

Michael T. Hirschmann
Roland Becker *Editors*

The Unhappy Total Knee Replacement



A Comprehensive Review
and Management Guide

 Springer

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Editors

Michael T. Hirschmann
Department of Orthopaedic Surgery
and Traumatology
Knee Surgery Unit
Kantonsspital Baselland (Bruderholz,
Liestal, Laufen)
Bruderholz
Switzerland

Roland Becker
Department of Orthopaedics and
Traumatology
Hospital Brandenburg
Brandenburg/Havel
Germany

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Foreword I

The paradox that the knee is a poor construct and ingenious edifice had long been recognized. It has evolved over millions of years, a marvellous system connecting the long levers of both femur and tibia, absorbing and cushioning the locomotory forces generated in the lower limb while maintaining movement in six degrees of freedom.

The knee, subject to growth disturbances with consequent deformity, inflammatory and degenerate diseases, injuries, and sport leading to secondary osteoarthritis, presents a great challenge to both clinician and patient alike for its reconstruction, rehabilitation, and return to full function.

Great strides have been made in many modes of treatment including the major advances of knee arthroplasty. However, the gains made here do not match those attained with total hip replacement (THR).

The hip joint with its three degrees of freedom and ball joint mechanics presented a smaller design problem, albeit great strides were needed to address the mechanical fixation of the cup and in particular the stem, including an appreciation of Pauwel's law on the morphology of the proximal femur.

On the other hand, the development of the total knee replacement (TKR) presented greater challenges. The trade-off between allowing six degrees of freedom and the task of maintaining stability by retaining the native ligaments to optimize knee kinematics continues.

How should the artificial knee joint be configured? A pure hinge was not the solution. As the early TKR results were not convincing, the profession relied heavily on the high tibial osteotomy. Many patients aware of the at this time still inherent problems of the early artificial knee joints continued to postpone the TKR "solution" for as long as possible.

Bringing together our new understanding of materials, tribology, and biology with state-of-the-art design technology offers the potential for real advancement in TKR. Thirty years ago, the Deane prosthesis delivered promising early results, allowing very good mobility, an excellent gait pattern with normal rotation, and hence very little patellar problems. Its tibial saddle and ball design allowed rotation in progressive flexion and stopped rotation whenever the knee came to extension like automatic rotation. It was ingenious for its time. Unfortunately, the implant materials failed; the femoral polyethylene cup receiving the ball on this saddle was too thin and too weak to withstand the forces beyond 8 to 10 years.

Nowadays, we are still fighting for more durable, long-lasting, pain- and problem-free TKR implants. The current 80 % success rate is not good enough.

Novel work on understanding knee joint anatomy, kinematics, biomechanics, tissue biology, and perhaps additional yet unknown discoveries may result in the development of well-equilibrated artificial joint systems.

The following analysis of the “unhappy knee replacement” gives real insight into why and where the mechanical and tissue physiology collide and why pain-free function so needed has not yet been achieved. The diagnostic and treatment recommendations given here are the state of the art of a renowned international expert faculty dealing with unhappy TKR.



Professor em. Dr. med. Werner Müller

Foreword II

Dear reader,

Total knee replacement has been one of the most thankful inventions in orthopedics of the last century. The mobility of patients can be preserved. Mobility is very important in order to participate actively in social life. Despite all novel technologies, such as computer assisted surgery and patient-specific instrumentation, we will never be able to achieve 100 % success rate. Therefore, the indication for total knee replacement should always be at the end of the road of our treatment options.

The majority of patients are very happy after joint replacement; however, there is a group of patients who complain about poor function, pain, limited range of motion, contraction, or instability. These are the patients who require special attention and care by the surgeons. In many cases it is not easy to identify the causes of the patient's complaint. Most of the time there is a combination of several factors that is the reason for the patient's unsatisfaction.

There are not many comprehensive books about revision total knee replacement on the market. This book fills the gap and provides detailed information about the diagnostic algorithm for indentifying the patient's problem.

The two editors of this excellent book about the "unhappy total knee arthroplasty" focus on a very difficult group of patients to treat. They have written a very special book in collaboration with many well known experts throughout the world. All of them are dedicated to revision total knee replacement and are aware of the difficulty of the treatment of these patients. I am very impressed about the number of authors and the countries there are from.

