoto W, Oae K. Arthroscopic diagnosis of tibiofibular syndesmosis disruption. *Arthroscopy* 2001; **17**: 836-843
- 40 **Ono A**, Nishikawa S, Nagao A, Irie T, Sasaki M, Kouno T. Arthroscopically assisted treatment of ankle fractures: arthroscopic findings and surgical outcomes. *Arthroscopy* 2004; **20**: 627-631
- 41 **Hintermann B**, Boss A, Schäfer D. Arthroscopic findings in patients with chronic ankle instability. *Am J Sports Med* 2002; **30**: 402-409
- 42 **LAUGE-HANSEN N**. Fractures of the ankle. II. Combined experimental-surgical and experimental-roentgenologic investigations. *Arch Surg* 1950; **60**: 957-985

- 43 **Miller AN**, Carroll EA, Parker RJ, Boraiah S, Helfet DL, Lorich DG. Direct visualization for syndesmotic stabilization of ankle fractures. *Foot Ankle Int* 2009; **30**: 419-426
- 44 **Gardner MJ**, Brodsky A, Briggs SM, Nielson JH, Lorich DG. Fixation of posterior malleolar fractures provides greater syndesmotic stability. *Clin Orthop Relat Res* 2006; **447**: 165-171

S- Editor Sun H L- Editor Hughes D E- Editor Zheng XM

Ultrasound-assisted musculoskeletal procedures: A practical overview of current literature

Nelson A Royall, Emily Farrin, David P Bahner, Stanislaw PA Stawicki

Nelson A Royall, David P Bahner, Department of Emergency Medicine, The Ohio State University Medical Center, Columbus, OH 43210, United States

Emily Farrin, Department of Orthopaedics, The Ohio State University Medical Center, Columbus, OH 43210, United States

Stanislaw PA Stawicki, Department of Surgery, Division of Critical Care, Trauma and Burn, The Ohio State University Medical Center, Columbus, OH 43210, United States

Author contributions: Royall NA contributed to conception of the manuscript, comprehensive literature search, drafting and critically revising the article and final manuscript approval before publication; Farrin E contributed to comprehensive literature search, drafting and critically revising the article and final manuscript approval before publication; Bahner DP contributed to conception and design, revising the article and final manuscript approval before publication; Stawicki SPA contributed to conception and design, drafting and critically revising the article and final manuscript approval before publication.

Correspondence to: Stanislaw PA Stawicki, MD, Department of Surgery, Division of Critical Care, Trauma and Burn, The Ohio State University Medical Center, Suite 634, 395 West 12th Avenue, Columbus, OH 43210,

United States. stanislaw.stawicki@osumc.edu

Telephone: +1-614-2939348 Fax: +1-614-2939155

Received: June 21, 2011 Revised: June 28, 2011

Accepted: July 5, 2011

Published online: July 18, 2011

ultrasound-based musculoskeletal procedures. In-depth discussion of each ultrasound procedure including pertinent technical details, indications and contraindications is provided. Despite the limited amount of prospective, randomized data in this area, a substantial body of observational and retrospective evidence suggests potential benefits from the use of musculoskeletal bedside sonography.

© 2011 Baishideng. All rights reserved.

Key words: Musculoskeletal ultrasound-guided procedures; Arthrocentesis; Tendon injection; Articular injection; Fluid collection; Abscess drainage; Foreign body removal

Peer reviewer: Nahum Rosenberg, MD, Orthopaedics A, Rambam Medical Center, POB 9602, Haifa 31096, Israel

Royall NA, Farrin E, Bahner DP, Stawicki SPA. Ultrasound-assisted musculoskeletal procedures: A practical overview of current literature. *World J Orthop* 2011; 2(7): 57-66 Available from: URL: <http://www.wjgnet.com/2218-5836/full/v2/i7/57.htm> DOI: <http://dx.doi.org/10.5312/wjo.v2.i7.57>

Abstract

Traditionally performed by a small group of highly trained specialists, bedside sonographic procedures involving the musculoskeletal system are often delayed despite the critical need for timely diagnosis and treatment. Due to this limitation, a need evolved for more portability and accessibility to allow performance of emergent musculoskeletal procedures by adequately trained non-radiology personnel. The emergence of ultrasound-assisted bedside techniques and increased availability of portable sonography provided such an opportunity in select clinical scenarios. This review summarizes the current literature describing common

INTRODUCTION

Bedside procedures involving the musculoskeletal system have traditionally been performed by highly trained specialists. Due to reliance on a select group of practitioners, many procedures may be delayed despite their often urgent nature. As a result, a need arose for more portable and accessible means to allow performance of emergent musculoskeletal procedures by adequately trained emergency surgical and non-surgical personnel. The emergence of ultrasound-assisted bedside techniques and increased availability of portable sonography provided such an opportunity in select clinical scenarios.

The purpose of this review is to summarize the current literature for the most common ultrasound-based musculoskeletal procedures. A thorough discussion of each ultrasound procedure including pertinent technical details and procedural indications/contraindications is included. Although there is a limited number of prospective, randomized studies in this clinical area, there is a significant amount of observational and retrospective evidence that demonstrates potential benefits that stem from ultrasound use in musculoskeletal bedside sonographic applications.

This review will be presented as a series of focused, clinical procedure-oriented sections, each of which is further sub-divided into procedural rationale (including indications and contraindications) and technical overview. Due to the limited scope of this review, the reader is referred to primary literature sources throughout the manuscript for further information pertaining to each topic/procedure.

ARTHOCENTESIS

Rationale

Arthrocentesis involves the aspiration of a synovial joint space, for both therapeutic and diagnostic indications^[1]. It is a commonly performed procedure, with an estimated 50%-62% of general medicine physicians utilizing information from arthrocentesis to guide patient management^[2]. Given the relative simplicity of the procedure and the overall prevalence of joint problems, a general level of comfort with arthrocentesis should be attainable among a variety of medical and surgical specialists. Major clinical indications include: (1) undiagnosed effusion; (2) undiagnosed arthritis; (3) septic arthritis; and (4) symptomatic relief of effusion. Contraindications to arthrocentesis include: (1) active infection overlying the puncture site; (2) tumor/mass overlying the site; and (3) rash overlying the sampling site (relative contraindication).

Adequate anatomic characterization of the intended joint space must be performed prior to arthrocentesis. Physical examination and knowledge of anatomy are crucial to a safe and effective performance of arthrocentesis. With the advent of modern imaging modalities, the practitioner now has multiple methods of anatomic characterization and pre-procedural planning (magnetic resonance imaging, computed tomography, and ultrasound). It is important to note that the physical exam, when compared to ultrasound of the knee, had only a 59% sensitivity and 65% specificity for detection of knee effusions^[3]. This may be due to the finding that the minimal volume of fluid needed for detection on knee ultrasound is approximately 7-10 mL^[4]. Having said that, when compared to other imaging modalities, joint ultrasonography is of uncertain value for purely diagnostic purposes. Thus, the most practical use would be for guidance in diagnostic and therapeutic arthrocentesis^[5].

Current evidence suggests that ultrasound-guided arthrocentesis may be less technically difficult for emer-



Figure 1 Ultrasound-guided arthrocentesis allows confirmation of the needle within the articular space and real-time visualization of fluid withdrawal. Flow can be noted within the articular space by using color or doppler flow while compressing the joint space. This technique prevents inaccurately inserting the needle within solid masses. Note the needle is best visualized when the probe is perpendicular to the needle. Long arrow indicates tibia cortical bone. Short arrow indicates needle tip. Star indicates joint space.

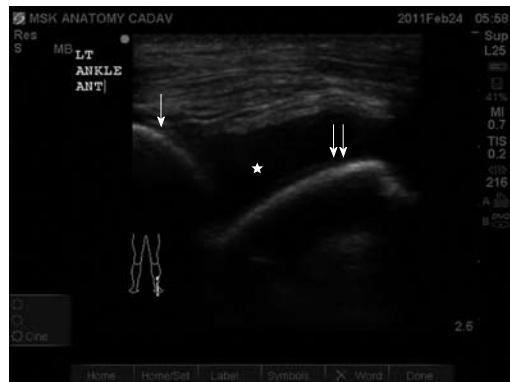


Figure 2 Ultrasound-guided arthrocentesis should be performed by first assessing the joint space for an effusion followed by direct observation of the needle entering the effusion. Use of ultrasound-guided arthrocentesis is highly accurate compared to blind or landmark-techniques for smaller joint spaces such as the tibiotalar joint demonstrated in the image above. Landmarks within the ultrasound image include the bone appearing as a hyperechoic region with superficial tissues including tendons and muscle appearing as heterogeneous echoic regions. Fluid within the joint space appears as hypoechoic shapes that conform to the space. Single white arrow indicates the tibia; double white arrow indicates the talus. Star indicates the tibiotalar effusion.

gency physicians, less time consuming, and produce less pain than the traditional “blind” arthrocentesis^[6]. Specifically, cadaver-derived evidence shows that ultrasound-guided arthrocentesis has a higher success rate compared to traditional blind arthrocentesis, particularly in the smaller joints (metatarsophalangeal, metacarpophalangeal, and proximal interphalangeal joints)^[7,8]. This highlights potential advantages of ultrasound-guided arthrocentesis over traditional methods, especially given the ability of sonography to provide direct visualization of pertinent anatomic structures and confirm accurate entrance of the needle into the joint space (Figures 1 and 2).

Technique overview

The ultrasound-guided arthrocentesis is performed under

standard precautions with appropriate draping of the joint and sterile procedure site preparation. Mandatory procedure site and laterality verification is performed. The ultrasound probe of choice will be determined by the joint of interest. In general, an appropriate probe choice is the linear probe (5-10 MHz) which provides good visualization of most superficial joints^[7,8]. If the joint of interest is deep and the linear probe is unable to provide adequate visualization of the space, a curvilinear probe may be necessary. The ultrasound probe is placed in a sterile cover with ultrasound gel within the probe cover or sterile ultrasound gel placed over the joint space in order to obtain adequate quality images. To help determine the intended joint space, the following recommended sonographic criteria may be helpful: (1) anechoic or hypoechoic space; (2) no evidence of flow under color doppler or power doppler; (3) compressible space under direct probe pressure; (4) hyperechoic region deep to the space of interest indicating the cartilage; and (5) hyperechoic region relative to hyaline cartilage, indicating bone^[7]. After verifying the site of interest, the ultrasound probe should be placed such that the aspirating needle will be directly visualized as it enters the intended fluid space. The needle is inserted into the space under direct observation and the fluid is aspirated with or without direct visualization.

