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Date of Birth: January 15, 1943  
 Place of Birth: San Diego, California  
 Child: Molly Weigent Hayes

### Education

B.S., Mechanical Engineering, Stanford University 1964  
 M.S., Mechanical Engineering, Stanford University 1966  
 Ph.D., Theoretical and Applied Mechanics, Northwestern University 1970

### Postdoctoral Training

Research Fellow, Laboratory for Experimental Surgery, Davos, Switzerland (Chief, S. Perren, M.D.) 1969-1970  
 NIH Special Research Fellow, Department of Orthopaedic Surgery, Karolinska Institute, Stockholm, Sweden (Chief, C. Hirsch, M.D.) 1970-1971

### Faculty Appointments

Instructor, Department of Orthopaedic Surgery, Northwestern University  
 Assistant Professor, Department of Mechanical Engineering and (by courtesy) Department of Surgery (Orthopaedics), Stanford University 1967-1969  
 Associate Professor, Department of Orthopaedic Surgery, University of Pennsylvania 1971-1976  
 Associate Professor, Department of Orthopaedic Surgery, Harvard Medical School, Beth Israel Hospital 1976-1979  
 Associate Professor of Orthopaedic Surgery, Harvard-MIT Division of Health Sciences and Technology, Massachusetts Institute of Technology 1979-1985  
 Professor of Biomechanics, Department of Orthopaedic Surgery, Harvard Medical School, Beth Israel Hospital 1979-1985  
 Professor of Biomechanics, Harvard-MIT Division of Health Sciences and Technology, Massachusetts Institute of Technology 1985-1998  
 Maurice Edmond Mueller Professor of Biomechanics, Harvard Medical School Hospital and Administrative Appointments 1985-1998  
 Vice Provost for Research, Oregon State University 1998-2001  
 Professor of Nutrition and Exercise Science, Oregon State University 1998-2001  
 Adjunct Professor of Mechanical Engineering, Oregon State University 1998-2010  
 Professor of Orthopaedics and Rehabilitation and Vice Chair for Research, Oregon Health Sciences University 1998-2004  
 Emeritus Professor of Nutrition and Exercise Sciences (NES), College of Health and Human Sciences, Oregon State University 2007-

**Hospital and Administrative Appointments**

Chief, Biomechanics Unit, Department of Orthopaedic Surgery, University of Pennsylvania	1976-1979
Director, Orthopaedic Biomechanics Laboratory, Dept. of Orthopaedic Surgery, Beth Israel Hospital	1979
Member, Admissions Committee, Harvard-MIT Division of Health Sciences and Technology	1984-1988
Member, Committee of Professors, Harvard Medical School	1985-1989
Member, Promotions and Appointments Committee, Harvard-MIT Division of Health Sciences and Technology	1986-1998
Member, Standing Committee on Promotions, Reappointments, and Appointments, Harvard Faculty of Medicine	1987-1990
Member, Orthopaedic Executive Committee, Harvard Combined Orthopaedic Program, Harvard Medical School	1990-1998
Member, Conference of Department Heads, Harvard Medical School	1990
Member, Subcommittee of Professors, Harvard Medical School Faculty of Medicine	1991-1994
Associate Chief, Department of Orthopedic Surgery, Beth Israel Hospital	1992-1993
Vice Chairman Research, Department of Orthopedic Surgery, Beth Israel Hospital	1993

**Honors and Awards**

Industrial Design Society Student Merit Award	1966
Engineering Research Initiation Award, National Science Foundation	1972
Research Career Development Award, National Institutes of Health	1978-1983
Kappa Delta Award, American Academy of Orthopaedic Surgeons' Award for Orthopaedic Research	1981
American Academy of Orthopaedic Sports Medicine Research Award	1983
Research Career Award, Schweizerische Arbeitsgemeinschaft für Osteosynthesefragen	1983-1986
Founding Fellow, American Institute of Medical and Biological Engineering	1993
American Society of Biomechanics Giovanni Borelli Award	1995
Bristol-Myers Squibb/Zimmer Institutional Grant for Excellence in Research in Orthopaedic Treatment	1996
Profiles in Ethical Integrity Award, The Program for Ethics, Science and the Environment, Department of Philosophy, Oregon State University	2000

