Influence of spinal rod curvature on scoliosis sagittal correction

Salmingo, Remel A.; Tadano, Shigeru; Abe, Yuichiro; Ito, Manabu

Published in:
Transactions of the Orthopaedic Research Society

Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Introduction: Adolescent idiopathic scoliosis is a complex spinal pathology characterized by three-dimensional spine deformation accompanied with vertebral rotation. Correction of severe scoliosis requires surgical fixation of implant rods and screws to deform and fix the spine into desired shape. Until now, optimal scoliosis correction is difficult to attain because surgical treatment is still dependent on the surgeon’s preferences and correction objectives. There is no consensus yet on what possible initial shape of rod could lead to a certain sagittal outcome.

The objective of this study was to analyze the deformation of implant rod using its angle of curvature during surgery and establish its influence on the sagittal correction of scoliosis deformity. Relationship between the degree of rod deformation and preoperative implant rod angle of curvature was sought to establish whether it is possible to predict the postoperative outcome from the initial rod shape.

Methods: Fifteen (n=15) adolescent idiopathic scoliosis patients underwent surgical operation after the approval of the university hospital research ethics committee. A proper informed consent was obtained from all patients. Figure 1(a) shows 6mm rods (USS II Synthes) implanted to the concave and convex side of the deformity. This figure also shows that the rod curvature constitutes the spine sagittal curve within its length. The preoperative implant rod geometry was measured before surgical implantation. The postoperative implant rod geometry a week after surgery was measured by CT scan (Aquilion CT). Implant rod geometry image was fitted using quintic polynomial function [1]. The implant rod angle of curvature was computed as the angle $\theta$ between two tangent vectors of the quintic polynomial function at the rod ends, Fig. 1(b). Degree of rod deformation $\Delta \theta$ was computed as the difference between the preoperative and postoperative implant rod angle of curvature ($\theta_1-\theta_2$).

The average normal spine sagittal curvature $\theta_{FL}$ of healthy adolescents between the vertebrae levels obtained by previous studies was used to evaluate scoliosis correction at the sagittal plane of each patient [2,3]. Ideal correction is attained when the normal sagittal angle of curvature $\theta_{FL}$ equals to the postoperative implant rod angle of curvature $\theta_1$ at the corresponding fixation level ends.

Results: The implant rod angles of curvature at the concave side of deformity for all patients tended to reduce indicating that the rods were significantly deformed after scoliosis surgery, average $\Delta \theta$: 15.7 deg. (8.0 to 23.7 deg.), Fig. 2(top). The implant rods at the convex side of all patients did not have significant deformation, average $\Delta \theta$: 1.1 deg. (4.9 to 7.4 deg.), Fig. 2(bottom). A positive relationship was found between the degree of rod deformation $\Delta \theta$ and preoperative implant rod angle of curvature $\theta_1$ at the concave side ($r = 0.87$, $p < 0.001$), Fig. 3.

The normal spine sagittal curvature $\theta_{FL}$ used for the concave and convex side was the same for each patient because the extreme fixation levels (most superior and inferior level) was also the same for both sides, Fig. 2. Differences between the postoperative implant rod angle of curvature $\theta_1$ and normal spine sagittal curvature $\theta_{FL}$ demonstrates over or under correction of scoliosis deformity at the sagittal plane.

Discussion: The positive relationship obtained indicates that the postoperative sagittal outcome could be predicted from the initial implant rod shape. Implant rod deformation at the concave side suggests that the corrective forces acting on that side are higher than the convex side. Implant rod angle of curvature greatly influenced the clinical outcome and careful preoperative planning of the initial implant rod shape is important because the sagittal curve can be over or under corrected during scoliosis corrective surgery.

Significance: This study revealed that the postoperative sagittal outcome of scoliosis corrective surgery could be predicted from the initial implant rod shape. Results suggest that careful preoperative planning of the rod shape is important to achieve optimal clinical outcome.

Poster No. 0773
Decellularized Matrix from Urine Stem Cells Benefits Human Bone Marrow Stromal Cell Chondrogenesis
Ming Pei, Jingteng Li, Mark Shoukry, Yuanyuan Zhang

Poster No. 0774
The Development of Degradable Alginate Microbeads for the Delivery of Stem Cells for Bone Regeneration
Shirae Leslie, Barbara D Boyan, Zvi Schwartz

Poster No. 0775
Characterization of an Empty Segmental Defect for Stem Cell Delivery in the Femur of the Rat
Christopher R Dosier, Nick J Willett, Laxminarayan Krishnan, Robert Guldberg

Poster No. 0776
Investigation of the Optimal Timing for Chondrogenic Priming of MSCs to Recreate the Endochondral Ossification Process In Vitro
Fiona E Freeman, Matthew G Haugh, Laoise M McNamara