TENDON AND ARTICULAR INJECTIONS

Rationale

Muscle and tendon injections are utilized for various musculoskeletal complaints. One common indication for tendon injections is tendinopathy. Tendinopathies affect over 500 000 people in the United States alone^[9]. Efficacy and safety of injections for management of tendinopathies vary based on the affected site^[10], with the most promising results in the treatment of first annular pulley tendinitis^[11]. Conversely, injections at other sites including the Achilles tendon are controversial as some studies have shown potential adverse effects on biomechanical properties and incidences of tendon rupture^[12,13]. Injections of articular surfaces of joints have been used as a therapy for arthritides and other inflammatory joint conditions. A brief summary of the clinical indications and contraindications are listed below in Table 1. The role of medication injections in the symptomatic and therapeutic treatment of musculoskeletal disease is beyond the scope of this review^[14,15].

Injection of tendons and articular surfaces requires a thorough knowledge of the anatomy as well as a detailed physical examination to determine the optimal injection site and placement of the injection agent. Given the great number of anatomic structures surrounding tendons and articular surfaces, as well as the lack of true physical feedback during needle placement, ensuring safe and appropriate placement may be extremely difficult. The use of advanced imaging techniques such as magnetic resonance imaging (MRI), computed tomography (CT),

Table 1 Ultrasound-guided tendon and articular injections: indications and contraindications

Indications	Contraindications
Tendinopathy Achilles tendinitis Trigger finger Carpal tunnel syndrome Lateral epicondylitis Rotator cuff tendinopathy DeQuervain tenosynovitis	Rash over injection site
Bursitis Trochanteric bursitis Olecranon bursitis	Infection over injection site or obstructing injection path
	Tumor over injection site or obstructing injection path

Table 2 Ultrasound-guided tissue biopsy: indications and contraindications

Indications	Contraindications
Solitary bone lesion with indeterminate imaging characteristics	Infection on overlying site
New bone lesion in patient with known primary tumor	Rash on overlying site (relative)
Determine tumor recurrence	Uncorrected bleeding diathesis (relative) Decreased platelet count (relative)
Evaluate etiology of vertebral body compression fracture	Inaccessible site (relative)
Determine infectious organism in chronic wound	
Determine infectious organism in osteomyelitis	

and ultrasound has allowed more precise visualization of these structures. Due to inherent limitations of real-time MRI and CT scanning for symptomatic injections of the musculoskeletal system, this approach seems to be less useful than sonography.

The use of ultrasound as a real-time imaging modality to directly visualize the needle placement into the tendon or articular surface is practical and safe. Evidence has demonstrated that ultrasound-guided tendon injection reduces pain both during and after the injection, decreases overall patient discomfort, and improves joint or muscle mobility more than traditional blind injections^[16-19]. Furthermore, ultrasound-guided intra-articular injections enable the practitioner to localize fluid collections and perform simultaneous arthrocentesis^[17] (Table 2).

TECHNIQUE OVERVIEW

Ultrasound-guided tendon or articular injection is performed under standard sterile precautions and appropriate preparation/draping of the site. The ultrasound probe of choice will be determined by the intended tendon or articular surface. In general, a good initial probe choice is the linear probe (10-15 MHz) which provides adequate visualization of most superficial structures/spaces. High-



Figure 3 Percutaneous tenotomy or dry-needling can be performed under ultrasound-guidance to provide ideal visualization of the needle. Use of the short-axis plane should be to localize neighboring structures and visualize complete disruption of the tendon fibers. Use of the long-axis plane should be to confirm complete disruption of the tendon from anterior to posterior. However, the actual procedure should be performed within the short-axis plane as maintaining the needle in long-axis is difficult and unreliable to prevent neighboring structure damage. Confirmation of the structure as tendon fibers should rely on noting anisotropy which is characteristic of tendons. Short arrow indicates needle tip. Long arrows indicate Achilles tendon sheath. Stars indicate Achilles tendon fibers in long-axis plane.

frequency transducers provide the best resolution for near-field tendons, although a curvilinear probe may be needed to visualize deep joint articular surfaces. The ultrasound probe is placed within a sterile cover with ultrasound gel within the cover or sterile ultrasound gel placed directly over the intended site. After procedure site and laterality are confirmed, the site is scanned in order to inspect regional anatomy and identify any nearby neurovascular structures. In the case of tendon injections, the muscle and tendon should be scanned throughout their course to determine the safest and most optimal injection site. For articular injections, the joint space should be scanned in all dimensions to determine the safest/optimal injection site. Whenever possible, the probe is placed so that the tendon is seen in longitudinal section, as a higher success rate for tendon injections has been noted in this view. Otherwise, a transverse section can be utilized^[18]. The needle is inserted such that it is seen at all times and can be directly visualized entering the tendon or articular space. The authors recommend injection of the agent under direct visualization to prevent inadvertent application into the peri-tendinous or peri-articular structures. Representative ultrasound images can be seen in Figures 3 and 4.

TISSUE BIOPSY

Rationale

In certain clinical situations, a diagnostic biopsy may be necessary before pursuing a more definitive treatment course. The ability to rapidly diagnose and initiate treatment may help improve outcomes. The advent of ultrasound-guided biopsies of the musculoskeletal system allows an appropriately trained clinician to readily obtain



Figure 4 Ultrasound-guided injection of the left flexor tendon in transverse plane. Tendon injection under ultrasound (US)-guidance allows improved accuracy in tendon injection. Furthermore, US-guidance allows visualization of the fluid forming a complete peri-tendon fluid collection as noted by the hypoechoic space surrounding the heterogenous tendon appearance. Short arrow indicates the needle in transverse. Long arrow indicates flexor tendon in transverse section.

Table 3 Ultrasound-guided drainage and catheter insertion: indications and contraindications

Indications	Contraindications
Undiagnosed soft tissue collection	Infection on overlying site
Cyst	
Abscess	
Hematoma	
Diagnosis of Abscess	Rash on overlying site (relative)
Obtain fluid for determination of causative organism	
Treatment of known abscess	Tumor on overlying site (relative)
Aspiration	
Placement of drainage catheter (if feasible)	
Aspiration of Cyst	
Ganglion cyst	
Synovial cyst	
Determination of causative organism for osteomyelitis	

important diagnostic information in situations where a rapidly progressive disease process is being considered. Furthermore, in situations where trained interventional radiologists are either unavailable or unable to perform timely biopsies, the ability of a general clinician to perform bedside biopsies may be invaluable in conserving medical resources. In the musculoskeletal system the differential diagnosis can include a large number of pathologies (i.e. primary bone tumors, bony tumor metastases, infections, and chronic inflammatory changes). A brief listing of clinical indications and contraindications is listed below in Table 3. More comprehensive discussion of this topic is beyond the scope of this review^[20]. It should be noted that a suspected primary tumor of bone or soft tissue in the musculoskeletal system should only be biopsied by a physician trained in orthopaedic oncology. Also, biopsy performed by general clinicians or at the referring facility (rather than definitive treatment center) may in-

crease both diagnostic errors and complication rates (i.e. need for wider tumor resection at time of surgery, skin complications requiring flap coverage, increased risk of amputation)^[21].

Biopsy of the musculoskeletal system includes a broad grouping of procedures that may be divided into open and percutaneous procedures. While certain clinical scenarios preclude percutaneous biopsy and require an open procedure, percutaneous biopsy should be attempted, if possible and safe, to decrease patient discomfort and diagnostic costs^[22]. Percutaneous biopsies can be further grouped by the type of imaging guidance used to aid the clinician performing the biopsy. Traditional percutaneous biopsy consists of utilizing physical exam findings and knowledge of anatomy to place the needle within the lesion of interest, a method utilized infrequently when the depth of the lesion is beyond a few centimeters of tissue. The availability of CT-guided and fluoroscopically-guided biopsies allows the clinician to perform highly accurate needle placement into lesions that are located near critical/sensitive (i.e. neurovascular) structures or in deeper locations^[20]. Advances in ultrasound technology and clinical implementation have made ultrasound-guided musculoskeletal biopsies both feasible and accurate^[23-28]. Ultrasound-guided needle and core biopsy sensitivities in obtaining the tissue of interest range from 80%-98.4%^[23-28]. Core-needle biopsy has been demonstrated to have a higher sensitivity in obtaining diagnosis with estimated sensitivity of 81%-95% compared to 76%-80% for fine-needle aspiration^[25-27,29]. Additionally, a method of creating a portal to enable forceps to perform a comprehensive biopsy of synovium has been described^[30]. While there may be a perception that ultrasound is less facilitating when performing a diagnostic biopsy of bone lesions, evidence shows sampling accuracy for such lesions of 92%-98% for ultrasound compared to 87% for CT-guided biopsies of similar lesions^[23,25]. Conventional biopsy performed under ultrasound-guidance relies on the echogenicity of the needle to localize it during the procedure - not always an easy task. Recent improvements may further aid the clinician in visualizing the needle. For example, biopsy needles are available that have been coated with echogenic surface markers (Teflon, etched tips, and an echogenic polymer) or feature a vibration system^[29,31]. While there is limited data supporting the use of these types of needles, the use of polymer coated needles may be the most beneficial for technically difficult biopsies^[31]. While further discussion on fine-needle aspiration *vs* core-needle biopsy in musculoskeletal lesions is beyond the scope of this review, it is important to note that the suspected etiology may dictate the type of percutaneous biopsy required Table 2.

Methods

Ultrasound-guided biopsy is performed under standard sterile conditions (i.e. appropriate procedural preparation and draping) over the intended biopsy site. Site and laterality verification is essential. The choice of the ultrasound

probe, as described in previous sections, should be guided by the anatomic location of the tissue to be sampled. The linear probe (10-15 MHz) provides appropriate visualization of most superficial sites including joints, superficial muscles, and superficial bones. For sites located deeper, a curvilinear probe (5-10 MHz) may be required. The ultrasound gel is then utilized as needed throughout the course of the procedure.

The first step in performing an adequate tissue biopsy is to confirm the site of the lesion, bone or soft tissue. If the lesion is located within the bone then a larger (i.e. 14-gauge) cutting needle should be used to allow for bone fragments to be contained within the needle sample. If the lesion is located within the soft tissues then a smaller (18 or 20 gauge) needle is usually sufficient^[22-28,31,32]. Local analgesia should be used generously for all biopsy procedures and should be performed along the entire anticipated biopsy tract (including periosteum and adjacent muscles) prior to initiation of the procedure. Sedation is not universally required, but may be needed for more extensive procedures and may help facilitate more accurate sampling and improve patient comfort. When utilized, sedation requires additional monitoring (i.e. frequent vital sign and pulse oxymetry assessments) and personnel (i.e. sedation nurse and/or anesthesiologist). When possible, the performance of biopsy under local anesthetic is preferred, with sedation used if the patient is unable to tolerate the pain and/or anxiety associated with the procedure.

