International Society of Biomechanics Newsletter

WINTER ISSUE 1989 N° 37

TABLE OF CONTENTS

ISB membership news

LIST OF NEW MEMBERS

n° 1047
KINATAKA, HIROFUMI
Institute of Fitness & Sport
1 Shiromizu
Kanoya City
Kagoshima 891-23
Japan

n° 1048
JOGANICH, TIM G.
1806 East Citation Lane
Tempe, AZ 85284
USA

n° 1049
KLEIN, PAUL J.
Université Libre de Bruxelles
ISEPK CP 168
28, Avenue P. Héger
1050 Brussels
Belgium

n° 1050
BARRY, EDWARD BRUCE
Plenty Road
Bundoora
Melbourne, Victoria
Australia 3083

n° 1051
RUSTON, SALLY A.
c/o 53 King's Avenue
Christchurch BH23 INA
Dorset, Australia

n° 1052
KARI LASSE KESKINEN
Auvilanpera 3 B 11
SF - 40740 Jyväskylä
Finland

n° 1053
JAG MADAN
8220 San Francisco Street
Brossard. Quebec
Canada

n° 1054
SASAKI TSUTOMU
Hokusoigakuen Women's Jr. College
Mimami 4 Jyo
Nishi 17 Ehome
Chuo-Ku. Sapporo. 064 Japan

n° 1055
CHRISTIAN F-J HÖGFORS
Chalmers University of Technology
Centre for Biomechanics
S-41296 Göteborg
Sweden

n° 1056
OWEN M. EVANS
625 Swanston Street
Carlton 3053
Victoria
Australia

n° 1057
CHUL S. CHUNG
489-52 Gilum-Dong
Sungbuk-Gu
Seoul
South Korea

n° 1058
BARRY A. MUNKASY
910 East Lemon Street
Apt. n° 3
Tempe. AZ 85201
USA

n° 1059
GERNOT HERING
Kornslumenweg 12
7750 Konstanz
BRD

n° 1060
TONI TRAMULLAS
Craywinkel 2-4 1-4a-B
Barcelona 08022
Spain

n° 1061
GERTJAN J.C. ETTEMA
Baanstraat 121
1941 CJ Beverwijk
Netherlands

n° 1062
DAN ROBERT KARLSSON
Chalmers University of Technology
Centre for Biomechanics
S-41296 Göteborg
Sweden

n° 1063
KIM A. BURTON
30 Queen Street
Huddersfield HD12SP
England

n° 1064
KAREN LEE PERELL
11203 Summertime Lane
Culver City. CA
USA

n° 1066
SCOTT L. DELP
1010 Noel Drive 5
Menlo Park. CA 94025
USA

n° 1065
NORIHISA FUJII
1-1. Minatojima-Nakamachi
7 Chome
Chuo-Ku
Kobe 650 Japan

n° 1067
ANTONY DE LANGE
P.O. BOX 135
5140 AC Waalwijk
Netherlands

n° 1068
ZVI LADIN
Biomedical Engineering Dept.
44 Cummington Street
Boston. MA
USA

n° 1069
ROSS HOWARD SANDERS
Faculty of Physical Education
University of Otago
Dunedin
New Zealand

n° 1070
STEVEN E. IRBY
Motion Analysis Laboratory
8001 Frost Street
San Diego. CA 92123
USA

n° 1071
DIRKJAN VEEGER
Faculty of Human Movement Sci.
Vrije Universiteit of Amsterdam
v.d. Boechortstraat 9
1081 BT Amsterdam Netherlands

n° 1072
HEIKKI ARIMO KYRÖLÄINEN
Viitaniemente 8C26
40720 Jyväskylä
Finland

n° 1073
ALBERT F. GOLLHOFER
Schwarzwaldstraße 175
7800 Frieborg
BRD

n° 1074
FINN BOJSEN-MOLLER
Dept. of Anatomy
Blegdamsvej 3C
2200 Copenhagen N
Denmark

n° 1084
GARY M. GREENSTEIN
2607 South Beverly Drive
Los Angeles. CA
USA

n° 1085
TACITO PESSOA SOUZA, JR.
Av. Alimirante Cocrane 02/14C
Santos S.P.
Brazil

n° 1086
Yiannis Laouris
University of Arizona
College of Medicine
Tucson. AZ 85724
USA

n° 1087
ANNA LEE
1500 Locust Street
Apt. 3816
Philadelphia. PA 19102
USA

n° 1088
JOZSEF KUWAIT TIHANYI
Faculty of Medicine
Dept. of Physiology
P.O. Box 24923
Safat 13110 Kuwait

n° 1089
OTMAR KRETTEK
effenter Weg 8
D 5100 Aachen
BRD

n° 1090
EILEEN GREENAN FOWLER
121 31st Street
Manhattan Beach. CA 90266
USA

n° 1091
TOM D. WHITAKER
3650 North Laughlin Road
Santa Rosa. CA 95403
USA

n° 1092
HENRY DAVID BROWNE
7350 La Mesita Place
Apt. n° 3
La Mesa. CA 92041
USA

n° 1093
ERIK L. DEPORTE
Vrije Universiteit Brussel
HILOK - BIOM
Pleinlaan 2
B-1050 Brussels Belgium

n° 1094
BARBARA J. LOITZ
UCLA
Dept. of Kinesiology
2859 Slichter Hall
Los Angeles. CA 90089-0602
USA

n° 1075
KAY CERNY
Physical Therapy Dept.
1250 Bellflower Blvd.
Long Beach. CA 90808
USA

n° 1076
BRYAN O. BUCHHOLZ
University of Michigan
Center of Economics - 10E BLDG.
Ann Arbor. MI 48109
USA

n° 1077
BONNIE L. ROBINSON
School of Physical Therapy
Children's Hospital of Los Angeles
P.O. Box 54700
Los Angeles. CA 90054-0700
USA

n° 1078
DER-MING HONG
299 Taichung Road
Taichung
Taiwan
China

n° 1079
LILIAM F. DE OLIVIERA
Av. Heitor Beltrao 152
Apt. 802
Rio de Janeiro
Brazil

n° 1080
LYNNE C. SHEEHAN
c/o 172 Burke Road
Malvern
Melbourne. Victoria 3144
Australia

