

# 医用生物力学

YIYONG SHENGWU LIXUE

双月刊 1986年6月创刊 第39卷 第3期 2024年6月出版



[期刊基本参数] CN 31-1624/R \* 1986 \* b \* A4 \* 186 \* zh+en \* P \* ¥25.00 \* 2000 \* 26 \* 2024-06

主 管	中华人民共和国教育部
主 办	上海交通大学
承 办	上海交通大学医学院附属第九人民医院
出 版	《医用生物力学》编辑部
编 辑 部	地址 上海市制造局路 639 号 邮编 200011 电话 (021)53315397 传真 (021)63137020 电子邮件 shengwulixue@163.com 网址 <a href="http://www.medbiomechanics.com">http://www.medbiomechanics.com</a> <a href="http://www.mechanobiology.cn">http://www.mechanobiology.cn</a>
微 博	<a href="http://weibo.com/u/2040064195">http://weibo.com/u/2040064195</a>
广 告 部	水 汝
名 誉 主 编	戴蔚戎
主 编	姜宗来
执 行 主 编	赵 杰
常 务 副 主 编	陈维毅 樊瑜波 冯西桥 郭向东 秦 岭 张西正
副 主 编	房 兵 刘有军 杨 慧 王向阳 蒲 放 顾耀东 刘 卉 于志锋
编 辑 部 主 任	于志锋 E-mail: zfyu@outlook.com
责 任 编 辑	徐 琦 E-mail: 1534340082@qq.com
英 文 编 辑	徐 琦
编 辑	《医用生物力学》编辑委员会
印 刷	山西同方知网印刷有限公司
国 内 发 行	上海市报刊发行局
国 外 总 发 行	中国国际图书贸易总公司
订 购	全国各地邮局 邮发代号 4-633
定 价	每期:25.00 元 全年 150.00 元 国内统一连续出版物号 CN 31-1624/R 国际标准连续出版物号 ISSN 1004-7220 CODEN YSLIBU ©2024 年版权归《医用生物力学》 编辑部所有

## 目 次

### 专家论坛

空间失重环境力学生物学 2023 年度研究进展 ..... (377)

窦向雅, 张译文, 刘帅廷, 续惠云

空间微重力下细胞力学感知-传导的研究进展 ..... (387)

田然, 吴欣童, 孙联文

### 论 著

髓内压对骨内液体流动行为的影响 ..... (393)

于纬伦, 杨风健, 时念秋, 欧仁侠, 陈珈宇, 刘建洋, 王慧,

邢爽, 高语晗, 刘昊庭, 孙启宇

内镜下单侧小关节分级切除对颈椎节段稳定性影响 ..... (400)

杨广南, 刘江, 蒋强, 张晗硕, 李土胜, 马靖博, 丁宇

双头螺钉对三柱截骨术后多棒结构稳定性的影响 ..... (407)

廖运钱, 周宇, 王政伦, 刘永胜, 李炜

有限元分析改良皮质骨轨迹置钉在腰椎翻修术中的力学性能  
..... (413)

张连鹏, 居来提·买提肉孜, 张治豪, 张瑞, 阿卜力克木·买买提,  
帕尔哈提·热西提

髓臼内陷技术对成人 DDH 全髋关节置换术髓臼杯生物力学影响  
的有限元分析 ..... (421)

张欣, 林文杰, 贺彬, 冯柏淋, 陈海聪, 钟环, 欧阳汉斌

泰森多边形多孔结构髓臼杯初始稳定性研究 ..... (428)

宜亚丽, 于润泽, 张金明, 李姣, 柴立平, 金贺荣

三维组架螺钉与环形钢板治疗 Sanders III AB 型跟骨骨折的有限  
元分析 ..... (435)

潘红元, 孔德伟, 刘粤, 龚璐璐, 赵一丁, 孔德策, 汪嘉琪,  
王治, 杨铁毅, 范鑫斌

基于传力路径的接骨板结构拓扑优化设计 ..... (442)

蔡俊, 丁晓红, 段朋云, 熊敏, 张横

基于深度相机和神经网络的下肢关节力矩估计 ..... (450)

高飞, 王正陶, 王冬梅, 于随然

连续疲劳干预对膝关节主被动生物力学特性的影响 ..... (457)

孔祥飞, 王洪丹, 连子瞻, 姚杰, 樊瑜波

中医推拿按摩法的上肢关节运动角度特征分析 ..... (463)