Prior to the incision for the biopsy, a sonographic scan of the intended biopsy site should be performed to visualize all critical anatomic structures in the area. The optimal biopsy path should be determined based on avoidance of nearby vessels/nerves, and avoidance of muscles if possible. Again, when primary musculoskeletal malignancy is suspected, it is imperative that the biopsy tract be determined by an orthopaedic oncologist, as biopsy obtained *via* an improperly planned tract may be a factor in subsequent inability to perform limb salvage surgery^[21]. Identification of vascular structures in the area of biopsy using color or power Doppler is encouraged^[31]. Detailed recording of the lesion echogenicity, margins, mass size, relation to bone (cortical invasion), and vascularity is an essential part of pre-biopsy evaluation of the intended sampling site because procedural bleeding or even the very presence of a biopsy tract can distort critical sonographic characteristics of the lesion in question^[25]. A small stab incision is then made in pre-marked skin and the biopsy needle is inserted into the lesion under direct sonographic visualization. Longitudinal orientation of the needle in relation to the ultrasound probe is preferred. Once the needle is confirmed to be within the lesion of interest, the biopsy is performed and the needle is removed with or without ultrasound visualization. A post-biopsy ultrasound scan of the region should be performed to confirm hemostasis of the sampled area. The biopsy specimen should then be handled according to established pathology guidelines regarding tissue/sample processing.

FLUID COLLECTION ASPIRATION AND DRAINAGE CATHETER INSERTION

Rationale

Tissue fluid collections are common in all areas of medicine. Therefore, practitioners in a variety of medical fields need to be aware of the relevant diagnostic and therapeutic considerations concerning tissue fluid collections. Within the realm of the musculoskeletal system, some specific subtypes of cysts and abscesses have been studied particularly closely. In general, the diagnosis of a fluid collection can be readily made using ultrasound, CT, or MRI. In many situations, the optimal therapy is either to aspirate the contents of the fluid collection or to place a drainage catheter for continuous drainage, depending on the precise character and/or size of the collection in question. A list of indications and contraindications for percutaneous aspiration or drainage catheter placement in the setting of tissue fluid collections is listed in Table 3. More comprehensive review of this topic is beyond the scope of this manuscript.

Ultrasound has been well described as a tool for diagnosis of tissue fluid collections as well as characterization of soft tissue infections^[33-35]. A brief listing of types of soft tissue infections where ultrasound can be used for diagnosis can be seen in Table 4^[33-35]. Additionally, ultrasound can be used to aid in the diagnosis of osteomyelitis, particularly in pediatric cases^[36]. There is also evidence to support the use of ultrasound in the diagnosis and characterization of soft tissue cysts in the musculoskeletal system^[37-39]. For example, the reported sensitivity and specificity for ultrasound in the diagnosis of meniscal cysts is 97% and 86%, respectively^[37]. However, evidence on the use of ultrasound as a therapeutic aid in aspiration or drainage catheter insertion is still limited. Currently, the most common method to perform fluid collection characterization is by imaging, with aspiration of fluid for analysis in clinically uncertain scenarios.

The use of ultrasound as an image-guidance method in the setting of tissue fluid collections is a relatively new concept. Among musculoskeletal applications, there may be distinct advantages of ultrasound as an image-guidance tool. Firstly, ultrasound-guided aspiration has been identified as an effective method for treating both ganglionic and synovial cysts^[40-43]. Given the evidence to support ultrasound as a diagnostic tool and the ease, cost, and lack of ionizing radiation exposure, the use of ultrasound-guidance in aspiration of these fluid collections should be considered as first-line therapy. Although a discussion of the optimal therapy for various ganglion and synovial cysts is beyond the scope of this review, there is some evidence to support the use of guided aspiration prior to or in lieu of surgical therapy^[44]. For infectious indications, the use of ultrasound for both diagnostic and therapeutic purposes is also well described^[45-52]. Ultrasound-guided aspiration or drainage catheter insertion has been successfully used to obtain fluid samples for microbial cultures as well as therapeutic drainage of

Table 4 Soft tissue infections identifiable on sonography

Cellulitis
Necrotizing fasciitis
Infective bursitis
Infective tenosynovitis
Pyomyositis
Abscess
Hydatid or Tuberculous cysts
Septic arthritis
Post-operative infection
Foreign body

collections^[46-51]. There is also evidence supporting the use of ultrasound-guided techniques in the critically ill where transporting patients between different hospital locations may be either dangerous or not at all feasible^[50]. In the case of multiple abscesses requiring drainage, the use of ultrasound guidance is further supported due to the ability to manipulate the probe rather than the patient, as well as the avoidance of excessive/additional exposure to ionizing radiation seen with CT-guidance^[48]. Another potential application of ultrasound is the performance of tissue aspiration for cultures in the diagnosis of suspected osteomyelitis. While data are still limited, the current literature suggests that ultrasound guidance can be particularly helpful when obtaining tissue samples in suspected pediatric osteomyelitis^[45].

Technique

Ultrasound-guided aspiration or drainage catheter insertion is performed under standard sterile conditions. Procedure site/laterality confirmation is essential. The ultrasound probe of choice is determined by the characteristics of the tissue in question. The linear probe (10-15 MHz) provides appropriate visualization of most soft tissue sites. For deeper lesions, a curvilinear probe (5-10 MHz) may be preferred/necessary. After placing the probe in a sterile cover and applying ultrasound gel, a brief scan through the site of interest should be performed prior to any definitive procedural intervention(s). Critical structures such as vessels and nerves should be identified. The fluid collection in question should be clearly identified and described with regards to the type (i.e. cyst), size, and overall characteristics (i.e. simple vs complex).

The ultrasound probe is then placed over the region of interest, with visualization of the needle passage in longitudinal section being preferred. The needle (typically 20- or 22-gauge) is inserted under direct sonographic visualization. Once the needle is within the fluid collection, an aspirate is obtained for analysis. If there is evidence of purulence or other signs of infection, then the placement of a drainage catheter should be considered. This involves the use of a larger needle with a guide-wire being inserted through the needle into the fluid space^[50]. After removing the needle with the guide-wire left in place, a dilator is placed over the guide-wire and the insertion site

Table 5 Percutaneous ultrasound-guided tenotomy: indications and contraindications

Indications	Contraindications
Chronic tendinosis refractory to conservative therapy	Infection on overlying site
Common extensor tendinosis	
Achilles tendinopathy	
Patellar tendinopathy	
Iliotibial band syndrome	
Trigger finger	
Symptomatic tendon release	Tumor on overlying site
Developmental dysplasia of the hip	
Spastic cerebral palsy	
Deformities of the foot	
	Rash on overlying site (relative)

is expanded to accommodate an appropriately-sized catheter^[50]. The catheter is then inserted over the guide-wire and placement of the catheter within the fluid collection confirmed by direct visualization. After removing the guide-wire, the catheter is sutured in place and connected to an appropriate drainage system.

PERCUTANEOUS TENOTOMY

Rationale

Tenotomy is the complete or incomplete surgical division of a tendon for therapeutic purposes. The procedure has been described for a myriad of purposes with some of the original descriptions relating to the treatment of foot deformities^[53]. The procedure can be performed using either an open or percutaneous method. The open version of the procedure was the first described and allows direct visualization of all para-tendon structures and the pathologic region of the tendon to confirm the diagnosis^[53]. However, with the advent of percutaneous techniques, shorter procedural times and improved aesthetic outcomes became possible. Furthermore, there is evidence to suggest that percutaneous tenotomy is as safe and effective as the open procedure. It is notable that the extent of the tendinous portion divided in the muscle of interest appears directly correlated with increased postoperative mobility^[54,55]. In animal studies, ultrasound-guided percutaneous tenotomy has been shown to increase complete tendon transection and decrease damage to surrounding structures compared to palpation-guided tenotomy. A brief listing of clinical indications and contraindications for percutaneous tenotomy are listed in Table 5. A comprehensive discussion of this topic is beyond the scope of this review^[53-63].

Percutaneous tenotomy is ideally performed at the bedside or in an outpatient setting. The percutaneous approach was first described in the setting of tenotomy of the common extensor tendon for “tennis elbow” with symptomatic improvement equivalent to other surgical procedures^[64,65]. The procedure has since been implemented for a variety of tendinopathies. While the initial descriptions of percutaneous tenotomy involved blind

palpation and determination of the site using anatomic landmarks alone, recent advances in imaging modalities have significantly enhanced the anatomic accuracy of tenotomy procedures. Although CT- and MRI-guided tenotomy is possible, the literature focuses heavily on ultrasound-guidance for percutaneous procedures. Although MRI and other advanced imaging modalities offer an accurate method of diagnosing tendinopathy and/or other tendon abnormalities, the reported sensitivity of ultrasound in tendinopathies of 67%-100% is sufficient to recommend it as a screening exam based, given cost and time requirements compared to the other imaging modalities^[66,67]. There is also evidence from animal models that, compared to surface anatomy/palpation-based techniques, ultrasound-guided tenotomy may be more accurate, faster, and associated with less morbidity^[68].

Technique

Ultrasound-guided percutaneous tenotomy is performed under full sterile precautions and standard draping over the site of interest. Procedural site/laterality confirmation is essential. The ultrasound probe of choice will be determined by anatomic considerations. Most practitioners choose a high frequency (10-15 MHz) linear probe when approaching most superficial structures. If the tendon of interest is located deeper or cannot be visualized anterior to bone or cartilage, then a lower frequency (5-10 MHz) curvilinear probe may be more appropriate. Using a sterile ultrasound cover and gel, a brief scan of the site of interest should be performed prior to any invasive intervention(s). In addition to identifying any important neuro-vascular structures, the preliminary scan may help better characterize the region of interest for the tenotomy. Typical findings of tendinopathy on ultrasound include hypoechoic or anechoic regions within a tendon. Calcifications may appear as hyperechoic regions with clean shadows deep to the region, and tenderness to transducer pressure over the affected area may be present^[66,67]. Most ultrasound machines can also facilitate color or power Doppler imaging to evaluate for vascularity of the region and help guide the procedure to minimize the potential for bleeding.

Although there are different ways to perform a tenotomy, we will focus on techniques that use ultrasound-guidance. Specifically, we will discuss partial tenotomy using a needle (needling) and complete tenotomy using a scalpel^[56-61]. The anatomic region of interest is first injected with local anesthetic. There is currently no evidence to support the routine use of general anesthesia for this procedure^[56-61]. Subsequent to achieving adequate analgesia, the ultrasound probe is positioned parallel to the tendon of interest in order to help guide the procedure, preferably in the longitudinal view.

