

# J B & J S

## THE JOURNAL OF BONE & JOINT SURGERY

PUBLISHED IN TWO VOLUMES

### AMERICAN VOLUME

*Editor and Chairman, Board of Editors:* JAMES D. HECKMAN

*Editor Emeritus:* HENRY R. COWELL

*Deputy Editors Emeriti for Research:* ALBERT H. BURSTEIN,  
LAWRENCE C. ROSENBERG

#### AMERICAN EDITORIAL BOARD

ROBERT W. BUCHOLZ, *Deputy Editor for Adult Reconstructive Surgery and Trauma*  
CHARLES R. CLARK, *Deputy Editor for Adult Reconstruction and Spine*  
THOMAS A. EINHORN, *Deputy Editor for Current Concepts Reviews*  
BRENT GRAHAM, *Deputy Editor for Methodology and Biostatistics*  
JEFFREY N. KATZ, *Deputy Editor for Methodology and Biostatistics*  
ELENA LOSINA, *Deputy Editor for Methodology and Biostatistics*  
MARK D. MILLER, *Deputy Editor for Sports Medicine*  
VINCENT D. PELLEGRINI Jr., *Deputy Editor for Surgical Techniques*

ROBERT POSS, *Deputy Editor for Electronic Media*  
DEMPSEY S. SPRINGFIELD, *Deputy Editor for Instructional Course Lectures*  
PETER STERN, *Deputy Editor for the Upper Extremity*  
MARC F. SWIONTKOWSKI, *Deputy Editor for Outcome Studies and Trauma*  
VERNON T. TOLO, *Deputy Editor for Pediatric Orthopaedics*  
PAUL TORNETTA III, *Deputy Editor for AOA Publications*  
KEN YAMAGUCHI, *Deputy Editor for the Upper Extremity*  
JAMES G. WRIGHT, *Associate Editor for Evidence-Based Orthopaedics*  
JAMES D. CAPOZZI, *Coordinator of Ethics in Practice*

JOHN G. BIRCH, Dallas, Texas  
R. DALE BLASIER, Little Rock, Arkansas  
MARTIN I. BOYER, St. Louis, Missouri  
EDWARD Y. CHENG, Minneapolis, Minnesota  
JOHN CLOHISY, St. Louis, Missouri  
MARK R. HUTCHINSON, Chicago, Illinois  
MICHELLE JAMES, Sacramento, California  
NORMAN JOHANSON, Philadelphia, Pennsylvania  
SETH S. LEOPOLD, Seattle, Washington  
BASSAM A. MASRI, Vancouver, British Columbia, Canada

#### THE JOURNAL OF BONE AND JOINT SURGERY INCORPORATED

Board of Trustees  
MICHAEL A. SIMON, *Chairman*  
BERNARD A. RINEBERG, *Vice-Chairman*  
JAMES H. HERNDON, *Treasurer*  
CECIL H. HORABECK, *Secretary*  
JAMES D. HECKMAN, *Editor*  
DAN M. SPENGLER  
VERNON T. TOLO  
EDWARD N. HANLEY Jr.  
STUART L. WEINSTEIN

#### THE AMERICAN ORTHOPAEDIC ASSOCIATION

*President:* PETER STERN  
6300 North River Road  
Rosemont, Illinois 60018

#### THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

*President:* E. ANTHONY RANKIN  
6300 North River Road  
Rosemont, Illinois 60018

#### BOARD OF CONSULTING EDITORS FOR RESEARCH

THOMAS W. BAUER, *Deputy Editor for Research*  
CLARE M. RIMNAC, *Deputy Editor for Research*  
H. CLARKE ANDERSON, Kansas City, Kansas  
STEVEN ARNOCKZY, East Lansing, Michigan  
SCOTT BODEN, Atlanta, Georgia  
THOMAS D. BROWN, Iowa City, Iowa  
JOSEPH A. BUCKWALTER, Iowa City, Iowa  
CHARLES CORNELL, New York, N.Y.  
KATHLEEN DERWIN, Cleveland, Ohio  
MICHAEL KLEIN, Birmingham, Alabama  
KEITH MARKOLF, Los Angeles, California  
EDWARD McCARTHY Jr., Baltimore, Maryland  
HARRY A. McKELLOP, Los Angeles, California  
JAVAD PARVIZI, Philadelphia, Pennsylvania  
TERRANCE D. PEABODY, Chicago, Illinois  
SCOTT A. RODEO, New York, N.Y.