Roland Becker worked for many years in my department at the Otto-von-Guericke University in Magdeburg and he started his research and clinical work very early in the large field of knee pathologies. He is a dedicated knee surgeon with great experience in joint preserving surgery and knee arthroplasty. He is the head of the Department of Orthopedic Surgery and Traumatology in Brandenburg.

Michael Hirschmann has taken over the Department of Knee Surgery at the Bruderholz Hospital, in the place of Prof. Werner Müller, one of the most famous orthopedic surgeon of the knee.

The editors have written numerous chapters themselves and worked as co-authors in others. The book provides detailed information about basic

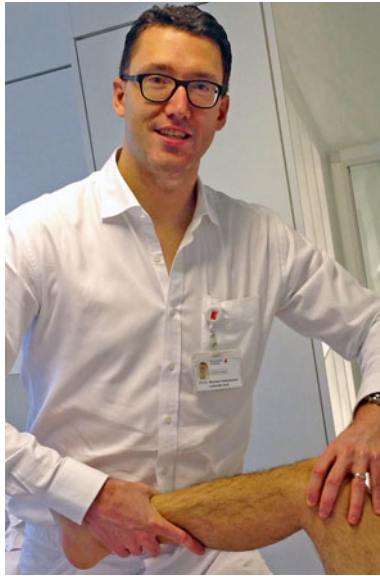
science, clinical aspects, and treatment options of patients who are unhappy after their total knee replacement. They have added interesting case reports, sharing their experience with many surgeons.

Congratulations for such an impressive book.

A handwritten signature in black ink, consisting of a large, stylized 'W' followed by a series of connected loops and a final horizontal stroke.

Prof. em. Dr. med. W Neumann

Preface



PD Dr. med. Michael T. Hirschmann



Prof. Dr. med. Roland Becker

Total knee replacement (TKR) is considered to be a very successful treatment in osteoarthritic knees leading to mostly satisfied and pain-free patients. Due to advancements in implant design, surgical technique, and better understanding of biomechanics and tribology, the survival rates of TKR have been improved to at least 15 years in 85–95 % of patients. Moreover, sports activity after TKR is not the exception anymore.

However, when looking more closely into orthopaedic literature, approximately 20–30 % of patients are not happy after TKR, complaining about pain, instability, swelling, or reduced range of motion. In a considerable number of patients, their need, demands, and expectations are not fully met. Considering rheumatology journals, only 40 % are pain free after TKR.

There are various reasons for unhappy knees after TKR. As causes, we differentiate implant- or surgery-related problems such as malpositioning, under- or oversizing, instability, stiffness, patellofemoral problems such as patellar maltracking, or infection from patient-related problems such as depression, anxiety, unrealistic expectations, low self-efficacy, and metal allergy or hypersensitivity.

Despite major advancements of clinical and radiological diagnostics over the last 20 years, the identification of the cause of the patient's problems remains challenging and not successful in every case.

There are patients in which the knee *looks good but feels bad*. There are others in which the knee *looks bad but feels good*. This paradox remains yet unsolved. The current clinical and radiological diagnostics very often do not unambiguously guide further treatment. In these cases, the choice of treatment is more influenced by the surgeon's gut feeling (experience and preference) than clear clinical evidence.

Only if the orthopedic surgeon has correctly identified the cause(s) of the patient's problems, the subsequent treatment will lead to ease of the patient's problems. It should be kept in mind that there is no revision surgery, which could not make it worse for the patient. Hence, we gathered expert knowledge contributed by renowned international knee surgeons with profound experience in revision TKR.

With this book, we strive to address the increasing need of improved diagnostic and treatment guidelines for the challenging and growing group of patients with an unhappy knee after TKR.

It also covers the basics of TKR and describes the causes of failure, giving practical hints on how to avoid those. Renowned international experts, who have extensively published in peer-reviewed journals, provide you with an evidence-based, clinically focused guidance on the causes of unhappy TKR, surgical approaches and techniques, state-of-the-art diagnostic algorithms, specific pathology-related treatment options such as salvage and revision TKR strategies.