Needle-based percutaneous tenotomy is performed by using a narrow (20- or 22-gauge) needle, which is inserted under direct ultrasound guidance and penetrates the abnormal tendon region while avoiding neighboring structures. Any calcifications are disrupted during needle



Figure 5 Tendon injection can be performed in either transverse or longitudinal planes. Insertion of the needle in long-axis allows excellent visualization of the tendon sheath and tendon fibers. Prior to injection the needle tip should be well-visualized between the tendon sheath and the tendon fibers. An important method to ensure needle visualization is to angle the probe to make the angle of ultrasound wave as close to perpendicular as possible. Additionally, confirmation of a structure as a tendon involves angling the probe along the tendon to note tendon anisotropy characteristic of a tendon and not noted in nerves or vessels. Short arrow indicates needle tip in long-axis section. Long arrows indicate tendon sheath. Star indicates tendon fibers in long-axis section.

passes through the region. This is repeated under direct ultrasound visualization until the entire tendon has been disrupted by the needle.

Section tenotomy using scalpel is performed using a number 11 blade scalpel. The scalpel is inserted parallel to the tendon fibers under direct ultrasound visualization and penetrates the fibers^[57,58]. The cutting edge of the blade is initially pointed proximally on the tendon^[57,58]. The joint is then passively flexed and extended under visualization. The scalpel is then withdrawn and rotated so that the cutting edge is pointed distally on the tendon. Joint flexion and extension is then repeated^[57,58]. This produces a disruption of a single region within the tendon fibers. The procedure is then repeated by angling the scalpel so that the blade penetrates a series of tendon fibers lateral to the original incision. This is then repeated until the tendon is completely disrupted along the region of interest. The skin incision should be minimized to a single entry point, thus decreasing the chance of any additional tissue injury. A representative sonographic example of tenotomy can be seen in Figure 5.

OTHER POTENTIAL USES

Foreign body removal

Ultrasound has been utilized in diagnosis and treatment of various types of foreign bodies within the soft tissue including wood, plastic, and other radiolucent objects^[69-72]. There is evidence to support the use of ultrasound as a screening tool for foreign bodies and identification of critical neighboring structures that may present difficulty during the removal of the object in question. Compared to imaging techniques such as plain radiography or computed tomography, modern ultrasound equipment is capable of rapidly producing a 3-dimensional image of the area in question and allows the physician to quickly and efficiently

plan a surgical or percutaneous removal of the foreign object. In situations where the exact nature of the foreign object is unknown, imaging methods such as MRI may be contraindicated due to the migration risk of metallic objects. Although the evidence is still limited, the use of ultrasound guidance during the removal of foreign bodies should be considered in appropriately selected cases^[69-73].

CONCLUSION

The ultimate goal of all image-guided procedures is to maximize patient safety, improve procedural accuracy, and optimize clinical outcomes. In addition to facilitating these objectives, ultrasound-guidance also offers the benefit of eliminating ionizing radiation exposure during procedures. Ultrasound-guided musculoskeletal procedures described in this review demonstrate the growing trend of using ultrasound as first-line modality in selected bedside musculoskeletal applications, among both specialist and generalist physicians. While additional information is needed to refine the utilization of ultrasound-guided bedside musculoskeletal procedures, there is sufficient evidence to support their increasing use in everyday clinical practice, as outlined in this review. The authors emphasize the need for adequate training, accreditation, and maintenance of skills among those who perform ultrasound-based procedures described herein, regardless of their specialty.

REFERENCES

- 1 Bianchi S, Zamorani MP. US-guided interventional procedures. In: Bianchi S, Martinoli C, editors. Ultrasound of the musculoskeletal system. Berlin: Springer-Verlag, 2007: 891-917
- 2 Thakkar R, Wright SM, Alguire P, Wigton RS, Boonyasai RT. Procedures performed by hospitalist and non-hospitalist general internists. *J Gen Intern Med* 2010; **25**: 448-452
- 3 Kane D, Balint PV, Sturrock RD. Ultrasonography is superior to clinical examination in the detection and localization of knee joint effusion in rheumatoid arthritis. *J Rheumatol* 2003; **30**: 966-971
- 4 Delaunoy I, Feipel V, Appelboom T, Hauzeur JP. Sonography detection threshold for knee effusion. *Clin Rheumatol* 2003; **22**: 391-392
- 5 Weybright PN, Jacobson JA, Murry KH, Lin J, Fessell DP, Jamadar DA, Kabeto M, Hayes CW. Limited effectiveness of sonography in revealing hip joint effusion: preliminary results in 21 adult patients with native and postoperative hips. *AJR Am J Roentgenol* 2003; **181**: 215-218
- 6 Wiler JL, Costantino TG, Filippone L, Satz W. Comparison of ultrasound-guided and standard landmark techniques for knee arthrocentesis. *J Emerg Med* 2010; **39**: 76-82
- 7 Balint PV, Kane D, Hunter J, McInnes IB, Field M, Sturrock RD. Ultrasound guided versus conventional joint and soft tissue fluid aspiration in rheumatology practice: a pilot study. *J Rheumatol* 2002; **29**: 2209-2213
- 8 Raza K, Lee CY, Pilling D, Heaton S, Situnayake RD, Carruthers DM, Buckley CD, Gordon C, Salmon M. Ultrasound guidance allows accurate needle placement and aspiration from small joints in patients with early inflammatory arthritis. *Rheumatology (Oxford)* 2003; **42**: 976-979
- 9 Tanaka S, Petersen M, Cameron L. Prevalence and risk factors of tendinitis and related disorders of the distal upper

- extremity among U.S. workers: comparison to carpal tunnel syndrome. *Am J Ind Med* 2001; **39**: 328-335
- 10 Coombes BK, Bisset L, Vicenzino B. Efficacy and safety of corticosteroid injections and other injections for management of tendinopathy: a systematic review of randomised controlled trials. *Lancet* 2010; **376**: 1751-1767
 - 11 Marks MR, Gunther SF. Efficacy of cortisone injection in treatment of trigger fingers and thumbs. *J Hand Surg Am* 1989; **14**: 722-727
 - 12 Metcalfe D, Achten J, Costa ML. Glucocorticoid injections in lesions of the achilles tendon. *Foot Ankle Int* 2009; **30**: 661-665
 - 13 Hugate R, Pennypacker J, Saunders M, Juliano P. The effects of intratendinous and retrocalcaneal intrabursal injections of corticosteroid on the biomechanical properties of rabbit Achilles tendons. *J Bone Joint Surg Am* 2004; **86-A**: 794-801
 - 14 Inês LP, da Silva JA. Soft tissue injections. *Best Pract Res Clin Rheumatol* 2005; **19**: 503-527
 - 15 Fredberg U. Local corticosteroid injection in sport: review of literature and guidelines for treatment. *Scand J Med Sci Sports* 1997; **7**: 131-139
 - 16 Naredo E, Cabero F, Beneyto P, Cruz A, Mondéjar B, Usón J, Palop MJ, Crespo M. A randomized comparative study of short term response to blind injection versus sonographic-guided injection of local corticosteroids in patients with painful shoulder. *J Rheumatol* 2004; **31**: 308-314
 - 17 Sibbitt WL, Peisajovich A, Michael AA, Park KS, Sibbitt RR, Band PA, Bankhurst AD. Does sonographic needle guidance affect the clinical outcome of intraarticular injections? *J Rheumatol* 2009; **36**: 1892-1902
 - 18 Luz KR, Furtado RN, Nunes CC, Rosenfeld A, Fernandes AR, Natour J. Ultrasound-guided intra-articular injections in the wrist in patients with rheumatoid arthritis: a double-blind, randomised controlled study. *Ann Rheum Dis* 2008; **67**: 1198-1200
 - 19 Smith J, Finnoff JT, Santaella-Sante B, Henning T, Levy BA, Lai JK. Sonographically guided popliteus tendon sheath injection: techniques and accuracy. *J Ultrasound Med* 2010; **29**: 775-782
 - 20 Gogna A, Peh WC, Munk PL. Image-guided musculoskeletal biopsy. *Radiol Clin North Am* 2008; **46**: 455-473, v
 - 21 Mankin HJ, Mankin CJ, Simon MA. The hazards of the biopsy, revisited. Members of the Musculoskeletal Tumor Society. *J Bone Joint Surg Am* 1996; **78**: 656-663
 - 22 Ward WG, Kilpatrick S. Fine needle aspiration biopsy of primary bone tumors. *Clin Orthop Relat Res* 2000; 80-87
 - 23 Saifuddin A, Mitchell R, Burnett SJ, Sandison A, Pringle JA. Ultrasound-guided needle biopsy of primary bone tumours. *J Bone Joint Surg Br* 2000; **82**: 50-54
 - 24 Konermann W, Wuisman P, Ellermann A, Gruber G. Ultrasonographically guided needle biopsy of benign and malignant soft tissue and bone tumors. *J Ultrasound Med* 2000; **19**: 465-471
 - 25 Gil-Sánchez S, Marco-Doménech SF, Irurzun-López J, Fernández-García P, de la Iglesia-Cerdeña P, Ambit-Capdevila S. Ultrasound-guided skeletal biopsies. *Skeletal Radiol* 2001; **30**: 615-619
 - 26 Torriani M, Etchebehere M, Amstalden E. Sonographically guided core needle biopsy of bone and soft tissue tumors. *J Ultrasound Med* 2002; **21**: 275-281
 - 27 Yeow KM, Tan CF, Chen JS, Hsueh C. Diagnostic sensitivity of ultrasound-guided needle biopsy in soft tissue masses about superficial bone lesions. *J Ultrasound Med* 2000; **19**: 849-855
 - 28 Rubens DJ, Fultz PJ, Gottlieb RH, Rubin SJ. Effective ultrasonographically guided intervention for diagnosis of musculoskeletal lesions. *J Ultrasound Med* 1997; **16**: 831-842
 - 29 Tikkakoski T, Päivänsalo M, Similuoto T, Hiltunen S, Typpö T, Jartti P, Apaja-Sarkkinen M. Percutaneous ultrasound-guided biopsy. Fine needle biopsy, cutting needle biopsy, or both? *Acta Radiol* 1993; **34**: 30-34
 - 30 Koski JM, Helle M. Ultrasound guided synovial biopsy using portal and forceps. *Ann Rheum Dis* 2005; **64**: 926-929
 - 31 Jandzinski DL, Carson N, Davis D, Rubens DJ, Voci SL, Gottlieb RH. Treated needles: do they facilitate sonographically guided biopsies? *J Ultrasound Med* 2003; **22**: 1233-1237
 - 32 Jones CD, McGahan JP, Clark KJ. Color Doppler ultrasonographic detection of a vibrating needle system. *J Ultrasound Med* 1997; **16**: 269-274
 - 33 Chau CL, Griffith JF. Musculoskeletal infections: ultrasound appearances. *Clin Radiol* 2005; **60**: 149-159
 - 34 Koc Z, Ağıldıre AM, Yalcın O, Pourbagher A, Pourbagher M. Primary hydatid cyst in the anterior thigh: Sonographic findings. *J Clin Ultrasound* 2004; **32**: 358-360
 - 35 Vastyam AM, MacKinnon EA. Primary psoas abscess in a neonate. *Am J Perinatol* 2006; **23**: 253-254
 - 36 Chao HC, Lin SJ, Huang YC, Lin TY. Color Doppler ultrasonographic evaluation of osteomyelitis in children. *J Ultrasound Med* 1999; **18**: 729-734; quiz 735-736
 - 37 Rutten MJ, Collins JM, van Kampen A, Jager GJ. Meniscal cysts: detection with high-resolution sonography. *AJR Am J Roentgenol* 1998; **171**: 491-496
 - 38 Ward EE, Jacobson JA, Fessell DP, Hayes CW, van Holsbeeck M. Sonographic detection of Baker's cysts: comparison with MR imaging. *AJR Am J Roentgenol* 2001; **176**: 373-380
 - 39 Seymour R, Lloyd DC. Sonographic appearances of meniscal cysts. *J Clin Ultrasound* 1998; **26**: 15-20
 - 40 Chiou HJ, Chou YH, Wu JJ, Hsu CC, Tiu CM, Chang CY, Yu C. Alternative and effective treatment of shoulder ganglion cyst: ultrasonographically guided aspiration. *J Ultrasound Med* 1999; **18**: 531-535
 - 41 DeFriend DE, Schranz PJ, Silver DA. Ultrasound-guided aspiration of posterior cruciate ligament ganglion cysts. *Skeletal Radiol* 2001; **30**: 411-414
 - 42 Nakamichi K, Tachibana S. Ganglion-associated ulnar tunnel syndrome treated by ultrasonographically assisted aspiration and splinting. *J Hand Surg Br* 2003; **28**: 177-178
 - 43 Macmahon PJ, Brennan DD, Duke D, Forde S, Eustace SJ. Ultrasound-guided percutaneous drainage of meniscal cysts: preliminary clinical experience. *Clin Radiol* 2007; **62**: 683-687
 - 44 Stephen AB, Lyons AR, Davis TR. A prospective study of two conservative treatments for ganglia of the wrist. *J Hand Surg Br* 1999; **24**: 104-105
 - 45 Azam Q, Ahmad I, Abbas M, Syed A, Haque F. Ultrasound and colour Doppler sonography in acute osteomyelitis in children. *Acta Orthop Belg* 2005; **71**: 590-596
 - 46 Ormeci N, Idilman R, Akyar S, Palabıyikoğlu M, Coban S, Erdem H, Ekiz F. Hydatid cysts in muscle: a modified percutaneous treatment approach. *Int J Infect Dis* 2007; **11**: 204-208
 - 47 Dib M, Bedu A, Garel C, Mazda K, Philippe-Chomette P, Rajguru M, Hassan M, Aujard Y. Ilio-psoas abscess in neonates: treatment by ultrasound-guided percutaneous drainage. *Pediatr Radiol* 2000; **30**: 677-680
 - 48 Heneghan JP, Everts RJ, Nelson RC. Multiple fluid collections: CT- or US-guided aspiration--evaluation of microbiologic results and implications for clinical practice. *Radiology* 1999; **212**: 669-672
 - 49 Ohara N, Tominaga O, Uchiyama M, Nakano H, Muto T. Primary iliopsoas abscess successfully treated by ultrasonographically guided percutaneous drainage. *J Orthop Sci* 1998; **3**: 221-224
 - 50 Crass JR, Karl R. Bedside drainage of abscesses with sonographic guidance in the desperately ill. *AJR Am J Roentgenol* 1982; **139**: 183-185
 - 51 Dinç H, Onder C, Turhan AU, Sari A, Aydin A, Yuluğ G, Gümele HR. Percutaneous catheter drainage of tuberculous and nontuberculous psoas abscesses. *Eur J Radiol* 1996; **23**: 130-134
 - 52 Chao HC, Lin SJ, Huang YC, Lin TY. Sonographic evaluation of cellulitis in children. *J Ultrasound Med* 2000; **19**: 743-749
 - 53 Barwell R. On Certain Grave Evils attending Tenotomy, and