陈金田, 周鑫, 单一鸣, 朱清广, 孙武权

外侧楔形鞋垫对足踝生物力学影响的有限元分析	(469)
杜玮瑾,陈维毅,郭媛	
应用随机森林与神经网络算法的足底软组织本构参数反演方法	(476)
李峰韬,孙丽芳,陶雅萍,杨鹏,纪猛强,桑建兵	
面向手过头任务的残差神经网络肌肉疲劳预测模型	(482)
赵晓一,赵川,杨文鑫,刘思棋	
脑卒中患者运动过程中动力学特征的智能预测	(489)
张楠,孟庆华,鲍春雨,周鲁星,崔帅琦	
影响我国男子1 500 m速滑直道速度的关键技术特征	(497)
张马森,崔婧,邵中平,刘卉	
二尖瓣运动的流固耦合仿真	(504)
居佳怡,颜文涛,魏来,高昊,王盛章	
考虑三维残余变形的主动脉生理稳态建模	(510)
高鹏,郭宝磊,张明,戴向晨,刘浩飞	
可降解血管吻合器的结构设计与实验验证	(518)
徐凯悦,蔡雪,胡钟欣,高钦贤,邢绪坡,宋成利,毛琳	
基于仿生物理模型的半规管壶腹嵴顶变形	(524)
张文萱,张禹,文先华,戴俊杰,边义祥,姜亚妮	
舌侧金属加强杆种植覆盖义齿的三维有限元分析	(532)
张馨月,王勇,陈倩,周团锋,马珂楠,王子轩,赵一姣	
正畸微植体动态植入过程有限元数值仿真	(539)
苗学林,张洪伟,仇玲玲,吉康康,张家麒	

## 综 述

线粒体的力学生物学研究进展	(545)
纳静,郑丽沙,樊瑜波	
离心式血泵优化设计研究进展	(552)
张珂嘉,吴鹏	

## 书 讯

妇产科护理中生物力学运用分析	(559)
卜薇薇	
膝关节功能强化训练对运动员运动表现提升的影响	(560)
刘藤升,黄明哲	
生物力学在心胸外科术后患者排痰护理中的应用	(561)
商希芹,李雪梅,王文静	
动力学视角下复杂生物神经网络的特性及建模分析	(562)
咸晶	

《医用生物力学》杂志由中华人民共和国教育部主管、上海交通大学主办,所发表之图文、版权(含翻译权)均归《医用生物力学》编辑部(出版人)所有。未经出版人书面许可,不得对本刊内容进行任何目的和形式的转载、转播及复制,包括转换成用于资料信息处理设施的机械、电子语言。

本刊实行通讯作者负责制,每篇论文均由2~3位同行评委(peer reviewer)独立审稿。发表的图文中所表达的任何内容与观点,均属作者个人的见解与意见,并不反映和代表《医用生物力学》编辑部的立场和观点。有关所发表文章的任何问题,均由作者负责解释,出版人不承担任何与之相关的责任。

本刊是中国科技核心期刊,已被北京大学图书馆《中文核心期刊要目总览》、《中国科学引文数据库》、荷兰《文摘与引文数据库》等国内外多家知名数据库收录。

本杂志采用无酸纸(acid-free)印刷。

# JOURNAL OF MEDICAL BIOMECHANICS

Published Bimonthly

Founded in June, 1986

Volume 39 Number 3, Jun. 2024

[ Journal Basic Information ] CN 31-1624/R \* 1986 \* b \* A4 \* 186 \* zh+en \* P \* ¥25.00 \* 2000 \* 26 \* 2024-06

**Supervised by**

Ministry of Education of  
the People's Republic of China

**Sponsored by**

Shanghai Jiao Tong University

**Organized by**

Shanghai Ninth People's Hospital,  
Shanghai Jiao Tong University  
School of Medicine

**Published by**

Editorial Office of  
*Journal of Medical Biomechanics*

**Editorial Office**

No. 639 Zhizaoju Rd.,  
Shanghai 200011, China  
Tel: + 86 21 53315397  
Fax: + 86 21 63137020  
E-mail: shengwulixue@163.com