With the clinical case scenarios, we assembled typical cases, which you will encounter in your life as orthopedic surgeons. This book should serve you as a practical management guide for your clinical practice. Furthermore, we have included a wide variety of illustrations explaining the key points made.

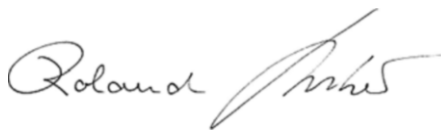
It is our hope that reading this book will allow you to know more and as a result contribute meaningfully to the care of your patients.

Finally, the editors would like to thank all the contributing authors in putting together their expertise and time to make this publication possible.

The Editors



PD Dr. med. Michael T. Hirschmann



Prof. Dr. med. Roland Becker

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Contributors

Ajay Aggarwal, MD Missouri Orthopaedic Institute, Columbia, MO, USA

Sufian S. Ahmad, MD Knee Surgery and Sport Traumatology,
Department of Orthopaedics and Traumatology, University of Bern,
Inselspital, Bern, Switzerland

Andrew A. Amis, Prof. Department of Mechanical Engineering,
Imperial College London, London, UK
Department of Musculoskeletal Surgery, Imperial College London,
School of Medicine, Charing Cross Hospital, London, UK

Markus P. Arnold, Asst. Prof. (PD), MD, PhD Department of
Orthopaedic Surgery and Traumatology, Kantonsspital Baselland,
Bruderholz, Switzerland

Rainer Bader, Prof., MD, Dipl.-Ing. Department of Orthopaedics,
Biomechanics and Implant Technology Research Laboratory, University
Medicine Rostock, Rostock, Germany

Andrea Baldini, MD Istituto Clinico Humanitas, IFCA Clinic,
Florence, Italy

Alexej Barg, MD Orthopaedic Department, University Hospital of Basel,
Basel, Switzerland

Andrew J. Barnett, MD Department of Knee Surgery, Robert Jones and
Agnes Hunt Orthopaedic Hospital, Oswestry, Shropshire, UK

Ryan A. Beasley, PhD, MSc Department of Engineering Technology
and Industrial Distribution, Texas A&M University, College Station,
TX, USA

Philippe Beaufils, Prof., MD Orthopedic Department, Centre Hospitalier
de Versailles, Versailles-Saint Quentin University, Le Chesnay, France

Roland Becker, Prof., MD Department of Orthopaedic and Traumatology,
Hospital Brandenburg, Brandenburg/Havel, Germany

Johan Bellemans, Prof., MD, PhD Department of Orthopaedic Surgery
and Traumatology, ZOL Hospitals Genk, Genk, Belgium

Julien Berhouet, MD Orthopedic Department, Centre Hospitalier
de Versailles, Versailles-Saint Quentin University, Le Chesnay, France

Simone Bignozzi, Laboratorio di Biomeccanica e Innovazione Tecnologica, Istituto Ortopedico Rizzoli, Bologna, Italy

Andreas J. Bircher, Prof., MD Department of Dermatology, Allergy Unit, University Hospital, Basel, Switzerland

Philippe Boisrenoult, MD Department of Orthopaedic Surgery, Versailles Hospital, Le Chesnay, France

Olivier Borens, Asst. Prof. (PD), MD, PhD Orthopaedic and Traumatology Service Septic Surgical Unit, Lausanne University Hospital, Lausanne, Switzerland

Victoria A. Brander, MD Department of Physical Medicine and Rehabilitation, Northwestern University's Feinberg School of Medicine, Northshore Orthopedic Institute, Chicago, IL, USA

Ivan J. Brenckel, MD Department of Orthopaedics, Victoria Hospital Kirkcaldy, Fife, Scotland, UK

Thomas A. Bucher, MBBS, MD, FRCS (Tr&Orth), MSc Department of Orthopaedic Surgery, Royal Perth Hospital, Perth, Australia

Vincent J. Busch, MD Sint Maartenskliniek, Ubbergen, The Netherlands

Simone Cerciello, MD Department of Medicine and Science for Health, University of Molise, Campobasso, Italy