n° 1081
KATHY J. SIMPSON
University of Georgia
Physical Education Bldg.
Athens. GA 30602
USA

n° 1082
JOHN R. FLINT
611 Tuttle Avenue
Apt. 12
Watsonville. CA
USA

n° 1083
RUSSELL J. BEST
Department of Sport
Crewe-Alsager College of Hlth. Ed.
Alsager
Stoke-on-Trent
England

n° 1095
MARTINE S. KORACH
1144 South Lapeer Drive
Los Angeles. CA 90035
USA

n° 1096
SOPHIE DE SERRES
11870
Valmont
Montreal. Quebec
Canada

n° 1097
MARY M. RYAN
6100 Buckingham Parkway
Apt. 302
Culver City. CA 90230
USA

n° 1098
JOSEPH A. MASTROPAOLO
Trisphere Inst. of Sports Medicine
16291 Magellan Lane
Huntington Beach. CA 92647
USA

n° 1099
SUSAN A. CHINWORTH
4777 South Ridge Terrace
Ft. Worth. TX 76133
USA

n° 1100
JAMES G. KENT
4640 Admiralty Way
Ste 402
Marina Del Rey. CA 90292
USA

n° 1101
NANCY JEAN LAMBERT
University of Denver
Dept. of Sport Science
University Park
Denver. CO 80208
USA

n° 1102
MORGAN D. EATON
13591 Nogales Drive
Del Mar. CA 92014
USA

n° 1103
JEFFREY B. WHEELER
Accident Research & Analysis
24359 Walnut Street
Newhall. CA 91321
USA

n° 1104
LISA M. SCHUTTE
552 Terman
Design Division
Stanford University
Stanford. CA 94305
USA

NEW INVESTIGATOR AWARDS

At UCLA the ISB was happy to have award money from three donors available to honour high quality papers from new investigators. The most long standing award was donated by Mrs. Wartenweiler, wife of the first President of the ISB, Jurg Wartenweiler. Mrs. Wartenweiler has, at her own expense, attended every Congress of the ISB since the Society's founding at Penn State in 1973 and has provided this prize each year. Professor Wartenweiler passed away unexpectedly in 1976, a great loss to the ISB.

This year Mrs. Wartenweiler's award was 'hidden' in a 'cherry tree'. She made this tree of life and good luck on which could be found one cherry for each of the member countries of the ISB and one coveted Swiss chocolate for each year of the Society's growth. The mature tree symbolized the maturity of the ISB founded on very strong roots. An enormous amount of time was spent by Mrs. Wartenweiler to make this unique memento. Unfortunately she had to leave the Congress before the winner was known and was not able to present the award.

The recipient of the Wartenweiler New Investigator Award for the best paper presented orally was:

Oliver Mills, Department of Mechanical Engineering, University of California, Davis, U.S.A. (co-author Prof. Maury Hull). — 'Flexibility of the Human Knee Under Varus/Valgus and Axial Moments in Vivo'.

The second award was graciously donated by the Amsterdam XIth Congress organizers. Their award maintained a short 'tradition' initiated in 1985 at Umea by the Waterloo Congress organizers who had hosted the IXth Congress in 1983 in Canada. The award was possible from money remaining after other Congress expenses had been paid. The organizers of the Swedish Congress were able to follow suit with an award in Amsterdam.

The recipient of the Amsterdam Congress Organizers' New Investigator Award for the best paper presented in poster format was:

Cheryl Johnson, School of PHE, Queen's University, Canada. (Co-authors Prof. Gavin Reid and Mr. Steven Byberg). — 'A Computer Model Analysis Determining the Lumbar Compressive and Shear Forces During Various Trunk Curl-up Exercises'.

The third award was new at this Congress and was donated by the journal 'Clinical Biomechanics' published by Butterworth Scientific Ltd., England. The award was for the paper with clinical biomechanics content judged to be the best of the Congress.

The recipient of the Clinical Biomechanics Award was:

Michael Morlock, Biomechanics Laboratory, University of Calgary, Canada — 'A Generalized Three-Dimensional Six Segment Model of the Ankle and the Foot'.

The New Investigator Award recipients are chosen by a panel of judges who this year evaluated more than 90 papers submitted for competition. These 90 were reduced to a short list in each of the categories and the quality of the poster or oral presentation was considered along with the quality of the research judged from the two-page paper. The judges then got together at the end of the Congress prior to the closing session to agree upon the three recipients. It takes a great deal of time to organize and judge the papers. Review and change in the process is ongoing, as more and more papers are submitted for the competition, to try to ensure that the most deserving work is recognized. The awards are currently $ 500 U.S. and the prestige of being a recipient is appreciable. The work of the judges and submissions by the contestants is very much appreciated by the ISB Council.

Department of Mechanical Engineering,
University of California,
Davis, California 95616

FLEXIBILITY OF THE HUMAN KNEE UNDER PURE VARUS/VALGUS AND AXIAL MOMENTS IN VIVO

O.S. Mills and M.L. Hull

ABSTRACT

Knee injuries remain a persistant problem in alpine skiing. To appreciate why this is so, we must first recognize that ligamentous injuries occur when an excessive tibia deformation with respect to the femur causes an excessive ligament strain. Clearly, if the strains are large, an injury results. Knee strength therefore depends on joint stiffness which may vary markedly depending on such variables as muscle contraction and weight bearing (3). But unfortunately, present ski bindings only release when the loads developed between the boot and the ski reach a preset level. These loads, however, often exceed the load capacity of the knee joint in its weakest state (ie. muscles relaxed and no weight bearing) (3). A new approach to binding design must be followed if knee injuries are to be prevented. This approach calls for basing release decisions on knee deformation in conjunction with externally applied loads.

To provide the information base necessary for such designs, relationships between external loads and joint deformation are required. Since in injury situations loading is the independent variable and deformation across the knee is the dependent variable, this study concentrates on flexibility relations rather than stiffness relations. In considering which loads to study, axial and varus/valgus moments are thought to account for the majority of injuries (2). Hence, the objectives of the present work are to first construct the equipment necessary to measure flexibility and second, to obtain knee flexibility of six test subjects in pure varus/valgus and axial moments.