- on a new mode of curing Deformities of the Foot. *Med Chir Trans* 1862; **45**: 25-41
- 54 **El Hage S**, Rachkidi R, Noun Z, Haidar R, Dagher F, Kharrat K, Ghanem I. Is percutaneous adductor tenotomy as effective and safe as the open procedure? *J Pediatr Orthop* 2010; **30**: 485-488
- 55 **Dunkow PD**, Jatti M, Muddu BN. A comparison of open and percutaneous techniques in the surgical treatment of tennis elbow. *J Bone Joint Surg Br* 2004; **86**: 701-704
- 56 **Rajeswaran G**, Lee JC, Eckersley R, Katsarma E, Healy JC. Ultrasound-guided percutaneous release of the annular pulley in trigger digit. *Eur Radiol* 2009; **19**: 2232-2237
- 57 **Testa V**, Capasso G, Maffulli N, Bifulco G. Ultrasound-guided percutaneous longitudinal tenotomy for the management of patellar tendinopathy. *Med Sci Sports Exerc* 1999; **31**: 1509-1515
- 58 **Testa V**, Capasso G, Benazzo F, Maffulli N. Management of Achilles tendinopathy by ultrasound-guided percutaneous tenotomy. *Med Sci Sports Exerc* 2002; **34**: 573-580
- 59 **McShane JM**, Nazarian LN, Harwood MI. Sonographically guided percutaneous needle tenotomy for treatment of common extensor tendinosis in the elbow. *J Ultrasound Med* 2006; **25**: 1281-1289
- 60 **McShane JM**, Shah VN, Nazarian LN. Sonographically guided percutaneous needle tenotomy for treatment of common extensor tendinosis in the elbow: is a corticosteroid necessary? *J Ultrasound Med* 2008; **27**: 1137-1144
- 61 **Housner JA**, Jacobson JA, Misko R. Sonographically guided percutaneous needle tenotomy for the treatment of chronic tendinosis. *J Ultrasound Med* 2009; **28**: 1187-1192
- 62 **Tamir E**, McLaren AM, Gadgil A, Daniels TR. Outpatient percutaneous flexor tenotomies for management of diabetic claw toe deformities with ulcers: a preliminary report. *Can J Surg* 2008; **51**: 41-44
- 63 **Lakhey S**, Mansfield M, Pradhan RL, Rijal KP, Paney BP, Manandhar RR. Percutaneous extensor tenotomy for chronic tennis elbow using an 18G needle. *Kathmandu Univ Med J (KUMJ)* 2007; **5**: 446-448
- 64 **Rosen MJ**, Duffy FP, Miller EH, Kremchek EJ. Tennis elbow syndrome: results of the "lateral release" procedure. *Ohio State Med J* 1980; **76**: 103-109
- 65 **Yerger B**, Turner T. Percutaneous extensor tenotomy for chronic tennis elbow: an office procedure. *Orthopedics* 1985; **8**: 1261-1263
- 66 **Tran N**, Chow K. Ultrasonography of the elbow. *Semin Musculoskelet Radiol* 2007; **11**: 105-116
- 67 **Stewart B**, Harish S, Oomen G, Wainman B, Popowich T, Moro JK. Sonography of the lateral ulnar collateral ligament of the elbow: study of cadavers and healthy volunteers. *AJR Am J Roentgenol* 2009; **193**: 1615-1619
- 68 **Esterline ML**, Armbrust L, Roush JK. A comparison of palpation guided and ultrasound guided percutaneous biceps brachii tenotomy in dogs. *Vet Comp Orthop Traumatol* 2005; **18**: 135-139
- 69 **Bray PW**, Mahoney JL, Campbell JP. Sensitivity and specificity of ultrasound in the diagnosis of foreign bodies in the hand. *J Hand Surg Am* 1995; **20**: 661-666
- 70 **Hill R**, Conron R, Greissinger P, Heller M. Ultrasound for the detection of foreign bodies in human tissue. *Ann Emerg Med* 1997; **29**: 353-356
- 71 **Crystal CS**, Masneri DA, Hellums JS, Kaylor DW, Young SE, Miller MA, Levsky ME. Bedside ultrasound for the detection of soft tissue foreign bodies: a cadaveric study. *J Emerg Med* 2009; **36**: 377-380
- 72 **Young AS**, Shiels WE, Murakami JW, Coley BD, Hogan MJ. Self-embedding behavior: radiologic management of self-inserted soft-tissue foreign bodies. *Radiology* 2010; **257**: 233-239
- 73 **Blyme PJ**, Lind T, Schantz K, Lavard P. Ultrasonographic detection of foreign bodies in soft tissue. A human cadaver study. *Arch Orthop Trauma Surg* 1990; **110**: 24-25

S- Editor Sun H **L- Editor** Hughes D **E- Editor** Zheng XM

ACKNOWLEDGMENTS

Acknowledgments to reviewers of *World Journal of Orthopedics*

Many reviewers have contributed their expertise and time to the peer review, a critical process to ensure the quality of *World Journal of Orthopedics*. The editors and authors of the articles submitted to the journal are grateful to the following reviewers for evaluating the articles (including those published in this issue and those rejected for this issue) during the last editing time period.

Masato Takao, MD, PhD, Professor, Department of Orthopaedic Surgery, Teikyo University School of Medicine, 2-11-1, Kaga, Itabashi, Tokyo, 173-8605, Japan

Shaohung Hung, MD, PhD, Department of Orthopedic Surgery, Fooyin University Hospital, No.5 Chun-Sun Rd. Tungkang PingTung 928, Taiwan, China

Alessandro Geraci, PhD, Department of Orthopedic and Traumatology Unit, University of Palermo – Santa Maria del Prato Hospital, Feltre, Via Montegrappa 18/c, 32032, Feltre (BL), Italy

Karin Grävare Silbernagel, PT, ATC, PhD, Mechanical Engineering, Biomechanics and Movements Science, University of Delaware, Spencer Laboratory, Newark, DE 19716, United States

Nahum Rosenberg, MD, Orthopaedics A, Rambam Medical Center, POB 9602, Haifa 31096, Israel

Jenni M Buckley, PhD, Research Director, Biomechanical Testing Facility, UCSF/SFGH Orthopaedic Trauma Institute, Department of Orthopaedic Surgery, University of California, San Francisco, San Francisco General Hospital, Building 100, Room 123, San Francisco, CA 94110, United States