Sebastian Christen Department of Orthopaedic Surgery and Traumatology, Knee Surgery Unit, Kantonsspital Baselland (Bruderholz, Liestal, Laufen), Bruderholz, Switzerland

Bernhard Christen, MD, MHA Orthopaedic Department Salemspital, Bern, Switzerland

Robert Coup, MD, FRACS Department of Orthopedic Surgery, Whangarei Hospital, Whangarei, New Zealand

Michael B. Cross, MD Rush University Medical Center, Chicago, IL, USA

Brian K. Daines, MD Colorado Joint Replacement, Denver, CO, USA

Koen C. Defoort, MD Sint Maartenskliniek, Ubbergen, The Netherlands

Craig J. Della Valle, Prof., MD Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL, USA

Guillaume Demey, MD Department of Orthopaedic Surgery, Centre Albert Trillat, CHU Lyon Nord, Hôpital de la Croix Rousse, Lyon, France

Douglas A. Dennis, MD Colorado Joint Replacement, Denver, CO, USA

Prashant P. Deshmane, MD Insall Scott Kelly Institute for Orthopedics and Sports Medicine, New York, NY, USA

Oliver Djahani, MD Orthopedic Hospital Stolzalpe, LKH Stolzalpe, Stolzalpe, Austria

Clive P. Duncan, Prof., MD, MSc, FRCSC Department of Orthopaedics, University of British Columbia, Vancouver, BC, Canada

Department of Orthopaedics, Vancouver Acute Health Services (Vancouver General and University Hospitals), Vancouver, BC, Canada

Victoria B. Duthon, MD Department of Orthopaedic Surgery and Traumatology, Hôpitaux Universitaires de Genève, Geneva, Switzerland

Jürgen Ederer, MD Kantonsspital Baselland, Institute of Radiology and Nuclear Medicine, Bruderholz, Switzerland

Stefan Eggli, Prof., MD Knee Surgery and Orthopaedic Sports Medicine Service, Sonnenhof Orthopaedic Clinic, Berne, Switzerland

Department of Orthopaedic Surgery, University of Berne, Berne, Switzerland

Reinhard Elke, Prof., MD Orthopädische Praxis am Merian Iselin, Basel, Switzerland

Rami Joseph Elkhechen, MD Department of Orthopaedics and Rehabilitation, State University of New York (SUNY) Downstate Medical Center, Brooklyn, NY, USA

Christian Fabry Department of Orthopaedics, Biomechanics and Implant Technology Research Laboratory, University Medicine Rostock, Rostock, Germany

Alessandro Felici, MD Department of Medicine and Science for Health, University of Molise, Campobasso, Italy

Flavio Forrer, Asst. Prof. (PD), MD Institute of Radiology and Nuclear Medicine, Kantonsspital Baselland, Bruderholz, Switzerland

Donald S. Garbuz, Asst. Prof., MD, MHSC, FRCSC Department of Orthopaedics, University of British Columbia, Vancouver, BC, Canada

Thorsten Gehrke, Prof., MD ENDO-Klinik Hamburg, Hamburg, Germany

Benjamin George, MD Regional Anesthesiology Department, Kings County Hospital, Brooklyn, NY, USA

Alli Gokeler, PhD Center for Rehabilitation, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

Nelson V. Greidanus, Asst. Prof., MD, MPH, FRSCS Department of Orthopaedic Surgery, University of British Columbia, Vancouver, BC, Canada

Sunny Gugale, MD Department of Orthopaedics, Sancheti Institute for Orthopaedics and Rehabilitation, Pune, India

Stephen C. Haskins, MD Department of Anesthesiology, Hospital for Special Surgery, New York, NY, USA

Basil Hatz Department of Orthopaedic Surgery and Traumatology, Knee Surgery Unit, Kantonsspital Baselland (Bruderholz, Liestal, Laufen), Bruderholz, Switzerland

Johann Henckel, MD Imperial College, Charing Cross Hospital, London, UK

Philipp Henle, MD Knee Surgery and Orthopaedic Sports Medicine Service, Sonnenhof Orthopaedic Clinic, Berne, Switzerland