**Membership in Professional Societies**

Orthopaedic Research Society	1972-
American Society of Mechanical Engineers	1975-
American Academy of Orthopaedic Surgeons, Associate Member	1985-
Society of Automotive Engineers	1998-
American Institute for Medical and Biological Engineering	2000-
International Society of Biomechanics	2002-
Association for the Advancement of Automotive Medicine	2003-
Human Factors and Ergonomics Society	2005-
American Society of Biomechanics	2007-

**Professional Activities**

Member, Bioengineering and Orthopaedic Sciences Travel Group to the People's Republic of China	1979
Chairman, Program Committee, Orthopaedic Research Society	1980
Organizing Committee and Panel Member, NIH Consensus Development Conference on Total Hip Joint Replacement	1982
Member, NIH Study Section, Orthopaedics and Musculoskeletal	1985-1989
Chairperson, Special Ad Hoc Committee, National Institutes of Health Study Section	1986
Chairperson, Injury Prevention Working Group of the Surgeon General's Workshop	1988

on Health Promotion and Aging, Washington, DC	
Member, NIH NIAMSD National Plan Task Force, Co-Chair Musculoskeletal Diseases Panel, Bethesda, MD	1990-1991
Member, American Academy of Orthopaedic Surgeon's Council on Research	1990-1993
Scientific Member, AO Switzerland	1991
Member, CDC Injury Research Grant Review Committee Study Section, Atlanta, GA	1993
Co-Chairman, AAOS Workshop on Fall Prevention in the Elderly, Rosemont, IL	1993
Member, NIH Study Section, Orthopedics and Musculoskeletal	1993-1997
Participant, CDC Biomechanics Research Planning Workshop, Atlanta, GA	1994
Acting Director, AO/ASIF Research Institute, Davos, Switzerland	1996-1997
Member, National Space Biomedical Research Institute Reviewer's Reserve	1999-
Member, Scientific Advisory Board, Harborview Injury Prevention & Research Center, Seattle, WA	2005-2006
Biomechanics Research Review Panel, Biomechanics Research Portfolio Review, Centers for Disease Control and Prevention, Atlanta, GA	2009

### Grants Awarded

National Science Foundation Engineering Research Initiation Award, "Stress-remodeling relationships in compact bone" Principal Investigator	1972-1973
National Science Foundation Center for Materials Research, Stanford University, "Fracture of compact bone" Principal Investigator	1972-1976
National Institutes of Health, "Mechanics of normal, arthritic and prosthetic knees" Principal Investigator	1975-1983
President's Fund, California Institute of Technology, "Mechanics of the knee joint" Principal Investigator	1975-1976
Orthopaedic Research and Education Foundation, "Flow independent viscoelastic properties of cartilage matrix" Principal Investigator	1977-1978
National Institutes of Health Research Career Development Award, "Material and structural properties of the knee" Principal Investigator	1978-1983
Veterans Administration Research Grant, "Analysis of fracture healing with internal fixation" Co-Principal Investigator	1978-1983
MIT Whitaker Health Sciences Fund, "Biomechanical studies of healing after spinal dislocation" Co-Principal Investigator	1979-1980
Laboratory for Experimental Surgery, "Mechanics of compression plate fixation" Principal Investigator	1980-1981
Zimmer USA, "Finite element and experimental studies of the Miller porous coated multi-radius tibial component" Co-Principal Investigator	1980-1981
Air Force Office of Scientific Research, "Fracture and viscoelastic characteristics of the human cervical spine" Principal Investigator	1981-1983
Howmedica, Inc., Orthopaedics Division, "Geometrical characterization of the proximal femur" Principal Investigator	1981-1982
Howmedica, Inc., Orthopaedics Division, "Effects of proximal femoral geometry on femoral component stem design" Principal Investigator	1982-1983
William F. Milton Fund, "Skeletal Aging and Exercise" Co-Principal Investigator	1982-1983
National Institutes of Health, "Stress morphology relations for trabecular bone in-vivo" Principal Investigator	1982-1983
Cintor Orthopaedic Division, Johnson & Johnson Products, Inc., "Geometrical Characterization of the distal femur" Principal Investigator	1982-1983
Cintor Orthopaedic Division, Johnson & Johnson Products, Inc., "Optimized Total Joint Replacement Designs" Principal Investigator	1982-1984
National Institutes of Health, "Bone/Gelatin Particulate Composite for Fracture Fixation" Co-Principal Investigator	1982-1984
National Institutes of Health, "Biochemistry of the Intervertebral Disc" Co-Investigator	1982-1985
Howmedica, Inc., Orthopaedic Division, "Biomechanics of the Asnis Screw System"	1983-1984

