

CONTENTS

Evolve Resources (Web Contents), ix

Preface to the Sixth Edition, xi

Biography of Dr Michael W. Whittle, xiii

Contributors, xv

1 Basic Sciences, 1

Michael Whittle, David Levine and Jim Richards

Introduction, 1

Anatomy, 1

Biomechanics, 9

Worked Example, 12

References, 13

2 Normal Gait, 14

Michael Whittle, David Levine and Jim Richards

Walking and Gait, 15

A Brief History, 15

Kinematics, 15

Force Platforms, 15

Mechanical Analysis, 16

Mathematical Modelling, 16

Clinical Application, 16

Terminology Used in Gait Analysis, 16

Gait Cycle Timing, 17

Foot Placement, 18

Cadence, Cycle Time and Speed, 19

Overview of the Gait Cycle, 21

Upper Body, 23

Hip, 24

Knee, 24

Ankle and Foot, 24

The Gait Cycle in Detail, 25

Initial Contact (Fig. 2.11), 25

Loading Response (Fig. 2.12), 26

Opposite Toe Off (Fig. 2.13), 27

Mid-stance (Fig. 2.14), 28

Heel Rise (Fig. 2.15), 29

Opposite Initial Contact (Fig. 2.16), 30

Toe Off (Fig. 2.17), 31

Feet Adjacent (Fig. 2.18), 32

Tibia Vertical (Fig. 2.19), 33

Terminal Foot Contact (Fig. 2.11), 33

Ground Reaction Forces, 34

Support Moment, 36

Energy Consumption, 36

*Energy Consumption per Unit Time
(Oxygen Consumption), 37*

*Energy Consumption per Unit Distance
(Oxygen Cost), 37*

Optimisation of Energy Usage, 37

Energy Transfers, 38

The Six Determinants of Gait, 38

1. Pelvic Rotation, 38

2. Pelvic Obliquity, 40

3. Knee Flexion in Stance Phase, 40

4. Ankle Mechanism, 40

5. Foot Mechanism, 41

*6. Lateral Displacement of the
Body, 41*

Starting and Stopping, 41

Other Varieties of Gait, 42

Changes in Gait With Age, 42

Gait in the Young, 42

Gait in the Elderly, 44

References, 45

3 Pathological and Other Abnormal Gaits, 47

Michael Whittle, David Levine and Jim Richards

Specific Gait Abnormalities, 48

Lateral Trunk Bending, 48

Anterior Trunk Bending, 51

Posterior Trunk Bending, 52

Increased Lumbar Lordosis, 52

Functional Leg Length Discrepancy, 53

Circumduction, 53

Hip Hiking, 53

Steppage, 54

Vaulting, 54

Abnormal Hip Rotation, 54

Excessive Knee Extension, 55

Excessive Knee Flexion, 56

Inadequate Dorsiflexion Control, 56

Abnormal Foot Contact, 57

Abnormal Foot Rotation, 58

Insufficient Push Off, 58

Abnormal Walking Base, 58

Rhythmic Disturbances, 58

Other Gait Abnormalities, 59

Walking Aids, 59*Canes, 59**Crutches, 60**Walking Frames, 61**Gait Patterns With Walking Aids, 61***Treadmill Gait, 63****References, 63****4 Methods of Gait Analysis, 64***Michael Whittle, Max Jordon, David Levine and
Jim Richards***Observational Gait Analysis 65****The Gait Analysis Environment, 66****Gait Assessment, 66***Examination by Video Recording, 67**Temporal and Spatial Parameters of Gait, 67**Cycle Time or Cadence, 68**Stride Length, 68**Speed, 68**General Gait Parameters from Video
Recording, 69***Measurement of Temporal and Spatial
Parameters of Gait, 69***Footswitches, 69**Instrumented Walkways, 69***Camera-Based Motion Analysis, 69***General Principles, 71**Camera-Based Motion Analysis Systems, 72**Common Marker Sets, 72**Active Marker Systems, 75***Electrogoniometers and Potentiometers, 76***Rotary Potentiometers, 76**Electrogoniometers, 77***Accelerometers and Inertial Measurement
Units, 77***Measurement of Transients With
Accelerometers, 77**Measurement of Motion With
Accelerometers, 77**Inertial Measurement Units, 78**Motion Capture Suits, 78***Measuring Force and Pressure, 78***Force Platforms, 78**Measuring Pressure Beneath the Foot, 80**Glass Plate Examination, 81**Direct Pressure Mapping Systems, 81**Pedobarograph, 81**Force Sensor Systems, 81**In-Shoe Devices, 82***Measuring Muscle Activity, 82***Electromyography, 82**Surface Electrodes, 82**Fine Wire Electrodes 83**Needle Electrodes, 83**Signal Processing of EMG Signals, 83***Measuring Energy Expenditure, 84***Oxygen Consumption, 84**Heart Rate Monitoring, 85**Mechanical Calculations of Energy