Thomas J. Heyse, Asst. Prof. (PD), MD Department of Orthopedics and Rheumatology, University Hospital Marburg, Marburg, Germany

Carlos Higuera, MD Rothman Institute, Philadelphia, PA, USA

Michael T. Hirschmann, Asst. Prof. (PD), MD Department of Orthopaedic Surgery and Traumatology, Knee Surgery Unit, Kantonsspital Baselland (Bruderholz, Liestal, Laufen), Bruderholz, Switzerland

Anna Hirschmann, MD Clinic of Radiology and Nuclear Medicine, University of Basel Hospital, Basel, Switzerland

Siegfried Hofmann, MD, PhD Orthopedic Hospital Stolzalpe, LKH Stolzalpe, Stolzalpe, Austria

Thomas J. Holme, MD Imperial College, London, UK

Francesco Iacono Laboratorio di Biomeccanica e Innovazione Tecnologica, Istituto Ortopedico Rizzoli, Bologna, Italy

Farhad Iranpour, MD, PhD Imperial College London, London, UK

Richard T. Keller Department of Mechanical Engineering, Imperial College London, London, UK

Raymond H. Kim, MD Colorado Joint Replacement, Denver, CO, USA

Jennifer Kirk, BS University of Illinois at Champaign-Urbana, River Forest, IL, USA

Sandro Kohl, MD Knee Surgery and Sport Traumatology, Department of Orthopaedics and Traumatology, University of Bern, Inselspital, Bern, Switzerland

Sebastian Kopf, MD Section Sports Traumatology & Arthroscopy, Center for Musculoskeletal Surgery, Charité - University Medicine Berlin, Berlin, Germany

Ryosuke Kuroda, MD Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan

Markus S. Kuster, Prof., MD, PhD, FRACS Department of Orthopaedic Surgery, Royal Perth Hospital, Perth, Australia

Sebastien Lustig, MD, PhD Department of Orthopaedic Surgery, Centre Albert Trillat, CHU Lyon Nord, Hôpital de la Croix Rousse, Lyon, France

Robert A. Magnussen Prof., MD Department of Orthopaedic Surgery,
The Ohio State University College of Medicine, Columbus, OH, USA

Aditya V. Maheshwari MD Department of Orthopaedics
and Rehabilitation, State University of New York (SUNY) Downstate
Medical Center, Brooklyn, NY, USA

Maurilio Marcacci, Prof., MD Clinica Ortopedicae Traumatologica III
and Laboratorio di Biomeccanica e Innovazione Tecnologica,
Istituto Ortopedico Rizzoli, Bologna, Italy

Bassam A. Masri, Prof., MD, FRCSC Department of Orthopaedics,
University of British Columbia, Vancouver, BC, Canada
Vancouver General Hospital, Vancouver Acute Health Services, Vancouver,
BC, Canada

Tomoyuki Matsumoto, MD Department of Orthopaedic Surgery,
Kobe University Graduate School of Medicine, Kobe, Japan

Philipp Mommsen, MD Trauma Department, Hannover Medical School
(MHH), Hannover, Germany

**Rhidian Morgan-Jones, MD, MB.BCh. FRCS (Ed), M.Med.Sci. FRCS
(Tr & Orth)** University Hospital of Wales, Cardiff BUPA Hospital,
Cardiff, Wales, UK

Armin Mucha Department of Orthopaedic Surgery and Traumatology,
Knee Surgery Unit, Kantonsspital Baselland (Bruderholz, Liestal, Laufen),
Bruderholz, Switzerland

Jacob T. Munro, MD, MBChB, FRACS Department of Orthopaedics,
University of British Columbia, Vancouver, BC, Canada

Philippe Neyret, Prof., MD Department of Orthopaedic Surgery, Centre
Albert Trillat, CHU Lyon Nord, Hôpital de la Croix Rousse, Lyon, France

Laura Nofrini Laboratorio di Biomeccanica e Innovazione Tecnologica,
Istituto Ortopedico Rizzoli, Bologna, Italy

Andrej M. Nowakowski, MD, BSc, PhD Orthopedic Department,
University Hospital of Basel, Basel, Switzerland