Principal Investigator	
National Science Foundation/Wenner Gren Foundation for Anthropological Research, Inc., "Biomechanical Characterization of the Primate Femur and Tibia Using CT Scanning" Co-Investigator	1983-1984
Electro-Biology, Inc., Medical Systems Division, "The Use of Pulsing Electromagnetic Fields in the Prevention of Disuse Osteoporosis" Principal Investigator`	1983-1984
General Motors Research Laboratories, "Biomechanical Studies of the Human Cervical Spine" Co-Principal Investigator	1984-1984
Johnson & Johnson, Inc. Orthopaedics, "Failure Analysis and Design Studies for a Porous-Coated Patellar Total Knee Component" Principal Investigator	1984-1985
Howmedica, Inc., "Design Parameters for Proximal Femoral Prosthetic Stems" Principal Investigator	1984-1985
Fiber Materials, Inc., "In-Vivo Testing of Carbon/Carbon Rods for Bone Ingrowth" Principal Investigator	1985-1986
National Cancer Institute, "Biomechanics of Metastatic Defects in Bone" Principal Investigator	1985-1999
Pfizer Hospital Products Group, "Finite Element Analysis of Prosthetic ACL Attachment" Principal Investigator	1985-1986
National Institutes of Health, "Hip Fracture Risk Prediction by X-ray Computed Tomography" Principal Investigator	1986-1995
General Motors Research Laboratories, "Mechanical Response and Strength of the Human Cervical Spine" Co-Principal Investigator	1986-1987
Johnson & Johnson, Inc. Orthopaedics, "Finite Element Design Analysis of a Carbon Fiber Femoral Prosthesis" Co-Principal Investigator	1987-1988
Protek, "Prosthetic Shoulder Design" Principal Investigator	1987-1988
Centers for Disease Control, "Biomechanics, Epidemiology, and Treatment of Hip Fractures" Principal Investigator	1987-1990
AO-Stiftung/ASIF-Foundation, "Fatigue Characteristics of Posterior-Lumbar Fixations" Co-Principal Investigator	1988-1989
National Institutes of Health, "Multiscan Photon Absorptiometry and Osteoporotic Fracture Risk" Principal Investigator	1989-1992
Centers for Disease Control, "Biomechanics of Hip Fracture Risk" Principal Investigator	1990-1993
National Institute of Dental Research "Mechanics and bone remodeling in an osteoporotic mandible" Co-Principal Investigator	1990-1995
Whitaker Foundation, "Magnetic Resonance Imaging of Bone Structure with Metastatic Defects in Bone" Co-Principal Investigator	1991-1994
AO-Stiftung/ASIF-Foundation, "Biodegradable Particulate Composites for Orthopaedic Applications" Principal Investigator	1991-1992
Genetics Institute, "Geometric, densitometric, and torsional properties of healing segmental defects in rat femoral tested with recombinant human BMP" Co-Principal Investigator	1991-1993
Howard Hughes Medical Institute Medical Student Research Training Co-Principal Investigator	1991-1993
National Institute on Aging, "Neuromotor changes with exercise in elderly women" Co-Principal Investigator	1991-1994
National Institutes of Health, "Hip fracture risk prediction by QDR" Principal Investigator	1991-2001
Norwich Eaton Pharmaceuticals "Effects of disphosphonates on biomechanical and morphological properties of bone in dogs" Co-Principal Investigator	1991-1992
Norwich Eaton Pharmaceuticals "Effects of NE-58095 on the biomechanical and morphological properties of bone from dogs treated for two years" Co-Principal Investigator	1992-1993
Osteonics, "Predicted effects of surface treatment on the long-term performance of cementless hip implants" Co-Principal Investigator	1992-1993