#### WESTERN ORTHOPAEDIC ASSOCIATION

*President:* GERARD L. GLANCY  
154-A West Foothill Boulevard, #107  
Upland, California 91786

#### EASTERN ORTHOPAEDIC ASSOCIATION

*President:* SCOTT D. BODEN  
110 West Road, Suite 227  
Towson, Maryland 21204

#### MID-AMERICA ORTHOPAEDIC ASSOCIATION

*President:* LYNN A. CROSBY  
20 Second Avenue, S.W.  
Rochester, Minnesota 55902

### BRITISH VOLUME

*Editor:* JAMES SCOTT

*Editor Emeritus:* FRANK HORAN

#### BRITISH EDITORIAL BOARD

ROBERT DICKSON, *Chairman*  
NEIL THOMAS, *Treasurer*  
ROBERT MARSHALL, *Secretary*  
JAMES SCOTT, *Editor*  
FRANK HORAN, *Editor Emeritus*  
RICHARD VILLAR, *Assistant Editor*  
ANDREW J. CARR, *Associate Editor*  
JOHN FIXSEN, *Associate Editor*  
DAVID JONES, *Associate Editor*  
DAVID L. LIMB, *Associate Editor for Education*  
ANDREW W. McCASKIE, *Associate Editor*  
ALISTAIR ROSS, *Associate Editor*  
GARETH SCOTT, *Associate Editor*  
NEIL RUSHTON, *Deputy Editor for Research Emeritus*

LESLIE KLENERMAN, *Associate Editor Emeritus*  
MICHAEL LAURENCE, *Associate Editor Emeritus*  
STEPHEN R. CANNON, *President, B.O.A., ex officio*  
COLIN DENT, *Editorial Secretary, B.O.A.*  
GEORGE BENTLEY, London, England (EFORT)  
TIMOTHY BRIGGS, London, England  
ANTHONY CATTERALL, London, England  
CHARLES COURT-BROWN, Edinburgh, Scotland  
CY FRANK, Calgary, Canada  
PETER GIANNOUNDIS, Leeds, England  
S. GOVENDER, Congella, South Africa  
FARES HADDAD, London, England  
ALEXANDER HADJIPAVLOU, Crete, Greece  
JOE W.M. HARPER, Leicester, England

ROBERT HAWKINS, Vancouver, Canada  
DAVID HUNT, London, England  
GREGORY JANES, Perth, Australia  
ROGER LEMAIRE, Liège, Belgium  
DAVID MORGAN, Brisbane, Australia  
RÉMY NIZARD, Paris, France  
MARK PATERSON, London, England  
ANDREW ROBINSON, Cambridge, England  
BRIGITTE SCAMMELL (B.O.R.S.)  
SUSAN STOTT, Auckland, New Zealand  
NICO VERDONSCHOT, Nijmegen, The Netherlands  
DAVID WARWICK, Southampton, England  
ANDREW WILLIAMS, London, England  
JOHAN WITT, London, England

#### BRITISH COUNCIL OF MANAGEMENT

ROBERT DICKSON, *Chairman*  
NEIL THOMAS, *Treasurer*  
ROBERT MARSHALL, *Secretary*  
ANTHONY CATTERALL  
STEPHEN R. CANNON, *President, B.O.A. ex officio*

#### BRITISH ORTHOPAEDIC ASSOCIATION

CLARE MARX, *President*  
35-43 Lincoln's Inn Fields, London WC2A 3PE

#### AUSTRALIAN ORTHOPAEDIC ASSOCIATION

JOHN B. NORTH, *President*  
Ground Floor, William Bland Centre,  
229 Macquarie Street,  
Sydney, New South Wales 2000

#### CANADIAN ORTHOPAEDIC ASSOCIATION

PETER J. O'BRIEN, *President*  
4150 Ste. Catherine Street West  
Suite 360, Westmount, Quebec H3Z 2Y5

#### NEW ZEALAND ORTHOPAEDIC ASSOCIATION

JOHN MATHESON, *President*  
P.O. Box 7451, Wellington South, New Zealand

#### SOUTH AFRICAN ORTHOPAEDIC ASSOCIATION

D.R. van der Jagt, *President*  
Suite 2, Sandton Clinic, Peter Place  
Main Road, Bryanston, Randburg 2194, South Africa

#### IRISH ORTHOPAEDIC ASSOCIATION

FRANK DOWLING, *President*  
Cappagh National Orthopaedic Hospital, Finglas, Dublin 11

#### EUROPEAN FEDERATION OF NATIONAL ASSOCIATIONS OF ORTHOPAEDICS AND TRAUMATOLOGY - EFORT

KARL-GÖRAN THORNGREN, *President*  
Technoparkstrasse 1, CH-8005 Zürich, Switzerland

#### BRITISH ORTHOPAEDIC RESEARCH SOCIETY

B.E. SCAMMELL, *President*  
Division of Orthopaedic and Accident Surgery, C Floor West Block  
Queen's Medical Centre, Nottingham NG7 2UH

#### EUROPEAN ORTHOPAEDIC RESEARCH SOCIETY

NICOLA BALDINI, *President*  
Weiner Medizinische Akademie für ärztliche Fortbildung und Forschung,  
Vienna Academy of Postgraduate Medical Education and Research,  
Alserstrasse 4, 1. Hof, DION, A-1090 Wien