Peter E. Ochsner, Prof., MD Emerited Professor of Orthopaedic Surgery,
University of Basel, Frenkendorf, Switzerland

Geert Pagenstert, Asst. Prof. (PD), MD Orthopaedic Department,
University Hospital of Basel, Basel, Switzerland

Alfredo Schiavone Panni, MD Department of Medicine and Science for
Health, University of Molise, Campobasso, Italy

Javad Parvizi, Prof., MD, FRCS Rothman Institute at Thomas Jefferson
University Hospital, Philadelphia, PA, USA

Kailash Patil, MD Department of Orthopaedics, Sancheti Institute for
Orthopaedics and Rehabilitation, Pune, India

Martin Pietsch, MD Orthopedic Hospital Stolzalpe, LKH Stolzalpe, Stolzalpe, Austria

Nicolas Pujol, MD Orthopedic Department, Centre Hospitalier de Versailles, Versailles-Saint Quentin University, Le Chesnay, France

Amar S. Ranawat, Asst. Prof., MD Adult Reconstruction & Joint Replacement Division, Hospital for Special Surgery, New York, NY, USA

Helmut Rasch, MD Institute of Radiology and Nuclear Medicine, Kantonsspital Baselland, Bruderholz, Switzerland

Vijay J. Rasquinha, MD Department of Orthopaedics and Rehabilitation, State University of New York (SUNY) Downstate Medical Center, Brooklyn, NY, USA

Chiara Del Regno, MD Department of Medicine and Science for Health, University of Molise, Campobasso, Italy

Bertram Rieger, MD Department of Orthopaedic Surgery and Traumatology, Kantonsspital Baselland (Bruderholz, Liestal, Laufen), Bruderholz, Switzerland

Michael D. Ries, Prof., MD UCSF Department of Orthopaedic Surgery, University of California, San Francisco, San Francisco, CA, USA

Parag Sancheti, MD, MS(Orth), FRCS (Ed) Department of Orthopaedics, Sancheti Institute for Orthopaedics & Rehabilitation, Pune, India

Dirk J. Schäfer, Prof., MD Chefarzt der Klinik für plastische, rekonstruktive und ästhetische Chirurgie und Handchirurgie, Basel, Switzerland

Rebecca Schubert Department of Orthopaedics, Biomechanics and Implant Technology Research Laboratory, University Medicine Rostock, Rostock, Germany

Adam J. Schwartz, MD Department of Orthopaedic Surgery, Mayo Clinic, Phoenix, AZ, USA

Giles R. Scuderi, Prof., MD Orthopedic Service Line, Northshore LIJ Health System, New York, NY, USA

Fellowship Director, Adult Knee Reconstruction, Lenox Hill Hospital, New York, NY, USA

Elvire Servien, MD Department of Orthopaedic Surgery, Centre Albert Trillat, CHU Lyon Nord, Hôpital de la Croix Rousse, Lyon, France

Bharat Sharma, MD Clinica Ortopedica e Traumatologica III, Istituto Ortopedico Rizzoli, Bologna, Italy

Ashok Shyam, MD Department of Orthopaedics, Sancheti Institute for Orthopaedics and Rehabilitation, Pune, India

Christian Stärke, Asst. Prof. (PD), MD Department of Orthopaedic Surgery, University Hospital, Otto-von-Guericke-University of Magdeburg, Magdeburg, Germany

S. David Stulberg, MD Northwestern University Feinberg School of Medicine, Chicago, IL, USA

Ricardo Telles de Freitas, MD Knee, Ankle and Sports Trauma Unit, Orthopaedic and Trauma Center, Hospital CufDescobertas, Lisbon, Portugal

Enrique A. Testa, MD Department of Orthopaedic Surgery and Traumatology, Kantonsspital Baselland (Bruderholz, Liestal, Laufen), Bruderholz, Switzerland

Carsten O. Tibesku, Prof., MD Sporthopaedicum Straubing, Straubing, Germany

Andrew H. Toms, MD, FRCS (Ed, Tr, Orth), MSc Exeter Knee Reconstruction Unit, Princess Elizabeth Orthopaedic Centre, Exeter, UK