National Center for Research Resources, Shared Instrumentation Grant Principal Investigator	1992-1993
Merck, Sharp & Dohme Research Laboratories, "Evaluation of the effects of MK-217 treatment on bone biomechanics" Co-Principal Investigator	1992-1995
National Institutes of Health, "Structural consequences of post-yield behavior of bone" Co-Principal Investigator	1992-1998
DynaGen, Inc., "PPF-based biodegradable particulate composites for orthopaedic applications" Principal Investigator	1992-1993
Massachusetts General Hospital "Effects of PTH on biomechanical and morphological properties of bone in rats" Co-Principal Investigator	1992-1993
National Institutes of Health "DXA based bone geometry and osteoporotic fracture risk" Principal Investigator	1993-1998
Centers for Disease Control and Prevention, Program Project Grant "Hip fracture prevention from falls in the elderly" Principal Investigator	1993-1998
Orthopaedic Research and Education Foundation, Bristol-Myers Squibb/Zimmer Institutional Award, "Clinical biomechanics of the patellofemoral joint" Principal Investigator	1996-2001
ClinTrials BioResearch Ltd., "Bone biomechanical procedures for a long-term efficacy study of risedronate as a treatment in the osteopenic, ovariectomized rat model" Principal Investigator	1997-1998
ClinTrials BioResearch Ltd., "Bone biomechanical procedures for a long-term efficacy study of risedronate as a preventative treatment in the osteopenic, ovariectomized rat model" Principal Investigator	1997-1998
ClinTrials BioResearch Ltd., "Bone biomechanical procedures for a 26-week oral (capsule) comparative efficacy study of NE-58095 and NE-10503 in the female beagle dog" Principal Investigator	1997-1998
ClinTrials BioResearch Ltd., "A 26-week oral (capsule) fracture healing study with risedronate (NE-58095) in male and female beagle dogs" Principal Investigator	1997-1998
National Institutes of Health, "Fall Biomechanics and Hip Fracture Risk," Principal Investigator	1990-2007
National Institutes of Health "The effects of jumping on growing bones" Co-Investigator	1998-
Nike, Inc. "Functional Biomechanics of Protective Systems for Soccer: Design Criteria for Goalkeeper Gloves and Shin Guards"	2006-2007

### Editorial and Review

Journal of Orthopaedic Research, Founding Co-Editor-in-Chief	1983-1995
Journal of Biomechanical Engineering, Associate Editor	1981-1985
Journal of Biomechanics, Editorial Advisory Board	1981-1983
Annals of Biomedical Engineering, Editorial Board	1980-1982
Clinical Orthopaedics and Related Research	
Critical Reviews in Bioengineering, CRC Press	
Journal of Applied Mechanics	
Journal of Bioengineering	
Journal of Biomedical Materials Research	
Journal of Bone and Joint Surgery	
National Science Foundation	
National Aeronautics and Space Administration	

### Doctoral Theses Supervised

Subrata Saha, Ph.D.: Tensile impact properties of bone and their relation to microstructure, Department of Applied Mechanics, Stanford University, 1973. (Professor and Director, Orthopaedic Biomechanics Lab, Department of Orthopedic Surgery, Loma Linda University Medical Center, Loma Linda, CA)