METHODS

To obtain joint deformation under pure varus/valgus and axial moments, we developed a relative motion three degree-of-freedom goniometer and an instrumented load stand. The three degree-of-freedom goniometer measures flexion/extension, varus/valgus and external/internal angulation using three miniature potentiometers which are oriented according to the coordinate system that Grood and Suntay (1983) present. The benefit behind selecting this system is that joint motions are obtained sequentially independent of the order in which they occur. To decouple the inherent joint translations while transmitting the rotations between the tribial and femoral attachment clamps, a dual-parallelogram linkage was designed. This linkage simultaneously decouples medial/ ateral and anterior/posterior translations while sliding hardened steel rods decouple distal/proximal translations. Specially designed fixation clamps attach the goniometer to the leg at the tibial crest, the medial and lateral epicondyles, and the thigh.

The instrumented load stand supports the test subject and has the capability of either varying and/or isolating the five variables which affect knee strength (muscle contraction, weight bearing, knee flexion angle, hip flexion angle, and rate of loading) while simultaneously applying either pure varus/valgus of axial moments to the right knee. By definition, pure moments are those which minimally create unwanted shear forces at the knee and are desirable in isolating which loads contribute to total joint angulation. With the load stand capable of also applying combination varus/valgus and axial moments, isolating the contribution of a load to joint deformation is vital if comparisons between individual and combination moments are to be done. Shear forces were effectively minimized by allowing the foot to translate medial/ laterally and anterior/posteriorly via two sliding loading carriages. The application of moments also follows the joint coordinate system of Grood and Suntay (1983); axial moments are applied along the long axis of the tibia and varus/ valgus moments are applied perpendicular to both the flexion/ extension and external/internal rotational axes. Gearmotors provide the necessary torques while a bicycle seat and backrest prevent movement of the upper body during testing. A removable fiber glass cast fitted to the foot of each test subject transmits the moments to the knee. Knee flexion angle is then varied by lowering the torso such that the leg and loading carriage slide forward. A data acquisition computer and custom software convent the raw data into moments and displacements for later plotting.

We cycled pure varus/valgus and axial moments to the right knees of six male test subjects with the knee at 0° and 45° knee flexion angles. Average and standard deviations for the age, height, and weight were 28.5 ± 6.4 years, 1.75 ± 0.04 meters and 712 ± 45 newtons respectively. Throughout all tests, the test subjects minimized muscle contraction and weight bearing. Varus/valgus tests consisted of cycling between 60 Nm of varus and 60 Nm of valgus over a time span of 60 seconds. During testing, the foot was unconstrained in external/internal rotation to insure that only a pure moment was developed at the knee. Before testing, the data acquisition program obtained the goniometer offsets with the test subject's leg muscles relaxed and his knee joint fully extended. Similarly, axial moments were cycled between 20 Nm of external and 20 Nm of internal axial moments except that the foot was unconstrained in varus/valgus.

RESULTS AND DISCUSSION

All flexibility plots showed significant nonlinearities. Figure 1 is a typical example of a varus/valgus flexibility plot for 0° and 45° flexion angles. Note the increase in angulation at 45° flexion over 0° and the significant amount of hysteresis for a complete load cycle. Figure 2 is a typical example of a cycled external/internal flexibility plot for 0° and 45° flexion angles. Note that the cycled curves closely trace over each other and that hysteresis is minimal. Also note that in external rotation, total deformation markedly increases. Seering et al. (1980), in an in-vitro study of knee stiffness, applied similar axial moment levels and observed similar external displacement trends to the ones we obtained. We defined laxity as the range of motion up to a predefined slope beyond which the joint becomes significantly stiffer. We determined these slopes to be 0.17°/Nm and 2.0°/Nm for varus/valgus and axial moments respectively.

CONCLUSION

Relieving knee injuries in alpine skiing calls for a new approach to binding design, one where release is based on knee deformation. Required by this new approach is information of knee flexibility. With the present three degree-of-freedom goniometer and instrumented load stand, we were able to obtain the flexibility of the knee for both pure varus/valgus and axial moments. Since the results show that flexibility is flexion angle dependent, knowledge of this relationship may be important in the design of ski bindings which protect against ligamentous injury. To determine this conclusively, flexibility data collected in vivo must be supported by ligament strain data collected under externally applied loads.

BIBLIOGRAPHY

1. Grood, E.S. and Suntay, W.J. (1983), *J. Biomech. Eng.*, Vol. 105, pp. 136-144.
2. Howe, J. and Johnson, R.J., (1985), *Orthop. Clin. North Am.*, Vol. 16, pp. 303-304.
3. Hull, M.L. and Johnson, C., (1988), to appear in Skiing Trauma and Skiing Safety VII, ASTM, Philadelphia.
4. Seering, W.P. et al. (1980), *J. Biomech.*, Vol. 13, pp. 785-794.

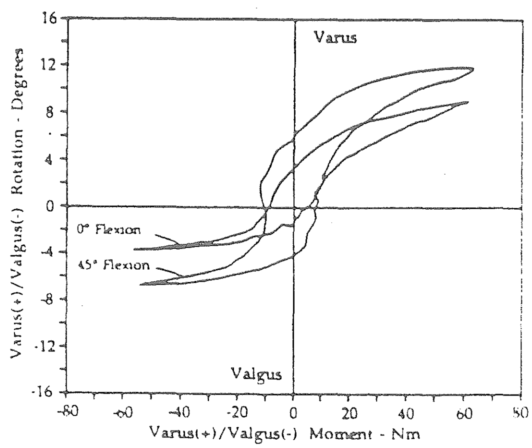


Figure 1

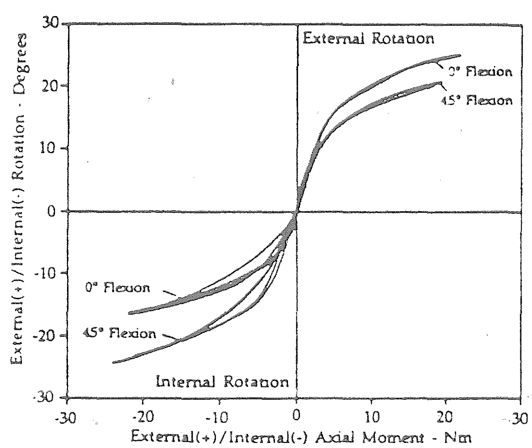


Figure 2

Biomechanics Laboratory,
University of Calgary,
2500 University Drive N.W., Calgary
Alta, Canada, T2N 1N4