Andreas C. Tschopp, MD Plastische, Rekonstruktive und Ästhetische Chirurgie der Klinik im Spiegel, Bern, Switzerland

Victor Valderrabano, Prof., MD, PhD Orthopaedic Department, University Hospital of Basel, Basel, Switzerland

Gerard G. Van Hellemond, MD Sint Maartenskliniek, Ubbergen, The Netherlands

Ricardo Varatojo, MD Knee, Ankle and Sports Trauma Unit, Orthopaedic and Trauma Center, Hospital CufDescobertas, Lisbon, Portugal

Michele Vasso, MD Department of Medicine and Science for Health, University of Molise, Campobasso, Italy

Patrick Vavken, MD, MSc Orthopaedic Department, University Hospital of Basel, Basel, Switzerland

Kelly G. Vince, MD Department of Orthopedic Surgery, Whangarei Hospital, Whangarei, New Zealand

Andrea Visani Laboratorio di Biomeccanica e Innovazione Tecnologica, Istituto Ortopedico Rizzoli, Bologna, Italy

Frank-Christiaan B. M. Wagenaar, MD Centre for Orthopaedic Surgery OCON, Geerdinksweg 141, Hengelo, The Netherlands
OCON Orthopedische kliniek, Hengelo, Nederland, Geerdinksweg 141, Hengelo, The Netherlands

Christopher R. Wagner, PhD OrthoImagingSolutions Ltd, London, UK

Phil Walmsley, MD Department of Orthopaedics, Victoria Hospital, Kirkcaldy, UK
Royal College of Surgeons of Edinburgh, Edinburgh, UK

Hugh B. Waterson, MD Department of Orthopaedics, Royal Infirmary of Edinburgh, Little France, Edinburgh, Scotland

Ueli Wehrli, MD Lugnorre, Switzerland

Peter White, MD Adult Reconstruction & Joint Replacement Division, Hospital for Special Surgery, New York, NY, USA

Leo A. Whiteside, Prof., MD Missouri Bone and Joint Research Foundation, St. Louis, MO, USA

Matthias D. Wimmer, MD Department of Orthopaedic Surgery and Traumatology, University Hospital Bonn, Bonn, Germany

Ate B. Wymenga, MD Sint Maartenskliniek, Ubbergen, The Netherlands

Erlangga Yusuf, MD Orthopaedic and Traumatology Service Septic Surgical Unit, Lausanne University Hospital, Lausanne, Switzerland

Stefano Zaffagnini, Prof., MD Sports Traumatology Dept. (III Orthopaedic Clinic) and Biomechanics Lab., Istituti Ortopedici Rizzoli – Bologna University, Bologna, Italy

Carmen Zietz Department of Orthopaedics, Biomechanics and Implant Technology Research Laboratory, University Medicine Rostock, Rostock, Germany

Part I

Basics Science and Principles in Total Knee Replacement

Anatomy and Biomechanics of the Natural Knee and After TKR

1

Richard T. Keller and Andrew A. Amis

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Keynotes

1. Kinematics is controlled by both the remaining soft tissues in the knee and articular surface geometries of the implant.
2. Knee kinematics can be characterised by a coupled internal rotation and role gliding during flexion. The tibia performs a coupled internal rotation during knee flexion.
3. TKR component designs can be differentiated in posterior cruciate retaining, posterior stabilised, total stabilised and rotating hinged TKR.
4. Axial knee loading can reach up to 8 times body weight.
5. Design factors in TKR include femoral condyle radii, tibial insert frontal plane conformity and mediolateral offset of the trochlear groove.

R.T. Keller (✉)
Department of Mechanical Engineering,
Imperial College London, South Kensington Campus,
London SW7 2AZ, UK
e-mail: richard.keller09@imperial.ac.uk

A.A. Amis, Prof.
Department of Mechanical Engineering,
Imperial College London, South Kensington Campus,
London SW7 2AZ, UK

Department of Musculoskeletal Surgery,
Imperial College London, School of Medicine,
Charing Cross Hospital, London W6 8RF, UK
e-mail: a.amis@imperial.ac.uk

1.1 Natural Knee Kinematics

One of the major challenges in total knee replacement (TKR) is to restore knee biomechanics as close as possible to the natural knee. The complex kinematics of the knee can be fully described by a ‘six-degrees-of-freedom’ movement, with three rotations and three linear translations along a set of perpendicular axes.