Website:  
<http://www.medbiomechanics.com>  
<http://www.mechanobiology.cn>

Microblog:  
<http://weibo.com/u/2040064195>

Advertising division: SHUI Wen

**Honorary Editor-in-Chief**

DAI Kerong

**Editor-in-Chief**

JIANG Zonglai

**Executive Editor-in-Chief**

ZHAO Jie

**Executive Vice Editor-in-Chief**

CHEN Weiyi FAN Yubo  
FENG Xiqiao GUO Xiangdong  
QIN Ling ZHANG Xizheng

**Associate Editors-in-Chief**

FANG Bing LIU Youjun  
YANG Hui WANG Xiangyang  
PU Fang GU Yaodong  
LIU Hui YU Zhifeng

**Editorial Director**

YU Zhifeng  
E-mail: zfyu@outlook.com

**Editor-in-charge**

XU Qi  
E-mail: 1534340082@qq.com

**English Editor**

XU Qi

**Edited by**

Editorial Board of  
*Journal of Medical Biomechanics*

**Printed by**

Shanxi Tongfang Knowledge Network Printing  
Co., Ltd.

**Overseas Distributor**

China International Book  
Trading Cooperation

**China Standard Serial Numbering**

ISSN 1004-7220  
CN 31-1624/R  
CODEN YSLIBU  
Subscription  
Yearly Subscription Rates: 150.00 RMB  
Single Issue: 25.00 RMB  
Copyright © 2024 by the Editorial  
Board of *Journal of Medical Biomechanics*

## Contents

### Expert Forum

- Research Progress of Mechanobiology under Weightless Environment in 2023 ..... (377)  
*DOU Xiangya, ZHANG Yiwen, LIU Shuaiting, XU Huiyun*  
Research Progress of Cellular Mechanoperception & Mechanotransmission under Space Microgravity ..... (387)  
*TIAN Ran, WU Xintong, SUN Lianwen*

### Original Articles

- Effects of Intramedullary Pressure on Fluid Flow Behavior in Bone ..... (393)  
*YU Weilun, YANG Fengjian, SHI Nianqiu, OU Renxia, CHEN Jiayu, LIU Jianyang, WANG Hui, XING Shuang, GAO Yuhan, LIU Haotong, SUN Qiyu*  
Effects of Unilateral Graded Facetectomy of Facet Joints under Endoscope on Stability of Cervical Spine ..... (400)  
*YANG Guangnan, LIU Jiang, JIANG Qiang, ZHANG Hanshuo, LI Tusheng, MA Jingbo, DING Yu*  
The Influence of Double-Headed Screws on Stability of Multi-Rod Structures in Posterior Three-Column Spinal Osteotomy ..... (407)  
*LIAO Yunqian, ZHOU Yu, WANG Zhenglun, LIU Yongsheng, LI Wei*  
Mechanical Properties of Modified Cortical Bone Trajectory Placement in Lumbar Revision: A Finite Element Analysis ..... (413)  
*ZHANG Lianpeng, Julaiti · MAITIROUZI, ZHANG Zhihao, ZHANG Rui, Abulikemu · MAIMAITI, Paerhati · REXITI*  
Effects of Medial Protrusio Technique of Total Hip Arthroplasty on Acetabular Cup in Adult Patient with Developmental Dysplasia of the Hip: A Finite Element Analysis ..... (421)  
*ZHANG Xin, LIN Wenjie, HE Bin, FENG Bolin, CHEN Haicong, ZHONG Huan, OUYANG Hanbin*  
Initial Stability of Acetabular Cup with Voronoi Polyhedral Porous Structure ..... (428)  
*YI Yali, YU Runze, ZHANG Jinming, LI Jiao, CHAI Liping, JIN Herong*  
Finite Element Analysis of Three-Dimensional Screws and Circular Plates for Treating Sanders Type III AB Calcaneal Fracture ..... (435)  
*PAN Hongyuan, KONG Dewei, LIU Yue, GONG Lulu, ZHAO Yidong, KONG Dece, WANG Jiaqi, WANG Zhi, YANG Tieyi, FAN Xinbin*  
Topology Optimization Design of Bone Plate Structure Based on Load Path ..... (442)  
*CAI Jun, DING Xiaohong, DUAN Pengyun, XIONG Min, ZHANG Heng*  
Lower Limb Joint Torque Estimation Based on Depth Camera and Neural Network ..... (450)  
*GAO Fei, WANG Zhengtao, WANG Dongmei, YU Suiran*