A GENERALIZED THREE-DIMENSIONAL SIX SEGMENT MODEL OF THE ANKLE AND THE FOOT

Michael M. Morlock

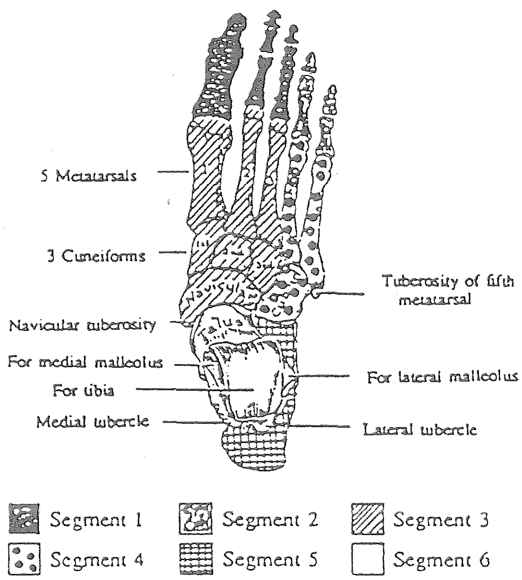
ABSTRACT

INTRODUCTION

Participation in physical activity has changed during the last two decades: physical activity has become a part of every day life for an increasing number of people. This development started with the 'jogging trend' in the late sixties and early seventies. A few years after the start of mass participation in running, other sports have become attractive with increasing numbers of participants. The most popular ones are swimming, cycling, tennis, and aerobics (Steinbrueck, 1987). The latter two sports frequently involve movements in medio-lateral direction, such as side shuffles, as well as movements in anterior-posterior direction, which are dominant in running. The frequency of sport injuries involving movements in medio-lateral direction is high. The most common injuries are ankle ligament sprain or rupture involving the lateral ligamenteous complex and joint distortions. It has been suggested that the frequency of sports injuries during lateral movements can be reduced by changing external conditions such as shoe construction and surface properties (Nigg et al., 1986). However, quantitative analyses of the influence of external conditions on the loading of internal structures during lateral movements do not exist. Internal forces can be estimated using mathematical models. Several models are available to estimate internal forces during anterior-posterior movements (Burdett, 1982; Procter et al., 1982). These models can not be used to estimate forces during lateral movements since the relevant anatomical structures and functional divisions are not specified.
The purpose of this study was to develop a mathematical model to estimate forces and moments in joints, and forces in ligaments and muscles of the foot in a generalized three-dimensional situation.

METHODS

Anatomical model: The foot and ankle complex was modelled as a six segment system (segment 1: phalangeals of 3 medial rays, segment 2: phalangeals of 2 lateral rays, segment 3: metatarsals of 3 medial rays and cuneiforms, segment 4: metatarsals of 2 lateral rays and cuboid, segment 5: calcaneus, segment 6: talus; Figure 1), taking the medio-lateral functional subdivision of the foot into account (Mann, 1986). The joints connecting these segments and the tibio talar joint were represented as hinge joints (Morris, 1977). The 12 long foot muscles were considered, being the important active force structures. Four ligamenteous structures were selected based on their importance for the functional anatomy of the foot and their injury frequency (plantar aponeurosis, talo-fibular, calcaneo-fibular, and deltoid ligaments). The equations of motion for this system were derived using an inverse dynamic approach with external forces acting on each segment which is part of the plantar surface of the foot.
Muscle and control model: Each muscle-tendon unit was assumed to consist of three different components which are arranged in series: the fiber elastic component within the contractile element, the contractile component of a muscle fiber, and the tendon as elastic structure (Pierrynowski et al., 1985). Muscle fibers were categorized into three different types (SO, FO, FG). The maximal possible force output of a muscle at a certain time was calculated considering the geometry, the elasticity of the serial elastic components, temporal phenomena (prior activation), muscle fiber type, the force-length, and the forc velocity relation. The stimulation of a muscle and, therefore, the actual force output at a certain time was calculated with a neurophysiological, central pattern generator (CPG) based control model (Pierrynowski et al. 1985). Each joint allows for a one degree of freedom movement (hinge joint) and is controlled by one CPG. This CPG facilitates muscles producing a moment in the direction of the required net joint moment and inhibits all other muscles. Muscles crossing more than one joint receive input from the CPGs of all joints they are crossing. This model therefore includes the influence of co-contraction for the bone-to-bone contact force in a joint.
Application: An EMED pressure distribution insole system with 72 sensors was used to determine the external forces acting at each segment. Each sensor was assigned to a segment by means of a dorsal X-ray picture. The resultant external force and its point of application was than calculated for each segment. The location of each segment with respect to certain skin markers (above bone landmarks) through the full range of motion of all considered joints, was determined in an in-vitro study. One cadaver specimen, matched with the test subject by means of 28 anthropometric measurements, as well as a lateral and a dorsal X-ray picture, was used in this study, since it was shown to be not appropriate to use averaged cadaveric information (Engsberg, 1987). The length of the ligamenteous structures of interest through the full range of motion was also determined in the cadaver study and th length of these structures was related to force with the help of a force-length relation, derived from the same structures. The results of the model at the tibio-talar level will be compared to a simple one segment model of the foot. A lateral side shuffle movement, executed under various conditions, will be the first application, to investigate the influence of different shoe constructions on internal loading. EMG information will be used to compare the predicted muscle stimulation pattern with the actual stimulation.



CONCLUSIONS

The model developed in this study is not restricted to lateral movements but can be applied to all kind of movements. It is formulated in a truely three dimensional way and is the first model available, which considers the medio-lateral functional subdivision of the foot and local forces.

EFERENCES

Burdett, R.G., 'Forces predicted at the ankle during running', *Med. Sci. Sports*, 14:308-316, 1982.