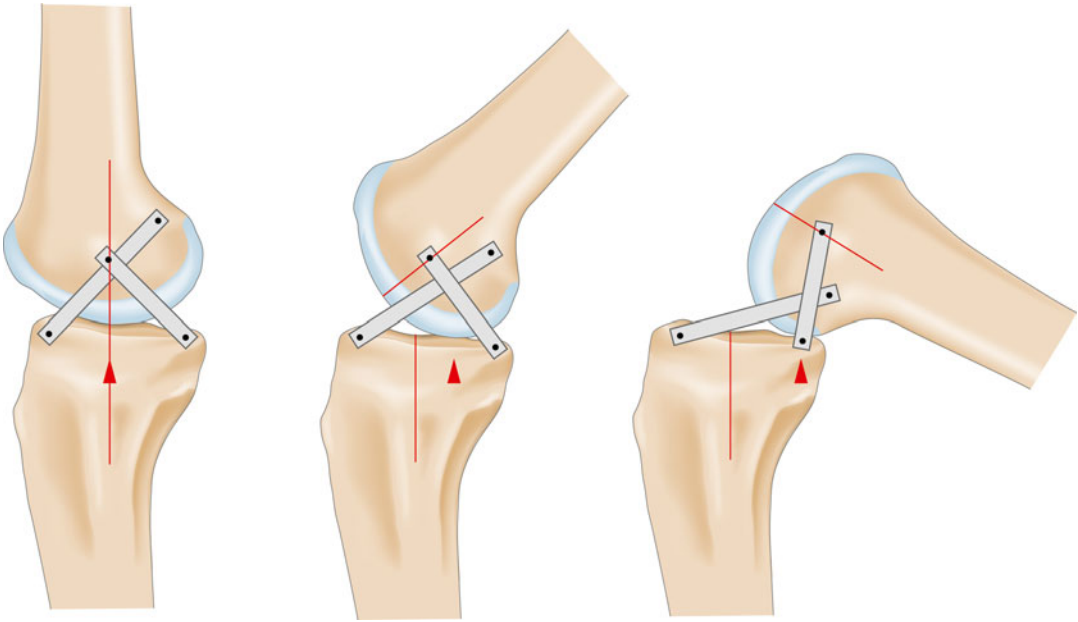


Fig. 1.1 The femoral rollback can be simplified and described in a two-dimensional (2D) four-bar linkage system

The rotations are internal and external (IE) rotation in the transverse plane, varus–valgus (VV) in the coronal plane and flexion and extension (FE) in the sagittal plane. Translations along those axes give displacement in proximal and distal (superior and inferior), anteroposterior and mediolateral directions, respectively.

In a simplified first step, the femoral rollback was described in a two-dimensional (2D) four-bar linkage system [1, 2] (Fig. 1.1). This provided a mechanical explanation of the relative motion of the femur on the tibia with increasing flexion. The ratio of rolling and gliding of the femur on the tibial plateau increases during flexion from 1:2 at the early stage of flexion, to 1:4 in deep flexion. There is no fixed axis to describe knee motion, like a simple hinge joint, secondary translations and rotations are involved throughout. Among those is the coupled internal rotation of the tibia about its long axis, which occurs automatically in response to the articular geometries of the medial and lateral compartments engaging during flexion. Additionally, the ligamentous restraints vary throughout the full range of motion.

Knee kinematics can be characterised by a coupled internal rotation and roll-gliding motion during flexion.

More recent studies have shown a significant difference between the knee kinematics of the medial and lateral compartment [3] (Fig. 1.2).

The medial femoral condyle predominantly rotates and demonstrates minor translation during flexion. In contrast, the lateral condyle rolls and glides posteriorly on the tibial plateau. The different kinematic behaviour in the medial and lateral compartments lead to coupled internal rotation of the tibia in relation to the femur during flexion.

The tibia performs a coupled internal rotation during knee flexion.

The condyles are almost spherical during the range of motion between 20° and 120° of knee