- Timothy M. Wright, Ph.D.: Tensile properties and fracture mechanics of bone, Department of Materials Science, Stanford University, 1976. (Professor and Director, Department of Biomechanics, Hospital for Special Surgery, New York, NY; Past President, Orthopaedic Research Society)
- Dennis R. Carter, Ph.D.: The fatigue behavior of compact bone, Department of Biomedical Engineering, Stanford University, 1976. (Professor, Department of Mechanical Engineering and Director, Biomechanics Lab, Stanford University, Stanford, CA; past-President, Orthopaedic Research Society)
- Eric E. Sabelman, Ph.D.: An organ culture method for study of fetal mouse bone under stress, Department of Mechanical Engineering, Stanford University, 1976. (Senior Research Associate, VA Medical Center, Palo Alto, CA)
- Christopher B. Ruff, Ph.D.: Structural remodeling of the femur and tibia with aging: An automated digital analysis of the Pecos skeletal sample, Department of Anthropology, University of Pennsylvania, August 1981. (Associate Professor, Department of Cell Biology and Anatomy, Johns Hopkins School of Medicine, Baltimore, MD)
- Carol A. Oatis, Ph.D.: The use of a mechanical model to predict the motion of the knee in normal locomotion: A study of healthy younger and older adult males, Department of Anatomy, University of Pennsylvania, 1982. (Associate Professor, Department of Physical Therapy, Beaver College, Philadelphia, PA)
- W. Thomas Edwards, Ph.D.: A biomechanical analysis of the lumbar and lumbo-sacral spine in the sagittal plane. Interdepartmental Program in Biomedical Engineering, Massachusetts Institute of Technology, May, 1983. (Visiting Associate Professor, Department of Bioengineering, Mechanical Aerospace Manufacturing Engineering, Syracuse University, Syracuse, NY)
- Anthony M. DiGioia III, M.D.: The role of interfragmentary strain in fracture healing. Harvard Medical School, Honors Thesis, March 1986. (Assistant Professor, Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA)
- Edward J. Cheal, Ph.D.: Trabecular bone remodeling around implants. Massachusetts Institute of Technology, June 1986. (Director of Applied Research, Johnson & Johnson Orthopaedics, Raynham, MA)
- Cheryl L. Riegger, Sc.D.: Tibiofemoral contact pressure, area and force in neutral, varus, valgus, and post-osteotomy loadings. Boston University, July 1986. (Assistant Professor, University of Colorado, Morrison, CO)
- Jeffrey C. Lotz, Ph.D.: Fracture risk predictions for the human femoral neck. Massachusetts Institute of Technology, August, 1988. (Assistant Professor of Orthopaedic Surgery and Director, Orthopaedic Biomechanics Laboratory, University of California at San Francisco School of Medicine, San Francisco, CA).
- Brian D. Snyder, M.D., Ph.D.: Anisotropic structure property relations for trabecular bone. University of Pennsylvania, February, 1991. (Instructor, Dept. of Orthopaedic Surg, Harvard Medical School, Boston, MA)
- Dr.med. Ralf H. Wittenberg: Biomechanische und Klinische Untersuchungen dorsaler lumbaler und lumbosakraler Fusions techniken. St. Josef Hospital, Assistant Professor, Bochum University, Germany, 1991.
- Xiang-Dong Edward Guo, Ph.D.: Fatigue of trabecular bone. Harvard/M.I.T. Division of Health Sciences and Technology, October, 1993. (Assistant Professor, Department of Mechanical Engineering, Columbia University, New York, NY)
- Jeffrey A. Guy, M.D.: The long term effects of the bisphosphonate alendronate on the mechanical and physical properties of bone in the estrogen-deficient rat. Harvard Medical School, Honors Thesis, February, 1994. (Orthopaedic Resident, Harvard Combined Orthopaedic Program, Boston, MA)
- Amy C. Courtney, Ph.D.: Mechanical properties of the proximal femur: Changes with age. Harvard-Massachusetts Institute of Technology Division of Health Sciences and Technology, May, 1994. (Staff Scientist, Department of Biomedical Engineering, Cleveland Clinic Foundation, Cleveland, OH)