Engsberg, J.R., 'A biomechanical analysis of the talocalcaneal joint - in vitro', *J. Biomech.*, 20:429-442, 1987.

Mann, R.A., 'Biomechanics of the foot and ankle', *Surgery of the foot*, ed. Mann, R.A., 1-30, Mosby, St. Louis, 1986.

Morris, J.M., 'Biomechanics of the foot and ankle', *Clin. Orthop. Rel. Res.*, 122-10-18, 1977.

Nigg, B.M. et al., 'Factors influencing short-term pain and injuries in tennis', *J. Biomech.*, 2:141-155, 1986.

Pierrynowski, M.R. et al., 'A physiological model of muscular forces in human locomotion: theoretical aspects', *Math. Biosc.*, 75:69-101, 1985.

Procter, P. et al., 'Ankle joint biomechanics', *J. Biomech.*, 15:627-634, 1982.

Steinbrueck, K., 'Epidemiology of sports injuries', *Sportverletzung-Sportschaden*, 1:1-16, 1987.

School of PHE and Department of Civil Engineering, Queen's University, Canada

A COMPUTER MODEL ANALYSIS DETERMINING THE LUMBAR COMPRESSIVE AND SHEAR FORCES DURING VARIOUS TRUNK CURL-UP EXERCISES

Cheryl Johnson, MSc.; J. Gavin Reid, PhD; Steven Byberg, MSc (Eng.)

ABSTRACT

Concern has developed recently that certain styles of sit-up exercises practiced today may result in increased loads being placed upon the spine and thus, may lead to the development of low back pain (1,3). In the literature to date, no non-invasive models have been developed to determine the lumbar forces during such exercises. Therefore, a need existed for the development of a non-invasive model which determines lumbar forces during the execution of curl-up exercises.

BIOMECH6, a 2-dimensional static computer in the sagittal plane, determines the lumbar compressive and shear forces during curl-up exercises. Several anthropometric parameters required for the model to operate were previously obtained. The purposes of this study was to determine the two remaining parameters (iliopsoas tension and lumbar spine curvature) and the lumbar compressive and shear forces during various curl-up exercises.

METHODS

The curl-up styles analyzed by BIOMECH6 were the longlaying (0° hip and knee flexion), hooklaying (hips flexed 45°, knees fixed 90°) and the bench (hips, knees flexed 90°). During each curl-up 2 positions were analyzed: the initial start position and the position when the trunk was 45° to the supporting surface. Using a system of external spine markers and Queen's University software, a photograph was taken in each curl-up position and dignitized to determine the lumbar spine curvature; 9 males and 10 female subjects were used. To determine the iliopsoas tension in each position, 14 males and 16 females were used as subjects. Five-second maximal voluntary isometric contractions on the right leg were performed with the Kinetic Communicator Exercise System at hip flexion angles of 0°, 45° and 90°. Peak torque in each position was analyzed as a percentage of each person's maximum torque. These data were entered into the computer model and the lumbar forces were determined for each curl-up position.

RESULTS AND DISCUSSION

The maximum compressive and shear forces were found to be at the 3/4 level and L2/L3 level, respectively, during the initial position of the longlaying (LL) curl-up. The maximum compressive force ranged from 743-1306 N (male) and 634-1262 N (female), depending on body weight. These results are slightly lower than those suggested by Nachemson (3). The maximum shear forces ranging from 148-246 N (male) and 119-238 N (female) were comparable to literature values (2).

Since there is limited comparable literature, the relationship in the force reduction from one position to another is discussed. The lumbar forces were maximized during the initial position of the LL curl-up because in this position the lumbar lordosis and iliopsoas were maximized. During the initial position of the hooklaying curl-up, the compressive forces were only reduced by 5% (male) and 4% (female) while the shear forces were reduced by 46% (male) and 39% (female). In this position, the lordotic curve reduced slightly and the iliopsoas still generated 80% (male) and 70% (female) of the maximal tension produced during the LL curl-up. The bench curl-up (initial position) minimized the lumbar forces; the compressive forces were reduced by 17% (male) and 18% (female) while the shear forces were reduced by 87% (male) and 97% (female). In this position, the lumbar spine flattened out and the contractile tension of the iliopsoas was only 50% (male) and 42% (female) of its maximum. The lumbar forces reduced for the 45° curl-up position in all 3 variations in comparison to the initial position, except for the bench curl-up where the shear forces increased slightly.

CONCLUSIONS

The results of the present study indicate that performance of the bench curl-up minimizes the lumbar compressive and shear forces. Additionally, the magnitude of the forces produced by BIOMECH6 seem to be reasonable and fit well with in the range of those expected during such exercises.

WCSB

WORLD COMMISSION FOR SPORTS BIOMECHANICS

VIth INTERNATIONAL SYMPOSIUM: BIOMECHANICS AND MEDICINE IN SWIMMING AT LIVERPOOL, U.K. 7-11th SEPTEMBER 1990

This is the sixth international symposium in a series that started at Brussels (1970) and continued to Bielefeld (1986). It is organised by Liverpool Polytechnic (Centre for Sport and Exercise Sciences) and held at the Britannia Adelphi Hotel. The aim of the Symposium is to provide a forum in which research related to swimming is reported and problems that confront swimming practitioners are debated. The Symposium is held under the aegis of the International Society of Biomechanics and the World Commission of Sports Biomechanics. The Symposium is multidisciplinary: besides biomechanics and medicine, any of the human sciences used for research into swimming is relevant.

Conference Topics

Offers of formal and poster presentations are invited for the open session of the Symposium. A wide variety of topics will be deemed relevant, such as:
Anthropometry of the swimmer; Biochemistry; Biomechanics of swimming; Body composition; Cardiology; Coaching; Computerised analysis; Energy Expenditure; Fitness Testing; Flexibility; Growth and ageing; Hydrodynamics; Medicine; Mental Training; Metabolism; Methodology; Nutrition; Overtraining; Orthopaedics; Peaking; Physiology; Physiotherapy; Psychology; Rehabilitation; Teaching; Training.