Expenditure, 86***Conclusion, 86****References, 86****5 Applications of Gait Analysis, 88***Michael Whittle, Hannah Shepherd, Gabor Barton and
Jim Richards***Clinical Gait Assessment, 88****Clinical Decision-Making, 89***Gait Assessment, 89**Hypothesis Formation, 89**Hypothesis Testing, 89***Diagnosis of Abnormal Gait, 90****Conditions Benefiting From Gait***Assessment, 90***New Developments in Gait Analysis, 91***Advanced Techniques Applied to Under
Researched Pathologies, 91**Self-Organising Maps and Single Summary
Measures, 92**Identifying Joint-Specific Mechanisms, 92**Modelling Muscle Forces and EMG Assisted
Models, 94**Moving Measurements Away From the
Laboratory, 95***Conclusion, 96****References, 97****6 Gait Assessment of Neurological Disorders, 98***Michael Whittle, Richard Baker, Nancy Fell, Derek Liuzzo,
Jim Richards and Cathie Smith***Gait Assessment in Cerebral Palsy, 98***Definition, Causes and Prevalence, 98**Classification, 99**Clinical Management, 102**Strengthening, 104**Clinical Gait Analysis, 104**Data Capture, 104**Clinical Examination, 104**Key Points, 106*

- Gait Assessment in Stroke, 107**
Definition, Causes and Prevalence, 107
Temporal and Spatial Parameters, 107
Kinematics, 108
Kinetics, 109
Clinical Management, 110
Key Points, 111
- Gait Assessment in Parkinson's Disease, 111**
Clinical Management, 112
Gait Initiation Problems in People with Parkinson's Disease, 112
- Conclusion, 114**
Key Points, 114
- Gait Assessment in Muscular Dystrophy, 114**
Clinical Management, 116
Key Points, 117
References, 117
- 7 Gait Analysis in Musculoskeletal Conditions, Prosthetics and Orthotics, 121**
Jim Richards, Frank Tudini, June Hanks, Hannah Shepherd, Gabor Barton, David Levine, Natalie Vanicek, Cleveland Barnett and Ashley Schilling
- Total Hip Arthroplasty, 121**
Spatiotemporal Factors, 121
Kinematics, 122
Kinetics, 122
Additional Clinical Relevance, 123
Key Points, 123
- Knee Osteoarthritis, 123**
Gait Analysis in Knee Osteoarthritis, 123
Surgical Management, 124
Nonsurgical Management of Knee Osteoarthritis, 126
Key Points, 127
- Prosthetic Gait, 127**
Lower Limb Amputation and Prosthetic Components, 127
Prosthetic Rehabilitation, 128
Temporal-Spatial Parameters, 128
Kinematics, 128
Kinetics, 129
Movement Patterns During Activities of Daily Living, 129
Measuring Prosthetic Gait, 131
Key Points, 131
- Orthotic Management, 131**
Foot Orthoses, 131
Ankle Foot Orthoses, 132
Orthotic Walkers, 134
Knee-Ankle-Foot Orthoses, 134
Key Points, 134
References, 135
- 8 Gait Analysis of Running and the Management of Common Injuries, 139**
Kim Hébert-Losier and Komsak Sinsurin
- Running Biomechanics, 139**
Key Differences to Walking, 139
Running Gait Analysis, 140
Kinematic Measures, 142
Kinetic Measures, 142
Note on Wearable Sensors, 144
- Common Running-Related Injuries and Clinical Considerations, 144**
- Patellofemoral Pain, 145**
Clinical Presentations, 145
Key Management Strategies, 146
- Achilles Tendinopathy, 147**
Clinical Presentations, 147
Key Management Strategies, 147
- Medial Tibial Stress Syndrome, 148**
Clinical Presentations, 148
Key Management Strategies, 148
- Plantar Heel Pain, 148**
Clinical Presentations, 148
Key Management Strategies, 149
- Iliotibial Band Syndrome, 149**
Clinical Presentations, 149
Key Management Strategies, 150
Key Points, 150
References, 150
- Index, 155
- Additional Online Only Content**
Supplementary Information to Chapter 1: Basic Sciences
Michael Whittle