MEETING

Events Calendar 2011

January 16-20, 2011 Combined 4th International Conference of the Saudi Orthopaedic Association & SICOT Trainee Day, Abha, Saudi Arabia	March 28-April 02, 2011 The Association of Children's Prosthetic-Orthotic Clinics 2011 Annual Meeting, Park City, UT, United States	of National Associations of Orthopaedics and Traumatology), Copenhagen, Denmark	SICOT 2011 XXV Triennial World Congress, Prague, Czech Republic
January 24-27, 2011 7th Middle East Orthopaedics Conference 2011, Dubai International Convention Centre, Dubai, Saudi Arabia	April 01-04, 2011 Ain Shams 2nd Orthopaedic intensive course (Orthopaedics from A to Z), Cairo, Egypt	June 08-12, 2011 2011 ABJS Annual Meeting (Association of Bone and Joint Surgeons), Dublin, Ireland	September 13-16, 2011 BOA/IOA Combined Meeting(British Orthopaedic Association & Irish Orthopaedic Association), Dublin, Ireland
January 28-30, 2011 National Orthopedic Conference 2011, San Francisco, California, United States	April 20-22, 2011 IMUKA 2011: Masterclass in Arthroscopy and Related Surgery, Maastricht, Netherlands	June 15-18, 2011 11th Annual Meeting of the International Society for Computer Assisted Orthopaedic Surgery, London, United Kingdom	September 14-17, 2011 23rd SECEC-ESSE Congress (European Society for Surgery of the Shoulder and the Elbow), Lyon, France
February 15-19, 2011 American Academy of Orthopaedic Surgeons, San Diego, CA, United States	May 11-14, 2011 2011 POSNA Annual Meeting, Montreal, Quebec, Canada	July 07-09, 2011 66th Annual Meeting of the Canadian Orthopaedic Association, St. John's, Newfoundland and Labrador, Canada	September 14-17, 2011 46th SRS Annual Meeting & Course (Scoliosis Research Society), Louisville, Kentucky, United States
February 16-20, 2011 2011 Annual Meeting of the American Academy of Orthopaedic Surgeons, San Diego, CA, United States	May 12-15, 2011 84th Annual Meeting of the Japanese Orthopaedic Association, Yokohama, Japan	July 13-16, 2011 18th International Meeting on Advanced Spine Techniques, Copenhagen, Denmark	September 15-18, 2011 2011 World Congress on Osteoarthritis, San Diego, California 92167, United States
February 19, 2011 Pediatric Orthopaedic Society of North America Specialty Day, San Diego, CA, United States	May 15-19, 2011 8th Biennial ISAKOS Congress (International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine), Rio de Janeiro, Brazil	July 22-24, 2011 Sri Sathya Sai International Orthopaedic Conference- 2011 On Pelvis And Lower Extremity Trauma", Sri Sathya Sai Institute of Higher Medical Sciences, Prasanthigram, Puttaparthi, Andhra Pradesh, India	September 21-23, 2011 HIP IMPROVEMENTS AND PROCEEDINGS, Toulouse, France
March 09-11, 2011 Annual London Imperial Spine Course, London, United Kingdom	May 25-28, 2011 16th Pan Arab Orthopedic Association Congress & 27th SOTCOT Congress, Tunis, Tunisia	July 25-28, 2011 2011 Update in Orthopaedics, Grand Wailea Hotel Resort & Spa,Wailea, Maui, Hawaii, United States	October 25-28, 2011 DKOU 2011-Deutscher Kongress für Orthopädie und Unfallchirurgie, Berlin, Germany
March 21-25, 2011 31st Caribbean Orthopaedic Meeting, Anse Marcel, Saint Martin	June 01-04, 2011 12th EFORT Congress in cooperation with the Danish Orthopaedic Association (European Federation	September 06-09, 2011	November 7-11, 2011 86ème Réunion Annuelle SOFCOT, Paris, France
			December 12-15, 2011 EOA 63rd Annual International Conference, Cairo, Egypt

INSTRUCTIONS TO AUTHORS

GENERAL INFORMATION

World Journal of Orthopedics (*World J Orthop*, *WJO*, online ISSN 2218-5836, DOI: 10.5312) is a monthly peer-reviewed, online, open-access (OA), journal supported by an editorial board consisting of 122 experts in orthopedics from 30 countries.

The biggest advantage of the OA model is that it provides free, full-text articles in PDF and other formats for experts and the public without registration, which eliminates the obstacle that traditional journals possess and usually delays the speed of the propagation and communication of scientific research results. The open access model has been proven to be a true approach that may achieve the ultimate goal of the journals, i.e. the maximization of the value to the readers, authors and society.

Maximization of personal benefits

The role of academic journals is to exhibit the scientific levels of a country, a university, a center, a department, and even a scientist, and build an important bridge for communication between scientists and the public. As we all know, the significance of the publication of scientific articles lies not only in disseminating and communicating innovative scientific achievements and academic views, as well as promoting the application of scientific achievements, but also in formally recognizing the "priority" and "copyright" of innovative achievements published, as well as evaluating research performance and academic levels. So, to realize these desired attributes of *WJO* and create a well-recognized journal, the following four types of personal benefits should be maximized. The maximization of personal benefits refers to the pursuit of the maximum personal benefits in a well-considered optimal manner without violation of the laws, ethical rules and the benefits of others. (1) Maximization of the benefits of editorial board members: The primary task of editorial board members is to give a peer review of an unpublished scientific article via online office system to evaluate its innovativeness, scientific and practical values and determine whether it should be published or not. During peer review, editorial board members can also obtain cutting-edge information in that field at first hand. As leaders in their field, they have priority to be invited to write articles and publish commentary articles. We will put peer reviewers' names and affiliations along with the article they reviewed in the journal to acknowledge their contribution; (2) Maximization of the benefits of authors: Since *WJO* is an open-access journal, readers around the world can immediately download and read, free of charge, high-quality, peer-reviewed articles from *WJO* official website, thereby realizing the goals and significance of the communication between authors and peers as well as public reading; (3) Maximization of the benefits of readers: Readers can read or use, free of charge, high-quality peer-reviewed articles without any limits, and cite the arguments, viewpoints, concepts, theories, methods, results, conclusion or facts and data of pertinent literature so as to validate the innovativeness, scientific and practical values of their own research achievements, thus ensuring that their articles have novel arguments or viewpoints, solid evidence and correct conclusion; and (4) Maximization of the benefits of employees: It is an iron law that a first-class journal is unable to exist without first-class editors, and only first-class editors can create a first-class academic journal. We insist on strengthening our team cultivation and construction so that every employee, in an open, fair and transparent environment, could contribute their wisdom to edit and publish high-quality articles, thereby realizing the maximization of the personal benefits

of editorial board members, authors and readers, and yielding the greatest social and economic benefits.

Aims and scope

The aim of *WJO* is to report rapidly new theories, methods and techniques for prevention, diagnosis, treatment, rehabilitation and nursing in the field of orthopedics. *WJO* covers diagnostic imaging, arthroscopy, evidence-based medicine, epidemiology, nursing, sports medicine, therapy of bone and spinal diseases, bone trauma, osteoarthropathy, bone tumors and osteoporosis, minimally invasive therapy, traditional medicine, and integrated Chinese and Western medicine. The journal also publishes original articles and reviews that report the results of applied and basic research in fields related to orthopedics, such as immunology, physiopathology, cell biology, pharmacology, medical genetics, and pharmacology of Chinese herbs.

Columns

The columns in the issues of *WJO* will include: (1) Editorial: To introduce and comment on major advances and developments in the field; (2) Frontier: To review representative achievements, comment on the state of current research, and propose directions for future research; (3) Topic Highlight: This column consists of three formats, including (A) 10 invited review articles on a hot topic, (B) a commentary on common issues of this hot topic, and (C) a commentary on the 10 individual articles; (4) Observation: To update the development of old and new questions, highlight unsolved problems, and provide strategies on how to solve the questions; (5) Guidelines for Basic Research: To provide Guidelines for basic research; (6) Guidelines for Clinical Practice: To provide guidelines for clinical diagnosis and treatment; (7) Review: To review systematically progress and unresolved problems in the field, comment on the state of current research, and make suggestions for future work; (8) Original Articles: To report innovative and original findings in orthopedics; (9) Brief Articles: To briefly report the novel and innovative findings in orthopedics; (10) Case Report: To report a rare or typical case; (11) Letters to the Editor: To discuss and make reply to the contributions published in *WJO*, or to introduce and comment on a controversial issue of general interest; (12) Book Reviews: To introduce and comment on quality monographs of orthopedics; and (13) Guidelines: To introduce consensuses and guidelines reached by international and national academic authorities worldwide on the research orthopedics.

Name of journal

World Journal of Orthopedics

ISSN

ISSN 2218-5836 (online)

Published by

Baishideng Publishing Group Co., Limited

SPECIAL STATEMENT

All articles published in this journal represent the viewpoints of the authors except where indicated otherwise.

Biostatistical editing

Statistical review is performed after peer review. We invite an expert

Instructions to authors

in Biomedical Statistics from to evaluate the statistical method used in the paper, including *t*-test (group or paired comparisons), chi-squared test, Ridit, probit, logit, regression (linear, curvilinear, or stepwise), correlation, analysis of variance, analysis of covariance, *etc.* The reviewing points include: (1) Statistical methods should be described when they are used to verify the results; (2) Whether the statistical techniques are suitable or correct; (3) Only homogeneous data can be averaged. Standard deviations are preferred to standard errors. Give the number of observations and subjects (*n*). Losses in observations, such as drop-outs from the study should be reported; (4) Values such as ED50, LD50, IC50 should have their 95% confidence limits calculated and compared by weighted probit analysis (Bliss and Finney); and (5) The word 'significantly' should be replaced by its synonyms (if it indicates extent) or the *P* value (if it indicates statistical significance).

Conflict-of-interest statement

In the interests of transparency and to help reviewers assess any potential bias, *WJO* requires authors of all papers to declare any competing commercial, personal, political, intellectual, or religious interests in relation to the submitted work. Referees are also asked to indicate any potential conflict they might have reviewing a particular paper. Before submitting, authors are suggested to read "Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Ethical Considerations in the Conduct and Reporting of Research: Conflicts of Interest" from International Committee of Medical Journal Editors (ICMJE), which is available at: http://www.icmje.org/ethical_4conflicts.html.

Sample wording: [Name of individual] has received fees for serving as a speaker, a consultant and an advisory board member for [names of organizations], and has received research funding from [names of organization]. [Name of individual] is an employee of [name of organization]. [Name of individual] owns stocks and shares in [name of organization]. [Name of individual] owns patent [patent identification and brief description].

Statement of informed consent

Manuscripts should contain a statement to the effect that all human studies have been reviewed by the appropriate ethics committee or it should be stated clearly in the text that all persons gave their informed consent prior to their inclusion in the study. Details that might disclose the identity of the subjects under study should be omitted. Authors should also draw attention to the Code of Ethics of the World Medical Association (Declaration of Helsinki, 1964, as revised in 2004).

Statement of human and animal rights

When reporting the results from experiments, authors should follow the highest standards and the trial should conform to Good Clinical Practice (for example, US Food and Drug Administration Good Clinical Practice in FDA-Regulated Clinical Trials; UK Medicines Research Council Guidelines for Good Clinical Practice in Clinical Trials) and/or the World Medical Association Declaration of Helsinki. Generally, we suggest authors follow the lead investigator's national standard. If doubt exists whether the research was conducted in accordance with the above standards, the authors must explain the rationale for their approach and demonstrate that the institutional review body explicitly approved the doubtful aspects of the study.