Keynote Addresses

Performance determing factors in swimming: H. Toussaint
Lactate metabolism and swimming: D. Costill
Analysis of spring swimming: K. Wilke

Invited Lectures and Workshops

Electromyography in aquatic environments
Biomechanical analysis of swimming motions
The relative influence of legs and arms in swimming
Biological rhythms and swimming
Nutrition of the swimmer
Coaching the Olympic Champion
The child swimmer
The female swimmer
Swimming pool design

Scientific Committee

T. Reilly (Chairman), Liverpool
J.P. Clarys, Brussels
P. Hollander, Amsterdam
A. Lees, Liverpool
D. Jameson, Liverpool
D. MacLaren, Liverpool
H. Toussaint, Amsterdam
B.E. Ungerechts, Hanover
K. Wilke, Cologne

Registration Fee

The Registration Fee for the Symposium will be £ 135. This will cover Symposium Registration materials and name badge, attendance at all scientific sessions, coffee breaks, lunch and a copy of the Proceedings that will follow the symposium. This will be published by E. and F.N. Spon, London.

Accommodation

Accomodation will be available for the majority of delegates at the Britannia Adelphi Hotel. This is located in the centre of Liverpool and is the site of the Symposium. Cheaper alternative will be available at the Polytechnic's Halls of Residence 8km from the City Centre in rural surroundings.

Social Programme

Liverpool's magnificent history is recalled in the National Maritime Museum and in the restored Albert Dock complex. This is now the major tourist attraction in the region. Besides visits to the renovated dockland, the social programme will include opportunity for trips to the Cavern Walks, which recreates Liverpool's magical 60's era, visit to the renowned Port Sunlight village on the Wirral Peninsula and to the walled city of Chester. These tours will be co-ordinated by the Merseyside Tourism Board.

Exhibitions

There will be a trade exhibition linked to the Symposium. There will also be a demonstration of training practices at the Everton Park Swimming Pool.

Abstracts

The deadline for receipt of Abstracts is March 30th, 1990. Contributors are invited to send 3 copies of an Abstract of their work to the Organisers. This should be about 300 words long and should be headed with a title, the name and institutional address of the author. It should clearly state the aim of this work, the methods, the main findings and the conclusion. Open communications may be in form of formal or poster presentations.
The Abstract should be sent to Don MacLaren at the address below, from whom more details of the Symposium are available.

Address

Don MacLaren,
Sixth International Symposium Biomechanics and Medici
in Swimming,
National Coaching Centre,
Liverpool Polytechnic,
I.M. Marsh Campus Barkhill Road,
Liverpool L17 6BD,
ENGLAND.

Thesis abstract corner

Liverpool Polytechnic
Faculty of Science

A BIOENGINEERING ANALYSIS OF MUSCLE AND JOINT FORCES ACTING IN THE HUMAN LOWER LIMBS DURING RUNNING

R.N. Harrison, BSc

Supervisor: Dr. A. Lees

A thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy (CNAA) following work carried out at Liverpool Polytechnic, Department of Mechanical, Marine and Production Engineering and Department of Sport & Recreation Studies.

Summary

A fully dynamic two dimensional bioengineering model of the human lower limbs has been produced and has been solved for the activity of running using an inverse dynamics approach. The model includes all the major contributory muscles and muscle groups in the lower limbs including the soleus and the tibialis anterior. The actions of all the muscles have been verified by coordinated electromyographic experimentation.

The analysis method of model production, data collection and data processing has been carried out using standard biomechanical practices, techniques and equipment and this allows comparison with other studies in similar fields. This equipment and technique, based around a Kistler force platform, a Locam high speed cinematographic camera, a magnetorestrictive digitising tablet and individually tailored bone model displays results reliable to within about 3% per subject. This produces results for ground reaction forces, joint moments, limb angles, muscular tensions and joint reactions. For a basic running speed of 4.47 m s^{-1} results indicate maximum joint moments of 150 Nm, 189 Nm occur in the hip, knee and ankle respectively. Maximum mean peak muscle forces of 15.0 BW and 10.7 BW occur in the quadriceps and triceps surea muscle group accordingly. The hamstrings and shin groups display more modest values of 2.8 BW and 0.5 BW respectively. Muscular loading rates of 116 kN s^{-1} are recorded in the triceps surea group and 292 kN s^{-1} in the quadriceps which compares favourably with values expressed by Komi et al. (1985) who used a strain gauge implant into the human body. Maximum joint reactions occur in the knee at 21.3 BW for the compressive component and 2.4 BW for the shear component.

Variations in these values were noted with changes in running style and speed. Rear foot strikers longer foot contact time ($p > 0.05$) and reduced loading rates when compared to front foot strikers. Increases in speed from 3.38 m s^{-1} to 4.47 m s^{-1} and to 5.36 m s^{-1} do not result in significant increases in compressive elements of the force system but significant increases in the shear force elements are noted ($p > 0.5$).

It is concluded from these findings that front foot strikers may be more susceptible to injury than rear foot strikers. Also it is hypothesised that it is not necessarily the high force values that result in athletic injury but rapid changes in training routine that result in the shear components of the lower limbs being overloaded. With this in mind, the design of running shoes maximising on grip rather than impact force protection is recommended.

Recommendations for further work include verification of the model via comparisons with known works in other activities, walking, squatting and weightlifting and investigations into the use of digital cameras to reduce analysis time.

Delft University of Technoloy,
Signal Processing Dept.
PO Box 5046, 2600 GA Delft, Holland
Fax 31-15-786081

TV/COMPUTER MOTION ANALYSIS SYSTEMS: THE FIRST TWO DECADES

E.H. Furnée

ABSTRACT

TV-based motion analysis systems are described, that were developed for the real-time, non-contacting data acquisition of contrasting moving markers. In most applications passive reflective markers are attached as unobstructive low-inertia landmarks to the objects under study in the animal, human or industrial movement research. The account ranges from the author's original multi-marker 50 Hz prototype system reported in 1967, to the recent innovations incorporated in the PRIMAS Precision Motion Analysis System.

Main features discussed are a) data reduction and sub-pixel resolution by the real-time estimation of marker centroid coordinates, b) marker contrast enhancement by the introduction of reduced-integrationtime solid-state TV-cameras, to allow daylight operation, c) the enhancement of precision together with raising the sample rate in order to get the highest spatio-temporal resolution in the motion analysis industry.