Poster No. 0777
Effect of Silicon-Doped Calcium Phosphate Bone Grafting Materials on Bone Formation and Osteoblastic Phenotype Expression In Vivo
Christine Knabe, Dirk Barnemitz, Antje Genzel, Fabian Peters, Wolf-Dietrich Hübner

Poster No. 0777A
Development of a Collagen-Ceramic Bone Substitute with Sustained-Release Calcitonin for Improving Bone Defect Repair
Yuan-Ming Hsu, Chih-Hung Chang, Hsu-Wei Fang

Poster No. 0778
Live-Animal Imaging of Growth Factor-Mediated Long Bone Defect Repair in a Xenopus Tissue Engineering Model System
Iwona Jasiuk, Derek Milner, Patrick Redwood, Deepika Chitturi, Howon Lee, Nick Fang, Jo Ann Cameron

Poster No. 0779
An Osteoinductive Synthetic Graft as an Instructive Micro-Environment for Posterolateral Fusion
Tomonori Yamaguchi, Ameya Phadke, Nozomu Inoue, Robert L Sah, Hiroshi Asahara, Shyni Varghese, Koichi Masuda

Poster No. 0780
Repair of Osteoporotic Rat Calvarial Defects using Poly(lactic-co-glycolic acid) with Adipose Stem Cells
Jingteng Li, David McConda, Nina Clovis, Suzanne Smith, Ming Pei

Poster No. 0781
Massive Bone Reconstruction with Heat-Treated Bone Graft Loaded Autologous Bone Marrow Derived Stromal Cells and β-Tricalcium Phosphate Composites in Canine Models
Hirotaka Koyanagi, Keisuke Ae, Masato Yuasa, Tomokazu Masaoka, Tsuyoshi Yamada, Takashi Taniyama, Toshitaka Yoshii, Masanori Saito, Atsushi Okawa, Shinichi Sotome

Poster No. 0782
How to Toughen Irradiation-Sterilized Bone Allograft
Thomas Willett, Brianne Burton, Marc Grynpas

Poster No. 0783
Investigation into the Role of TCDD in Smoking-Mediated Bone Healing Inhibition

Poster No. 0784
Material Specific Effects of Wear-Particle-Induced Osteolysis at the Bone-Implant Interface
Lisa Longhofer, Alexander Chong, Nora Zacharias, Shang-You Yang, Paul Wooley

Poster No. 0785
Synthesis and Characterization of Aspartic Acid Modify PLGA-g-PEG Nanoparticles for Bone Targeting
Chih-Kuang Wang, Yin-Chih Fu, Tzu-Fun Fu, Hung-Jen Wang, Chau-Zen Wang, Mei-Ling Ho

PS1 SPINE: SCOLIOSIS

Poster No. 0786
Transverse Process Hooks at Upper Instrumented Vertebra Provide a More Gradual Transition to Normal Motion Compared to Pedicle Screws in Long Posterior Spinal Fusion Constructs
David Glos, Dinesh Thawrani, Matthew Coombs, Kevin Louis, Donita Bylski-Austrow, Peter Sturm

Poster No. 0787
The Utility of an Allograft Tendon for Scoliosis Correction via the Costotransverse Foreman
Dong Sun, Michael McCarthy, Sandra G McLaren, Raghu H Ramakrishnaiah, Larry J Suva, Richard E McCarthy

Poster No. 0788
Inter and Intra Observer Reliability of X-ray Assessments of Apical Vertebral Rotation
Darryl Auston, Nathaniel R Ordway, Richard Tallarico, Mark Palumbo, William F Lavelle

Poster No. 0789
Influence of Spinal Rod Curvature on Scoliosis Sagittal Correction
Remel A Salmingo, Shigeru Tadano, Manabu Ito, Yuichiro Abe

Poster No. 0790
Genetic Determinants of Severe Scoliosis in NF1 Patients
Nancy H Miller, Heejong Sung, Kandice Swindle, Alex Pernov, Cristina Justice, Alexander Wilson, Douglas R Stewart

Poster No. 0791
Analysis of Cell Viability in Intervertebral Disc Under IGF-1 Treatment
Qiaoqiao Zhu, Xin Gao, Chun-Yuh Huang, Weiyong Gu

PS1 NERVE AND SPINAL CORD INJURY

Poster No. 0792
Evaluation of Injured Axons Using Two-Photon Excited Fluorescence Microscopy after Spinal Cord Contusion Injury in EYFP H-Line Mice
Hideki Horiuchi, Tadanori Ogata, Tadao Morino, Gotaro Ymaoka, Hiromasa Miura, Atsuhiro Hikita, Yusuke Oshima, Takeshi Imamura