Before submitting, authors should make their study approved by the relevant research ethics committee or institutional review board. If human participants were involved, manuscripts must be accompanied by a statement that the experiments were undertaken with the understanding and appropriate informed consent of each. Any personal item or information will not be published without explicit consents from the involved patients. If experimental animals were used, the materials and methods (experimental procedures) section must clearly indicate that appropriate measures were taken to minimize pain or discomfort, and details of animal care should be provided.

SUBMISSION OF MANUSCRIPTS

Manuscripts should be typed in 1.5 line spacing and 12 pt. Book Antiqua with ample margins. Number all pages consecutively, and start each of the following sections on a new page: Title Page, Abstract, Introduction, Materials and Methods, Results, Discussion, Acknowledgements, References, Tables, Figures, and Figure Legends. Neither the editors nor the publisher are responsible for the opinions expressed by contributors. Manuscripts formally accepted for publication become the permanent property of Baishideng Publishing Group Co., Limited, and may not be reproduced by any means, in whole or in part, without the written permission of both the authors and the publisher. We reserve the right to copy-edit and put onto our website accepted manuscripts. Authors should follow the relevant guidelines for the care and use of laboratory animals of their institution or national animal welfare committee. For the sake of transparency in regard to the performance and reporting of clinical trials, we endorse the policy of the ICMJE to refuse to publish papers on clinical trial results if the trial was not recorded in a publicly-accessible registry at its outset. The only register now available, to our knowledge, is <http://www.clinicaltrials.gov> sponsored by the United States National Library of Medicine and we encourage all potential contributors to register with it. However, in the case that other registers become available you will be duly notified. A letter of recommendation from each author's organization should be provided with the contributed article to ensure the privacy and secrecy of research is protected.

Authors should retain one copy of the text, tables, photographs and illustrations because rejected manuscripts will not be returned to the author(s) and the editors will not be responsible for loss or damage to photographs and illustrations sustained during mailing.

Online submissions

Manuscripts should be submitted through the Online Submission System at: <http://www.wjgnet.com/2218-5836office>. Authors are highly recommended to consult the ONLINE INSTRUCTIONS TO AUTHORS (http://www.wjgnet.com/2218-5836/g_info_20100722172650.htm) before attempting to submit online. For assistance, authors encountering problems with the Online Submission System may send an email describing the problem to wjo@wjgnet.com, or by telephone: +86-10-85381892. If you submit your manuscript online, do not make a postal contribution. Repeated online submission for the same manuscript is strictly prohibited.

MANUSCRIPT PREPARATION

All contributions should be written in English. All articles must be submitted using word-processing software. All submissions must be typed in 1.5 line spacing and 12 pt. Book Antiqua with ample margins. Style should conform to our house format. Required information for each of the manuscript sections is as follows:

Title page

Title: Title should be less than 12 words.

Running title: A short running title of less than 6 words should be provided.

Authorship: Authorship credit should be in accordance with the standard proposed by International Committee of Medical Journal Editors, based on (1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be published. Authors should meet conditions 1, 2, and 3.

Institution: Author names should be given first, then the complete name of institution, city, province and postcode. For example, Xu-Chen Zhang, Li-Xin Mei, Department of Pathology,

Chengde Medical College, Chengde 067000, Hebei Province, China. One author may be represented from two institutions, for example, George Sgourakis, Department of General, Visceral, and Transplantation Surgery, Essen 45122, Germany; George Sgourakis, 2nd Surgical Department, Korgialenio-Benakio Red Cross Hospital, Athens 15451, Greece

Author contributions: The format of this section should be: Author contributions: Wang CL and Liang L contributed equally to this work; Wang CL, Liang L, Fu JF, Zou CC, Hong F and Wu XM designed the research; Wang CL, Zou CC, Hong F and Wu XM performed the research; Xue JZ and Lu JR contributed new reagents/analytic tools; Wang CL, Liang L and Fu JF analyzed the data; and Wang CL, Liang L and Fu JF wrote the paper.

Supportive foundations: The complete name and number of supportive foundations should be provided, e.g. Supported by National Natural Science Foundation of China, No. 30224801

Correspondence to: Only one corresponding address should be provided. Author names should be given first, then author title, affiliation, the complete name of institution, city, postcode, province, country, and email. All the letters in the email should be in lower case. A space interval should be inserted between country name and email address. For example, Montgomery Bissell, MD, Professor of Medicine, Chief, Liver Center, Gastroenterology Division, University of California, Box 0538, San Francisco, CA 94143, United States. montgomery.bissell@ucsf.edu

Telephone and fax: Telephone and fax should consist of +, country number, district number and telephone or fax number, e.g. Telephone: +86-10-59080039 Fax: +86-10-85381893

Peer reviewers: All articles received are subject to peer review. Normally, three experts are invited for each article. Decision for acceptance is made only when at least two experts recommend an article for publication. Reviewers for accepted manuscripts are acknowledged in each manuscript, and reviewers of articles which were not accepted will be acknowledged at the end of each issue. To ensure the quality of the articles published in *WJO*, reviewers of accepted manuscripts will be announced by publishing the name, title/position and institution of the reviewer in the footnote accompanying the printed article. For example, reviewers: Professor Jing-Yuan Fang, Shanghai Institute of Digestive Disease, Shanghai, Affiliated Renji Hospital, Medical Faculty, Shanghai Jiaotong University, Shanghai, China; Professor Xin-Wei Han, Department of Radiology, The First Affiliated Hospital, Zhengzhou University, Zhengzhou, Henan Province, China; and Professor Anren Kuang, Department of Nuclear Medicine, Huaxi Hospital, Sichuan University, Chengdu, Sichuan Province, China.

Abstract

There are unstructured abstracts (no more than 256 words) and structured abstracts (no more than 480). The specific requirements for structured abstracts are as follows:

An informative, structured abstracts of no more than 480 words should accompany each manuscript. Abstracts for original contributions should be structured into the following sections. AIM (no more than 20 words): Only the purpose should be included. Please write the aim as the form of “To investigate/study/...”; MATERIALS AND METHODS (no more than 140 words); RESULTS (no more than 294 words): You should present *P* values where appropriate and must provide relevant data to illustrate how they were obtained, e.g. 6.92 ± 3.86 vs 3.61 ± 1.67 , $P < 0.001$; CONCLUSION (no more than 26 words).

Key words

Please list 5-10 key words, selected mainly from *Index Medicus*, which reflect the content of the study.

Text

For articles of these sections, original articles and brief articles, the main text should be structured into the following sections: INTRODUCTION, MATERIALS AND METHODS, RESULTS and DISCUSSION, and should include appropriate Figures and Tables. Data should be presented in the main text or in Figures and Tables, but not in both. The main text format of these sections, editorial, topic highlight, case report, letters to the editors, can be found at: http://www.wjgnet.com/2218-5836/g_info_list.htm.

Illustrations

Figures should be numbered as 1, 2, 3, etc., and mentioned clearly in the main text. Provide a brief title for each figure on a separate page. Detailed legends should not be provided under the figures. This part should be added into the text where the figures are applicable. Figures should be either Photoshop or Illustrator files (in tiff, eps, jpeg formats) at high-resolution. Examples can be found at: <http://www.wjgnet.com/1007-9327/13/4520.pdf>; <http://www.wjgnet.com/1007-9327/13/4554.pdf>; <http://www.wjgnet.com/1007-9327/13/4891.pdf>; <http://www.wjgnet.com/1007-9327/13/4986.pdf>; <http://www.wjgnet.com/1007-9327/13/4498.pdf>. Keeping all elements compiled is necessary in line-art image. Scale bars should be used rather than magnification factors, with the length of the bar defined in the legend rather than on the bar itself. File names should identify the figure and panel. Avoid layering type directly over shaded or textured areas. Please use uniform legends for the same subjects. For example: Figure 1 Pathological changes in atrophic gastritis after treatment. A: ...; B: ...; C: ...; D: ...; E: ...; F: ...; G: ...etc. It is our principle to publish high resolution-figures for the printed and E-versions.

Tables

Three-line tables should be numbered 1, 2, 3, etc., and mentioned clearly in the main text. Provide a brief title for each table. Detailed legends should not be included under tables, but rather added into the text where applicable. The information should complement, but not duplicate the text. Use one horizontal line under the title, a second under column heads, and a third below the Table, above any footnotes. Vertical and italic lines should be omitted.

Notes in tables and illustrations

Data that are not statistically significant should not be noted. ^a*P* < 0.05, ^b*P* < 0.01 should be noted (*P* > 0.05 should not be noted). If there are other series of *P* values, ^c*P* < 0.05 and ^d*P* < 0.01 are used. A third series of *P* values can be expressed as ^e*P* < 0.05 and ^f*P* < 0.01. Other notes in tables or under illustrations should be expressed as ¹F, ²F, ³F; or sometimes as other symbols with a superscript (Arabic numerals) in the upper left corner. In a multi-curve illustration, each curve should be labeled with ●, ○, □, ▲, △, etc., in a certain sequence.

Acknowledgments

Brief acknowledgments of persons who have made genuine contributions to the manuscript and who endorse the data and conclusions should be included. Authors are responsible for obtaining written permission to use any copyrighted text and/or illustrations.

REFERENCES

Coding system

The author should number the references in Arabic numerals according to the citation order in the text. Put reference numbers in square brackets in superscript at the end of citation content or after the cited author's name. For citation content which is part of the narration, the coding number and square brackets should be typeset normally. For example, “Crohn's disease (CD) is associated with increased intestinal permeability^[1,2]”. If references are cited directly in the text, they should be put together within the text, for example, “From references^[19,22-24], we know that...”.

Instructions to authors

When the authors write the references, please ensure that the order in text is the same as in the references section, and also ensure the spelling accuracy of the first author's name. Do not list the same citation twice.

PMID and DOI

Please provide PubMed citation numbers to the reference list, e.g. PMID and DOI, which can be found at <http://www.ncbi.nlm.nih.gov/sites/entrez?db=pubmed> and <http://www.crossref.org/SimpleTextQuery/>, respectively. The numbers will be used in E-version of this journal.

Style for journal references

Authors: the name of the first author should be typed in bold-faced letters. The family name of all authors should be typed with the initial letter capitalized, followed by their abbreviated first and middle initials. (For example, Lian-Sheng Ma is abbreviated as Ma LS, Bo-Rong Pan as Pan BR). The title of the cited article and italicized journal title (journal title should be in its abbreviated form as shown in PubMed), publication date, volume number (in black), start page, and end page [PMID: 11819634 DOI: 10.3748/wjg.13.5396].