A wide-sweeping literature review discusses several families of derived and alternative systems, based on TV and other (mainly optoelectronic) sensors, while positioning these developments within a historical framework. Specifically, proven systems like VICON and Selspot are put in perspective with CODA-3 and the more recent ELITE, Expert-Vision, Watsmart, CoStel, OPTOTRAK and Hentschel systems.

Performance criteria are formulated, the PRIMAS test results are given, and a comparison of this and contemporary vendors' systems is provided. The thesis includes an account of software development as well as early and recent 2-D and 3-D motion analysis applications.

PhD thesis Delft University of Technology, october 1989.

Warsaw University of Technology
Institute for Aircraft Engineering and Applied Mechanics
ul. Nowowiejska 22/24, 00-665 Warsaw, Poland

BIOMECHANICAL ANALYSIS OF THE GLENO-HUMERAL JOINT IN ERGONOMICAL ASPECTS

K. Gielo-Perczak and A. Morecki

ABSTRACT

Introduction

The application of the biomechanical model of the gleno-humeral joint (GHJ) ergonomical activities, including the variety of joint types found in population, has been discussed. The essence of the proposed procedure resolves itself into the choice of such a worker for the working process, whose acetabulum profile of the GHJ is known, to reduce the harmfulness of the joint loading to a minimum. The calculations proved that for certain types of occupations an optimum shape exists of the joint surface for which the GHJ reaches the maximum load capacity.

Method

The investigations have been restricted to a certain class of chosen working processes in a lamp producing factory. Ten typical kinds of activities were distinguished, performed at the intra-factory transport stand. Using the values of the geometrical parameters of the acetabulum as well as the data concerning the loading, the maximum load capacity for the respective acetabulum profiles during the realization of ten different types of activities has been calculated by means of an appropriate algorithm. In choosing the acetabulum from the point of view of the maximization of multi-criterion functionality the weight-correlation method (Pogorzelski, 1986) has been employed. It solves the problem by characterizing an optimum acetabulum with one number found out on the basis of partial utilities in the form:

$$q_0 = \sum_{i=1}^{40} w_i \cdot q_i$$

where: w_i - weights; q_i - partial criteria

The maximum values of the joint load capacity during performing the ten chosen types of activities, calculated for the 17 chosen acetabulum profiles have been regarded as partial criteria. Partial criteria are treated as different evaluation aspects of the given acetabulum. A problem of adjusting q_1, ..., q_{10} criteria arises by characterizing them with one number.

Results

The analysis of the forces in muscles, ligaments and of contact force between humerus and scapula as well as the analysis of the boundary load capacity shows that their values are influenced by the geometry of the joint (Gielo-Perczak, 1988). In Fig. 1 the value of contact force —RS (dash-dot-dot-line), in muscle 1-RMI (continuous line), in ligament 1-W1 (dotted line), in ligament 2-W2 (dash-dot-dot-line) for this type of the acetabulum profile are presented. The calculations of the loading (Fig. 2) of the joint (Fig. 1 arrow 5) show that certain arm positions under given load are impossible due to the damaging stresses.

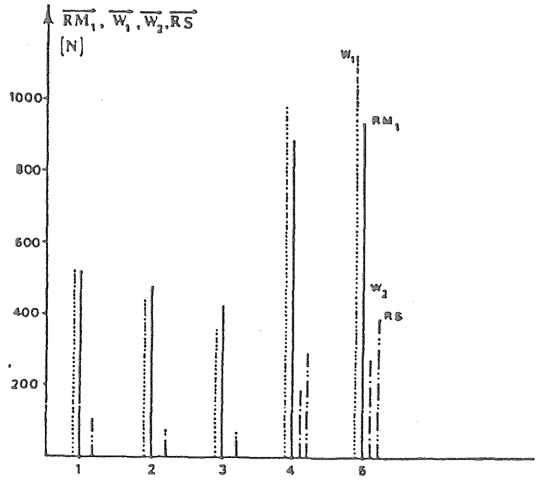


Fig.1

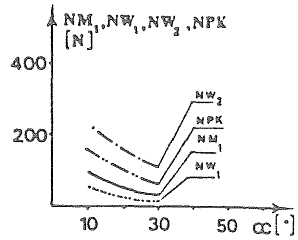


Fig.2

The ranking list of the profiles for the investigated work-stand has been obtained. The compromise criterion has been computed by means of WAKOR programme (software for weight-correlation method):

q_0 = 0.0018.q_1 + 0.0013.q_2 + 0.0018.q_3 + 0.0074.q_4 + 0.0053.q_5 + 0.0106.q_6 + 0.0117.q_7 + 0.0195.q_8 + 0.0034.q_9 + 0.0004.q_{10} - 10.4633

Thus the participation of the individual criteria in the compromise criterion could have been fully observed. It implies the fact that not only the mutual meaning of the particular loadings but also biomechanical capabilities of the investigated joint have an influence on the final form of the criterion.

Conclusions

An essential property of the assumed model of the GHJ is the possibility of evaluating the influence of the geometrical parameters of the joint in the function of the arm position towards the trunk and the load conveyed by the arm. On the basis of the obtained results a range of practical applications is expected including in designing working stands, assigning the employers to their appropriate working stands and in examining the arduousness of the chosen activities for the human organism.

References

Gielo-Perczak K.: Analysis and modelling of the gleno-humeral joint mechanism structure. Ph.D. Dissertation, 1988

Pogorzelski W.: Weight-correlation method define compromise utility products with multitude of criteria. Materials of the V Conference Multioptimization in Designing, Mielno, 1986, 252-268 (in Polish).

THE INFLUENCES OF DIFFERENT DOSES ALPRAZOLAM ON MUSCLE ACTIVITY, IN FUNCTION AND CARDIOVASCULAR RESPONSES TO CONCENTRIC AND ECCENTRIC EFFORTS IN ISOKINETIC MOVEMENT CONDITIONS

J. Cabri

Dept. Experimental Anatomy, Vrije Universiteit Brussel, Belgium.