Effects of Sustained Fatigue on Passive and Active Biomechanical Characteristics of the Knee .....	(457)
<i>KONG Xiangfei, WANG Hongdan, LIAN Zizhan, YAO Jie, FAN Yubo</i>	
Analysis of Characterization of Upper Limb Joint Movement Angle in Rolling Manipulation in Traditional Chinese Tuina .....	(463)
<i>CHEN Jintian, ZHOU Xin, SHAN Yiming, ZHU Qingguang, SUN Wuquan</i>	
Biomechanical Effects of Lateral Wedge Insoles on Foot and Ankle: A Finite Element Analysis .....	(469)
<i>DU Weijin, CHEN Weiyi, GUO Yuan</i>	
Inversion Method of Constitutive Parameters from Plantar Soft Tissues Based on Random Forest and Neural Network Algorithms .....	(476)
<i>LI Fengtao, SUN Lifang, TAO Yaping, YANG Peng, JI Mengqiang, SANG Jianbing</i>	
A Residual Neural Network Muscle Fatigue Prediction Model for Overhead Tasks .....	(482)
<i>ZHAO Xiaoyi, ZHAO Chuan, YANG Wenxin, LIU Siqui</i>	
Intelligent Prediction for Dynamic Characteristics of Stroke Patients During Exercise .....	(489)
<i>ZHANG Nan, MENG Qinghua, BAO Chunyu, ZHOU Luxing, CUI Shuaiqi</i>	
The Key Technical Characteristics Affecting the 1 500-m Straight Performance of Chinese Male Speed Skaters ...	(497)
<i>ZHANG Masen, CUI Jing, SHAO Zhongping, LIU Hui</i>	
Fluid-Structure Interaction Simulation of the Mitral Valve Motion .....	(504)
<i>JU Jiayi, YAN Wentao, WEI Lai, GAO Hao, WANG Shengzhang</i>	
Modeling Method of Aortic Homeostasis Considering Three-Dimensional Residual Deformation .....	(510)
<i>GAO Peng, GUO Baolei, ZHANG Ming, DAI Xiangchen, LIU Haofei</i>	
Structure Design and Experimental Verification of a Degradable Vascular Anastomotic Device .....	(518)
<i>XU Kaiyue, CAI Xue, HU Zhongxin, GAO Qinxian, XING Xupo, SONG Chengli, MAO Lin</i>	
Deformation of the Cupula of a Semicircular Canal Based on a Biomimetic Physical Model .....	(524)
<i>ZHANG Wenxuan, ZHANG Yu, WEN Xianhua, DAI Junjie, BIAN Yixiang, JIANG Yani</i>	
Three-Dimensional Finite Element Analysis of Implant-Supported Overdenture with Lingual Metal-Reinforced Bar .....	(532)
<i>ZHANG Xinyue, WANG Yong, CHEN Qian, ZHOU Tuanfeng, MA Kenan, WANG Zixuan, ZHAO Yijiao</i>	
Dynamic Implantation Process of Orthodontic Micro-Implant: A Finite Element Numerical Simulation .....	(539)
<i>MIAO Xuelin, ZHANG Hongwei, QIU Lingling, JI Kangkang, ZHANG Jiaqi</i>	

## Review Articles

Research Progress on Mechanobiology of Mitochondria .....	(545)
<i>NA Jing, ZHENG Lisha, FAN Yubo</i>	
Research Progress on Design and Optimization of Centrifugal Blood Pumps .....	(552)
<i>ZHANG Kejia, WU Peng</i>	

## Information

.....	(559) (560) (561) (562)
-------	-------------------------

The *Journal of Medical Biomechanics* (JMB) is sponsored by Shanghai Jiao Tong University and supervised by Ministry of Education of the People's Republic of China. The copyright is reserved by Editorial Office of *Journal of Medical Biomechanics*. No contents are allowed to be reproduced or transmitted in any form or by any means, electronic or mechanical, for any purpose, without the written permission from the publisher.

All manuscripts are reviewed by two or three independent expert reviewers. The information presented in the papers and the opinions expressed therein are those of the individual authors and not necessarily reflect the views of the Editorial Board of *Journal of Medical Biomechanics*. The publisher assumes no liability for any materials published in the journal. All statements are the responsibilities of the authors, particularly the corresponding author (s).

JMB is the source journal for Chinese Scientific and Technical Papers and Citations, and is selected in the *Guide to the Core Journals of China* by Peking University Library. It has been included in certain famous databases such as China Science Citation Database (CSCD) and Scopus.

This journal is printed on acid-free papers.