- Rebecca Elovic, D.M.D., Sc.D.: The effect of ovariectomy on the rat mandible. Harvard University, May, 1994. (Private practice, Brookline, MA)
- Philippe K. Zysset, Ph.D.: A constitutive law for trabecular bone. Ecole Polytechnique Federale de Lausanne, Switzerland. June, 1994. (Assistant Professor, ETH, University of Lausanne, Lausanne, Switzerland)
- Stephen N. Robinovitch, Ph.D.: Hip fracture and fall impact biomechanics. Harvard-Massachusetts Institute of Technology Division of Health Sciences and Technology, September, 1994. (Associate Professor and Director of the Injury Prevention and Mobility Laboratory, School of Kinesiology, Simon Fraser University, Burnaby, British Columbia)
- Aya van den Kroonenberg, Ph.D.: Dynamic models of human falls for prediction of hip fracture risk. Massachusetts Institute of Technology, January, 1995. (Staff Scientist, TNO Road Vehicle Institute, Crash Safety Research Center, Delft, The Netherlands)
- J. Douglas Patterson, M.D.: Parathyroid hormone (PTH 1-84) increases bone morphologic and biomechanical properties in estrogen-deficient rats: Promise for the treatment of established osteoporosis. Harvard Medical School, Honor's Thesis, February, 1995. (Orthopaedic Resident, Duke University, Durham, NC)
- Michael J. Yaszemski, M.D., Ph.D.: The design, synthesis, characterization, and mechanical testing of a novel degradable polymeric biomaterial for use as a bone substitute. Massachusetts Institute of Technology, June, 1995. (Assistant Professor, Department of Orthopedics, Mayo Clinic, Rochester, MN)
- Matthew J. Silva, Ph.D.: Predicting the failure behavior of the human vertebral body. Massachusetts Institute of Technology, February, 1996. (Director, Biomechanics Laboratory, Department of Orthopedic Surgery, Washington University School of Medicine, St. Louis, MO)
- Catherine M. Ford Corrigan, Ph.D.: Failure of the human proximal femur: Material and structural properties. Massachusetts Institute of Technology, September, 1996. (Vice President and Principal Engineer, Exponent, Philadelphia, PA)
- Steven M. Bowman, Ph.D.: Creep of trabecular bone. Harvard-Massachusetts Institute of Technology Division of Health Sciences and Technology, May, 1997. (Senior Engineer, Mitek Products, Westwood, MA)
- Conrad Wang, M.D.: Densitometric and mechanical testing in an animal model of tumor-induced osteolysis in long bones. Harvard Medical School, M.D. Thesis, February, 1998. (Orthopaedic Resident, Harvard Medical School, Boston, MA)
- Sara E. Wilson, Ph.D.: Analysis of the forces on the spine during a fall with application towards predicting vertebral fracture risk. Harvard-MIT Division of Health Sciences and Technology, June, 1999. (Assistant Professor, Department of Mechanical Engineering, University of Kansas, Lawrence, KS)
- Cecile N. Smeesters, Ph.D.: Fall biomechanics and hip fracture risk. Division of Applied Sciences, Harvard University, June, 1999. (Professeure Adjointe, Département de Génie Mécanique University of Sherbrook, Sherbrook, Quebec)
- Jeremy J. Bauer, Ph.D.: Defining intensity of skeletal loading in children. Oregon State University Department of Nutrition and Exercise Sciences, June, 2006. (Associate, Hayes + Associates, Corvallis, OR)

## **Publications**

### **A. Refereed Articles**

1. Hayes, W.C. and Mockros, L.F.: Viscoelastic properties of human articular cartilage. *J. Appl. Physiol.*, 31: 562-568, 1971.
2. Hayes, W.C.: Some viscoelastic properties of human articular cartilage. *Acta Orthop. Belg.*, 38: 23-32, 1972.