#### CANADIAN ORTHOPAEDIC RESEARCH SOCIETY

NADR M. JOMHA, *President*  
4150 Ste. Catherine Street West  
Suite 360, Westmount, Quebec H3Z 2Y5

#### British Office

22 Buckingham Street, London WC2N 6ET, England  
*General Manager:* STEPHEN BISHOP  
*Editorial Production Manager:* EMMA VODDEN  
*Circulation Manager:* MICHAEL SEARLE

*Published in the United Kingdom by  
The British Editorial Society of Bone & Joint Surgery*

# JB&JS

## THE JOURNAL OF BONE & JOINT SURGERY

### EDITORIAL STAFF

#### AMERICAN OFFICE

20 Pickering Street, Needham, Massachusetts 02492-3157 U.S.A.

*Editor:* JAMES D. HECKMAN, MD  
*General Manager:* MADY TISSENBAUM  
*Managing Editor:* AMY BORDIUK  
*Subscription Manager:* ABRAHAM N. BRODY  
*Advertising Director:* AMBER HOWARD  
*Marketing Director:* MICHELLE HACHÉ  
*Controller:* GEORGE S. HILL

*Published and printed in the United States by The Journal of Bone and Joint Surgery, Incorporated*

#### INFORMATION FOR SUBSCRIBERS

*Subscription Manager,* ABRAHAM N. BRODY  
*Assistant Subscription Manager,* MERLE ADELSON  
To start or stop a subscription, to change your address, or for non-receipt of issues: ext. 1241  
Fax: 781.449.9742  
e-mail: subs@jbjs.org

JBJS-A is a benefit of AAOS Active Fellowship.

#### 2008 SUBSCRIPTION RATES

AMERICAN VOLUME: \$162.00 in USA; \$176.30 outside USA  
*published monthly*

AMERICAN AND BRITISH VOLUMES: \$285.00, combined rate

BRITISH VOLUME: \$132.00  
*published monthly*

Abstracts from the British Volume appear in this issue and are listed in the Table of Contents

Resident/fellow discount rates and complimentary subscriptions are available, contact subs@jbjs.org for details.

SUBSCRIPTION DVD OR CD-ROM (QUARTERLY)

COMBINED VOLUME:  
Residents/fellows, \$182.40; JBJS subscribers, \$228.00;  
non-subscribers, \$285.00

Above subscription rates apply to individuals only.  
For institutional subscription rates,  
please contact the subscription department.

#### ONLINE INFORMATION

Online access to the full text plus additional electronic features is included in the print subscription price. Visit us at:

[www.jbjs.org](http://www.jbjs.org)  
[www.jbjs.org.uk](http://www.jbjs.org.uk)

#### INFORMATION FOR AUTHORS

For questions concerning submission of manuscripts or status of submitted manuscripts: ext. 1210  
Fax: 781.449.9787  
e-mail: editorial@jbjs.org

*Managing Editor,* AMY BORDIUK  
*Editorial Manager,* ALLAN HARPER

For questions regarding manuscript style and format: ext. 1243  
e-mail: copyediting@jbjs.org

#### ADVERTISING

*Director,* AMBER HOWARD  
e-mail: howarda@jbjs.org, ext. 1233

*Production Manager,* BEVERLY OUANNASS,  
e-mail: ouannass@jbjs.org, ext. 1234

*Classified/Recruitment Coordinator,* TERRY PAOLINO,  
e-mail: paolinot@jbjs.org, ext. 1239

*Advertising Sales Executive,* SUSAN O'HAGAN  
e-mail: ohagans@jbjs.org, ext. 1229

Advertising Department Fax: 781.449.3485

*Pharmaceutical Advertising Representative,* JAMES T. BRADY, INC.  
Phone: 516.742.7960 Fax: 516.742.7908  
e-mail: jtbrady1@verizon.net

#### INFORMATION ON VIDEO SUPPLEMENTS

*Video Journal of Orthopaedics*  
P.O. Box 4367, Santa Barbara, CA 93140  
Phone: 805.962.3410  
Fax: 805.962.1260  
e-mail: customersupport@vjortho.com  
url: www.vjortho.com

#### SELECTED SCIENTIFIC EXHIBITS

#### THE ANNUAL MEETING OF THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

*Supplement Editor:* James D. Heckman, MD

#### *Editorial Department:*

Amy Bordiuk, Managing Editor  
Allan Harper, Editorial Manager  
Ann Lynch, Senior Copy Editor  
Jane Boston, Senior Copy Editor

Nancy Oliveira, Proofreader  
Nancy Cohen, Proofreader  
Michael Dehn, Proofreader  
Melissa Viola, Department Assistant  
Coree Taylor, Editorial Assistant

#### *Composition and Design:*

So Yuk Wong  
Carla Hillyard