Supervisors: J.P. Clarys & T. Reilly (Liverpool Polytechnic, UK)

Although benzodiazepines (BZ) are known for their anti-anxiety and muscle relaxant activity, it is still questioned how a centrally-acting drug can mediate this particularity at the level of the muscle itself. However, there is but little evidence of their influences when a human subject is put under abrupt physical stress such as all-out exercise. The basic question submitted in this study was: what is the effect of orally ingested doses of alprazolam (a BZ) on the electromyographic (EMG) signal during maximal voluntary effort?

Twenty healthy male subjects (mean age: 21.6 years) were asked to participate in the study. The test protocol consisted of a randomized controlled double-blind protocol. In order to determine a standardized physical effort, a computer-linked isokinetic dynamometer (Kin-Com, Chattex Corp., TN) was used for the experiment. The subjects were asked to perform a maximal effort, both during concentric and eccentric knee extension at angular velocities of 3.66, 2.04, 1.05 and 0 rad.s-1. Three active electrodes, fixed on the M. vastus medialis, were used to measure the EMG output. The signals (both EMG and dynamometer output) were low-pass filtered at 500 Hz [second order Butterworth] and sampled at 2000 Hz using the Electromyography Signal Processing and Analysis System. The EMG signals at the respective angular velocity tests were full wave rectified and then normalized in time and in respect to the highest peak. Both integrated EMG (iEMG) and maximal EMG amplitude (mEMG) were averaged for all three electrodes. Cardiovascular responses were measured using standard sphyngomanometry and heart rate measurements.

The statistical analysis included Kolmogorow-Smirnov test for the normal distribution of the data, analysis of variance, and a-posteriori protected least significant difference and Scheffé tests ($p < 0.05$).

The results from this study showed a clear trend, i.e. that ingestion of a dose of alprazolam decreased electrical activity (both maximal amplitude and iEMG) in a significant way.

The cardiovascular parameters did not differ significantly, probably because of the short term nature of the effort produced. Plausible explanations of the mechanisms may be found in the action attributed to BZs. It is well documented that BZ enhance the action of gamma-aminobutyric acid (GABA), in that they amplify the inhibitory action of GABA.

Thus, post-synaptic inhibition, whereby the release of the neurotransmitter (i.e. GABA) into the motoneural synapse, leads to hyperpolarization of the post-synaptic membrane and a subsequent reduction in the ability of incoming excitatory impulses to depolarize the motoneuron.

Book news

THEORY OF CRIMINALISTIC TRACES AND IDENTIFICATION
(Technical and Biomechanical Aspects)

Victor Porada

The book presents an original systematic conception of criminalistic biomechanics aimed primarily at the processes of origination, retainment, and decay of criminalistic traces as well as at the analytical and synthetical aspects of criminalistic identification. The monograph consists of eleven chapters: a trace of a criminal act and identification, the relationship between a criminalistic trace and the corresponding criminal activity, a systematic approach to identification of objects, general qualitative and quantitative concepts of criminalistic identification, a functional model of the identification process, the correspondence between the external composition of the impacting object and its criminalistic trace, application of computer technology for enhanced effectiveness of the process of criminalistic identification, biomechanical analysis of traces of human locomotion, and, finally, methods of fixation, measurement and documentation of the biomechanical content of trace.

These individual sections of the book deal in detail with the evolution of criminalistic techniques of measurement and evaluation of microreliefs of objects, with analysis of selected geometric, kinematic and dynamic biomechanical features of the process of origination of a trace of human locomotion as well as with classification of traces based upon study within the framework of the individual branches of the biomechanics of man.

The book has been intended for scientific workers and teachers as well as for both undergraduate and graduate of engineering and law university departments, and for specialists of law-making and law-enforcing bodies.

Academia publishing house - Praha - Czechoslovakia
(Note: the book is written in the Czech language)

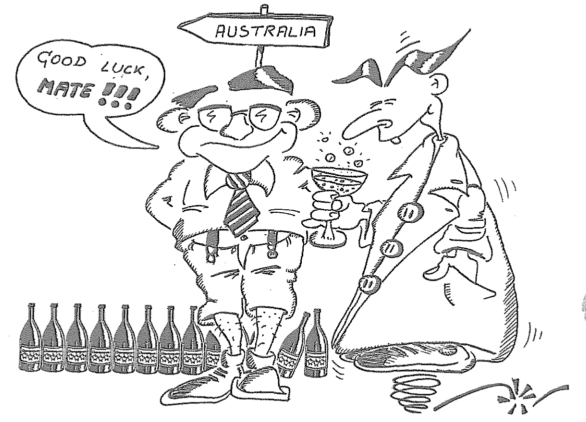
The Last Editor's page

Our editorship started with the summer issue n° 7 in 1982 and it ends with this last page of the winter issue n° 37, 1989 — 30 newsletters in 7 years — we enjoyed it very much although the response from the council and the members was not overwhelming — we are convinced this newsletter is the best communication tool of the society.

Your editor Jan Pieter Clarys (1982 - 1989) and his assistent editors Nicole Arras (1982 - 1984) and Jan Cabri (1984 - 1989) have been very happy to work with you and for you.

The six last presidents of ISB. (Note : the first President of ISB was the late Jurg Wartenweiler). From left to right : President n° 6 John Paul — gentle and helpful; President n° 2 Dick Nelson — he used 2 newsletter editors for six issues; President n° 4 Benno Nigg — Swiss-Canadian and aristocratic who gave full freedom to the editors; President n° 7 Bob Norman — has sent us more material for our last two issues than we can use but we leave the appreciation of our new president to Graeme Wood; President n° 5 Jim Hay — gentle and helpful but with a different approach of what we think 'editorial freedom' should be; President n° 3 Paavo Komi — helped us to give a 'traditional label to the newsletter'. We survived all seated presidents.

Reviewing our 30 newsletters, we published many items of sometimes very different nature, such as : editorials (21), ISB and membership scientific events (18), letters to the editor (8), special articles (14), conference news (10), laboratory features (6), book reviews (6), free and commercial publicity (27), and introduced the succesful items of M.Sc. and Ph. D. thesis abstract corner (+/– 50) and 'you should know...' items (+/– 30).



We wish all members of ISB, its new Council and the new editor, Mr. Graeme Wood, a happy and prosperous 1990 !