3. Hayes, W.C., Keer, L.M., Herrmann, G., and Mockros, L.F.: A mathematical analysis for indentation tests of articular cartilage. *J. Biomech.*, 5: 541-551, 1972.
4. Hayes, W.C. and Perren, S.M.: Plate-bone friction in the compression fixation of fractures. *Clin. Orthop.*, 89: 236-240, 1972.
5. Saha, S. and Hayes, W.C.: Instrumented tensile-impact tests of bone. *Exper. Mech.*, 14: 473-478, 1974.
6. Perren, S.M. and Hayes, W.C.: Biomechanik der plattenosteosynthese. *Medizinisch-Orthop. Technik*, 2: 56-61, 1974.
7. Carter, D.R. and Hayes, W.C.: Fatigue life of compact bone. I. Effects of stress amplitude, temperature and density. *J. Biomech.*, 9: 27-34, 1976.
8. Carter, D.R., Hayes, W.C., and Schurman, D.J.: Fatigue life of compact bone. II. Effects on microstructure and density. *J. Biomech.*, 9: 211-218, 1976.
9. Saha, S. and Hayes, W.C.: Tensile impact properties of human compact bone. *J. Biomech.*, 9: 243-251, 1976.
10. Hayes, W.C. and Carter, D.R.: Post-yield behavior of subchondral trabecular bone. *J. Biomed. Mater. Res.*, 7: 537-544, 1976.
11. Wright, T.M. and Hayes, W.C.: The fracture mechanics of fatigue crack propagation in compact bone. *J. Biomed. Mater. Res.*, 7: 637-648, 1976.
12. Carter, D.R. and Hayes, W.C.: Bone compressive strength: The influence of density and strain rate. *Science*, 194: 1174-1176, 1976.
13. Wright, T.M. and Hayes, W.C.: Tensile testing of bone over a wide range of strain rate: Effects of strain rate, microstructure and density. *Med. Biol. Eng.*, 14: 671-680, 1976.
14. Wright, T.M. and Hayes, W.C.: Comments on "The elastic properties of compact bone tissue" by Reilly, D.T. and Burstein, A.H., *J. Biomech.*, 9: 744, 1976.
15. Jones, H.H., Priest, J.D., and Hayes, W.C., Tichenor, C.C. and Nagel, D.A.: Humeral hypertrophy in response to exercise. *J. Bone Joint Surg. [Am]*, 59(2): 204-208, 1977.
16. Carter, D.R. and Hayes, W.C.: Compact bone fatigue damage. I. Residual strength and stiffness. *J. Biomech.*, 10: 325-337, 1977.
17. Wright, T.M. and Hayes, W.C.: Fracture mechanics parameters for compact bone. Effects of density and specimen thickness. *J. Biomech.*, 10: 419-430, 1977.
18. Hayes, W.C. and Wright, T.M.: An empirical strength theory for compact bone. *Fracture (Proc. 4th Int'l Conf. on Fracture)*, Volume III: 1173-1180, 1977.
19. Carter, D.R. and Hayes, W.C.: Compact bone fatigue damage. II. A microscopic examination. *Clin. Orthop.*, 127: 265-274, 1977.
20. Saha, S. and Hayes, W.C.: Relations between tensile impact properties and microstructure of compact bone. *Calcif. Tissue Res.*, 24: 65-72, 1977.
21. Carter, D.R. and Hayes, W.C.: The compressive behavior of bone as a two-phase porous material. *J. Bone Joint Surg. [Am]*, 59: 954-962, 1977.
22. Hayes, W.C., Swenson, L.W., and Schurman, D.J.: Axisymmetric finite element analysis of the lateral tibial plateau. *J. Biomech.*, 11: 21-33, 1978.
23. Hayes, W.C. and Bodine, A.J.: Flow-independent viscoelastic properties of articular cartilage matrix. *J. Biomech.*, 11: 407-419, 1978.
24. Wright, T.M. and Hayes, W.C.: Technical note: Strain gage application on compact bone. *J. Biomech.*, 12: 471-475, 1979.