Style for book references

Authors: the name of the first author should be typed in bold-faced letters. The surname of all authors should be typed with the initial letter capitalized, followed by their abbreviated middle and first initials. (For example, Lian-Sheng Ma is abbreviated as Ma LS, Bo-Rong Pan as Pan BR) Book title. Publication number. Publication place: Publication press, Year: start page and end page.

Format

Journals

English journal article (list all authors and include the PMID where applicable)

- 1 **Jung EM**, Clevert DA, Schreyer AG, Schmitt S, Rennert J, Kubale R, Feuerbach S, Jung F. Evaluation of quantitative contrast harmonic imaging to assess malignancy of liver tumors: A prospective controlled two-center study. *World J Gastroenterol* 2007; **13**: 6356-6364 [PMID: 18081224 DOI: 10.3748/wjg.13.6356]

Chinese journal article (list all authors and include the PMID where applicable)

- 2 **Lin GZ**, Wang XZ, Wang P, Lin J, Yang FD. Immunologic effect of Jianpi Yishen decoction in treatment of Pixu-diarrhoea. *Shijie Huaren Xiaohua ZaZhi* 1999; **7**: 285-287

In press

- 3 **Tian D**, Araki H, Stahl E, Bergelson J, Kreitman M. Signature of balancing selection in Arabidopsis. *Proc Natl Acad Sci USA* 2006; In press

Organization as author

- 4 **Diabetes Prevention Program Research Group**. Hypertension, insulin, and proinsulin in participants with impaired glucose tolerance. *Hypertension* 2002; **40**: 679-686 [PMID: 12411462 PMCID:2516377 DOI:10.1161/01.HYP.0000035706.28494.09]

Both personal authors and an organization as author

- 5 **Vallancien G**, Emberton M, Harving N, van Moorselaar RJ, Alf-One Study Group. Sexual dysfunction in 1, 274 European men suffering from lower urinary tract symptoms. *J Urol* 2003; **169**: 2257-2261 [PMID: 12771764 DOI:10.1097/01.ju.0000067940.76090.73]

No author given

- 6 21st century heart solution may have a sting in the tail. *BMJ* 2002; **325**: 184 [PMID: 12142303 DOI:10.1136/bmj.325.7357.184]

Volume with supplement

- 7 **Geraud G**, Spierings EL, Keywood C. Tolerability and safety of frovatriptan with short- and long-term use for treatment of migraine and in comparison with sumatriptan. *Headache* 2002; **42** Suppl 2: S93-99 [PMID: 12028325 DOI:10.1046/j.1526-4610.42.s2.7.x]

Issue with no volume

- 8 **Banit DM**, Kaufer H, Hartford JM. Intraoperative frozen section analysis in revision total joint arthroplasty. *Clin Orthop Relat Res* 2002; **(401)**: 230-238 [PMID: 12151900 DOI:10.1097/00003086-200208000-00026]

No volume or issue

- 9 Outreach: Bringing HIV-positive individuals into care. *HRS/A Careaction* 2002; 1-6 [PMID: 12154804]

Books

Personal author(s)

- 10 **Sherlock S**, Dooley J. Diseases of the liver and biliary system. 9th ed. Oxford: Blackwell Sci Pub, 1993: 258-296

Chapter in a book (list all authors)

- 11 **Lam SK**. Academic investigator's perspectives of medical treatment for peptic ulcer. In: Swabb EA, Azabo S. Ulcer disease: investigation and basis for therapy. New York: Marcel Dekker, 1991: 431-450

Author(s) and editor(s)

- 12 **Breedlove GK**, Schorfheide AM. Adolescent pregnancy. 2nd ed. Wieczorek RR, editor. White Plains (NY): March of Dimes Education Services, 2001: 20-34

Conference proceedings

- 13 **Harnden P**, Joffe JK, Jones WG, editors. Germ cell tumours V. Proceedings of the 5th Germ cell tumours Conference; 2001 Sep 13-15; Leeds, UK. New York: Springer, 2002: 30-56

Conference paper

- 14 **Christensen S**, Oppacher F. An analysis of Koza's computational effort statistic for genetic programming. In: Foster JA, Lutton E, Miller J, Ryan C, Tettamanzi AG, editors. Genetic programming. EuroGP 2002: Proceedings of the 5th European Conference on Genetic Programming; 2002 Apr 3-5; Kinsdale, Ireland. Berlin: Springer, 2002: 182-191

Electronic journal (list all authors)

- 15 Morse SS. Factors in the emergence of infectious diseases. *Emerg Infect Dis* serial online, 1995-01-03, cited 1996-06-05; 1(1): 24 screens. Available from: URL: <http://www.cdc.gov/nidod/eid/index.htm>

Patent (list all authors)

- 16 **Pagedas AC**, inventor; Ancel Surgical R&D Inc., assignee. Flexible endoscopic grasping and cutting device and positioning tool assembly. United States patent US 20020103498. 2002 Aug 1

Statistical data

Write as mean \pm SD or mean \pm SE.

Statistical expression

Express *t* test as *t* (in italics), *F* test as *F* (in italics), chi square test as χ^2 (in Greek), related coefficient as *r* (in italics), degree of freedom as *v* (in Greek), sample number as *n* (in italics), and probability as *P* (in italics).

Units

Use SI units. For example: body mass, *m* (*B*) = 78 kg; blood pressure, *p* (*B*) = 16.2/12.3 kPa; incubation time, *t* (incubation) = 96 h, blood glucose concentration, *c* (glucose) 6.4 ± 2.1 mmol/L; blood CEA mass concentration, *p* (CEA) = 8.6 24.5 μ g/L; CO₂ volume fraction, 50 mL/L CO₂, not 5% CO₂; likewise for 40 g/L formaldehyde, not 10% formalin; and mass fraction, 8 ng/g, etc. Arabic numerals such as 23, 243, 641 should be read 23 243 641.

The format for how to accurately write common units and quantums can be found at: http://www.wjgnet.com/2218-5836/g_info_20100724204625.htm.

Abbreviations

Standard abbreviations should be defined in the abstract and on first mention in the text. In general, terms should not be abbreviated unless they are used repeatedly and the abbreviation is helpful to the reader. Permissible abbreviations are listed in Units, Symbols

and Abbreviations: A Guide for Biological and Medical Editors and Authors (Ed. Baron DN, 1988) published by The Royal Society of Medicine, London. Certain commonly used abbreviations, such as DNA, RNA, HIV, LD50, PCR, HBV, ECG, WBC, RBC, CT, ESR, CSF, IgG, ELISA, PBS, ATP, EDTA, mAb, can be used directly without further explanation.

Italics

Quantities: *t* time or temperature, *c* concentration, *A* area, *l* length, *m* mass, *V* volume.

Genotypes: *gyrA*, *arg 1*, *c myc*, *c fos*, etc.

Restriction enzymes: *Eco*RI, *Hind*II, *Bam*HI, *Kpn*I, *Kpn*I, etc.

Biology: *H. pylori*, *E. coli*, etc.

Examples for paper writing

Editorial: http://www.wjgnet.com/2218-5836/g_info_20100723140942.htm

Frontier: http://www.wjgnet.com/2218-5836/g_info_20100723141035.htm

Topic highlight: http://www.wjgnet.com/2218-5836/g_info_20100723141239.htm

Observation: http://www.wjgnet.com/2218-5836/g_info_20100723141532.htm

Guidelines for basic research: http://www.wjgnet.com/2218-5836/g_info_20100723142040.htm

Guidelines for clinical practice: http://www.wjgnet.com/2218-5836/g_info_20100723142248.htm

Review: http://www.wjgnet.com/2218-5836/g_info_20100723145519.htm

Original articles: http://www.wjgnet.com/2218-5836/g_info_20100723145856.htm

Brief articles: http://www.wjgnet.com/2218-5836/g_info_20100723150253.htm

Case report: http://www.wjgnet.com/2218-5836/g_info_20100723150420.htm

Letters to the editor: http://www.wjgnet.com/2218-5836/g_info_20100723150642.htm

Book reviews: http://www.wjgnet.com/2218-5836/g_info_20100723150839.htm

Guidelines: http://www.wjgnet.com/2218-5836/g_info_20100723150924.htm

SUBMISSION OF THE REVISED MANUSCRIPTS AFTER ACCEPTED

Please revise your article according to the revision policies of *WJO*. The revised version including manuscript and high-resolution image figures (if any) should be copied on a floppy or compact disk. The author should send the revised manuscript, along with printed high-resolution color or black and white photos, copyright transfer letter, and responses to the reviewers by courier (such as EMS/DHL).

Editorial Office

World Journal of Orthopedics

Editorial Department: Room 903, Building D,
Ocean International Center,
No. 62 Dongsihuan Zhonglu,
Chaoyang District, Beijing 100025, China
E-mail: wjo@wjgnet.com
<http://www.wjgnet.com>
Telephone: +86-10-5908-1630
Fax: +86-10-8538-1893

Language evaluation

The language of a manuscript will be graded before it is sent for revision. (1) Grade A: priority publishing; (2) Grade B: minor language polishing; (3) Grade C: a great deal of language polishing needed; and (4) Grade D: rejected. Revised articles should reach Grade A or B.

Copyright assignment form

Please download a Copyright assignment form from http://www.wjgnet.com/2218-5836/g_info_20100724204516.htm.

Responses to reviewers

Please revise your article according to the comments/suggestions provided by the reviewers. The format for responses to the reviewers' comments can be found at: http://www.wjgnet.com/2218-5836/g_info_20100724204306.htm.

Proof of financial support

For paper supported by a foundation, authors should provide a copy of the document and serial number of the foundation.

Links to documents related to the manuscript

WJO will be initiating a platform to promote dynamic interactions between the editors, peer reviewers, readers and authors. After a manuscript is published online, links to the PDF version of the submitted manuscript, the peer-reviewers' report and the revised manuscript will be put on-line. Readers can make comments on the peer reviewer's report, authors' responses to peer reviewers, and the revised manuscript. We hope that authors will benefit from this feedback and be able to revise the manuscript accordingly in a timely manner.

Science news releases

Authors of accepted manuscripts are suggested to write a science news item to promote their articles. The news will be released rapidly at EurekAlert/AAS (<http://www.eurekalert.org>). The title for news items should be less than 90 characters; the summary should be less than 75 words; and main body less than 500 words. Science news items should be lawful, ethical, and strictly based on your original content with an attractive title and interesting pictures.

Publication fee

WJO is an international, peer-reviewed, Open-Access, online journal. Articles published by this journal are distributed under the terms of the Creative Commons Attribution Non-commercial License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non commercial and is otherwise in compliance with the license. Authors of accepted articles must pay a publication fee. The related standards are as follows. Publication fee: 1300 USD per article. Editorial, topic highlights, book reviews and letters to the editor are published free of charge.