25. Nagurka, M.L. and Hayes, W.C.: Technical note: An interactive graphics package for calculating cross-sectional properties of complex shapes. *J. Biomech.*, 13: 59-64, 1980.
26. Woo, S. L-Y, Kuei, S.C., Amiel, D., Gomez, M.A., Hayes, W.C., White, F.C. and Akeson, W.H.: The effect of prolonged physical training on the properties of long bone. A study of Wolff's Law. *J. Bone Joint Surg. [Am]*, 63: 780-786, 1981.
27. Ruff, C.B. and Hayes, W.C.: Subperiosteal expansion and cortical remodeling of the human femur and tibia with aging. *Science*, 217: 945-948, 1982.
28. Posner, I., White, A.A., Edwards, W.T. and Hayes, W.C.: A biomechanical analysis of the clinical stability of the lumbar and lumbosacral spine. *Spine*, 7: 374-389, 1982.
29. Ruff, C.B. and Hayes, W.C.: Cross sectional geometry of Pecos Pueblo femora and tibiae: A biomechanical investigation. I. Method and general patterns of variation. *Am. J. Phys. Anthropol.*, 60: 359-381, 1983.
30. Ruff, C.B. and Hayes, W.C.: Cross-sectional geometry of Pecos Pueblo femora and tibiae: A biomechanical investigation. II. Sex, age and size differences. *Am. J. Phys. Anthropol.*, 60: 383-400, 1983.
31. Beaupre, G.S., Hayes, W.C., Jofe, M.H. and White, A.A.: Monitoring fracture site properties with external fixation. *J. Biomech. Eng.*, 105: 120-126, 1983.
32. Cheal, E.J., Hayes, W.C., White, A.A., III, and Perren, S.M.: Stress analysis of a simplified compression plate fixation system for fractured bones. *J. Computers and Structures*, 17: 845-855, 1983.
33. Stone, J.L., Beaupre, G.S., and Hayes, W.C.: Multiaxial strength characteristics of trabecular bone. *J. Biomech.*, 16: 743-752, 1983.
34. Hayes, W.C., Gran, J.D., Nagurka, M.L., Feldman, J.M., and Oatis, C.: Leg motion analysis during gait by multiaxial accelerometry: Theoretical foundations and preliminary validations. *J. Biomech. Eng.*, 105: 283-289, 1983.
35. Huberti, H.H. and Hayes, W.C.: Patellofemoral contact pressures: The influence of Q-angle and tendo-femoral contact. *J. Bone Joint Surg. [Am]*, 66: 715-724, 1984.
36. Ruff, C.B., Larsen, C.S., and Hayes, W.C.: Structural changes in the femur with the transition to agriculture on the Georgia coast. *Am. J. Phys. Anthropol.*, 64: 125-136, 1984.
37. Huberti, H.H., Hayes, W.C., and Stone, J.L.: Force ratios in the quadriceps tendon and ligamentum patellae. *J. Orthop. Res.*, 2: 49-54, 1984.
38. Ruff, C.B. and Hayes, W.C.: Bone mineral content in the lower limb: Relationship to cross-sectional geometry. *J. Bone Joint Surg. [Am]*, 66: 1024-1031, 1984.
39. Cheal, E.J., Hayes, W.C., White, A.A., III, and Perren, S.M.: Three-dimensional finite element analysis of a simplified compression plate fixation system. *J. Biomech. Eng.*, 106: 295-301, 1984.
40. Ruff, C.B. and Hayes, W.C.: Age changes in geometry and mineral content of the lower limb bones. *Ann. Biomed. Eng.*, 12: 573-584, 1984.
41. Cheal, E.J., Hayes, W.C., White, A.A., III, and Perren, S.M.: Stress analysis of compression plate fixation and its effects on long bone remodeling. *J. Biomech.*, 18:141-150, 1985.
42. McBroom, R.J., Hayes, W.C., Edwards, W.T., Goldberg, R.P., and White, A.A.: Prediction of vertebral body compressive fracture using quantitative computed tomography. *J. Bone Joint Surg. [Am]*, 67: 1206-1214, 1985.
43. Kaplan, S.J., Hayes, W.C., Mudan, P., Lelli, J.L., and White, A.A.: Monitoring the healing of a tibial osteotomy in the rabbit treated with external fixation. *J. Orthop. Res.*, 3: 325-330, 1985.
44. Kaplan, S.J., Hayes, W.C., Stone, J.L., and Beaupre, G.S.: Tensile strength of bovine trabecular bone. *J. Biomech.*, 18: 723-727, 1985.

45. Beaupre, G.S. and Hayes, W.C.: Finite element analysis of a three-dimensional open-celled model for trabecular bone. *J. Biomech. Eng.*, 107: 249-256, 1985.
46. Cheal, E.J., Hayes, W.C., Lee, C.H., Snyder, B.D., and Miller, J.: Stress analysis of a condylar knee tibial component: Influence of metaphyseal shell properties and cement injection depth. *J. Orthop. Res.*, 3: 424-434, 1985.
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### C. Books

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