

Contents

<i>Chapter I. Aims and Limitations of the Work</i>	1
<i>Chapter II. Review of the Literature</i>	3
<i>Chapter III. Methods</i>	9
I. Mathematical Analysis	9
II. Experiments on Anatomical Specimens	9
III. Photoelastic Models	10
A. Theoretical Basis	11
B. Historical	11
C. Application and Limitation of the Photoelastic Technique	12
IV. Clinical and Radiological Material	12
 <i>Chapter IV. Mechanics of the Knee</i>	 15
I. Load and Mechanical Stresses	15
A. Concept of Load and Stresses. Rigid Models	15
B. Articulated Models	18
1. Forces	18
2. Contact Stresses	20
II. Mechanical Stress in the Knee	22
A. Forces Exerted on the Knee	22
1. Force Exerted on the Knee During Symmetrical Stance on Both Legs	22
2. Forces Exerted on the Knee in Standing on One Leg	24
a) Coronal Plane	24
b) Sagittal Plane	26
3. Forces Exerted on the Knee During Gait	28
a) Displacement of the Centre of Gravity S_7	29
b) Forces of Inertia Due to the Accelerations of S_7	33
c) Force P Exerted on the Knee by the Partial Mass S_7 of the Body	36
d) Position in Space of Point G Which Lies Centrally on the Axis of Flexion of the Knee	37
e) Position of the Knee in Relation to the Partial Centre of Gravity S_7	43
f) Distance a Between the Line of Action of Force P and Point G	46

g) Muscular and Ligamentous Forces Balancing Force P	48
α) Formularization	48
β) Calculation	51
γ) Critical Analysis of the Chosen Solution	52
h) Curves Illustrating the Forces Transmitted Across the Femoro-Tibial Joint	56
i) Patello-Femoral Compressive Force	58
B. Weight-Bearing Surfaces of the Joint	62
1. Femoro-Tibial Joint	62
a) Technique	62
b) Results	65
2. Patello-Femoral Joint	70
C. Contact Articular Stresses	71
1. Femoro-Tibial Joint	71
2. Patello-Femoral Joint	73
III. Conclusion	73

Chapter V. The Pathomechanics of Osteoarthritis of the Knee 75

I. Theoretical Analysis of the Causes of Knee Osteoarthritis	75
A. Medial Displacement of Force R	76
B. Lateral Displacement of Force R	81
C. Unstable Knees	86
D. Evolution of the Maximum Stress in Relation to Several Parameters	88
1. Varus or Valgus Deformity	89
a) Magnitude and Line of Action of R	89
b) Articular Compressive Stresses	91
2. Strengthening or Weakening of the Muscular Force L	94
3. Cumulative Effect of a Change of the Force L and a Deformity of the Leg	96
4. Modification of Force P	100
5. Horizontal Displacement of S_7 in the Coronal Plane	102
6. Conclusion	103
E. Posterior Displacement of Force R	104
F. Anterior Displacement of Force R	106
G. Increase of the Patello-Femoral Compressive Force	107
H. Lateral Displacement of the Patello-Femoral Compressive Force	108
II. Radiographic Examination of the Osteoarthritic Knee with Demonstration of the Effect of Changes in the Compressive Force on the Stress Distribution	110
A. Demonstration of Joint Stresses	110
1. A.-P. View	110
2. Lateral View	113
3. Tangential View	116
B. Utility of X-Rays in the Standing Position	117
C. Arthrography	118
D. Computerized Axial Tomography	119

III. The Use of Photoelastic Models to Illustrate How the Position of Compressive Femoro-Tibial and Patello-Femoral Forces Affects the Distribution of Articular Stresses	121
A. Femoro-Tibial Joint	121
1. Normal Load, Centred	122
2. Normal Load, Off Centre	123
3. Inclined Load, Centred	126
4. Inclined Load, Off Centre	127
B. Patello-Femoral Joint	128
1. Directional Distribution of the Stresses	128
2. Quantitative Distribution of the Stresses	130
IV. Osteoarthritis of the Knee of Mechanical Origin	131

<i>Chapter VI. Instinctive Mechanisms Which Reduce Stress in the Knee</i>	<i>133</i>
I. Effects of Limping	133
II. Use of a Walking Stick	136
III. Comment and Conclusion	137

<i>Chapter VII. Biomechanical Treatment of Osteoarthritis of the Knee</i>	<i>139</i>
I. Rationale of Biomechanical Treatment	140
II. Biomechanical Treatment of Osteoarthritis of the Knee . .	141
A. Correction of Flexion Contracture	142
1. Rationale	142
2. Operative Procedure	143
a) Capsulotomy Alone	143
b) Capsulotomy Associated with Other Procedures	143
3. Results	143
B. Anterior Displacement of the Tibial Tuberosity . . .	144
1. Rationale	144
2. Operative Procedures	146
a) Anterior Displacement of the Tibial Tuberosity by Elevating the Tibial Crest	146
b) Anterior and Medial Displacement of the Tibial Tuberosity	151
c) Anterior Displacement of the Tibial Tuberosity Combined with Upper Tibial Osteotomy	154
d) Anterior Displacement of the Tibial Tuberosity Combined with Osteotomy of the Lower End of the Femur	154
3. Anterior Displacement of the Tibial Tuberosity After Patellectomy	155
4. Changes at Arthroscopy	156
C. Recentring the Load	158
1. Osteoarthritis of the Knee with a Varus Deformity	158
a) Necessity of Overcorrecting the Varus Deformity	158
b) Accurate Estimation of Overcorrection	159
c) Choice of Procedure: Tibial or Femoral Osteotomy?	162

d) Previous Operative Procedures	164
e) The Barrel-Vault-Osteotomy for Varus Deformity	165
α) Planning	165
β) Instruments	168
γ) Surgical Procedure	169
δ) Postoperative Care	171
ε) Comments and Examples	171
f) Cases Requiring a Derotation of the Leg	193
g) Revisions	197
α) Revision After Undercorrection	197
β) Revision After Exaggerated Overcorrection	202
h) The Exceptions. Femoral Osteotomy for a Varus Deformity of the Knee	209
α) Planning	209
β) Surgical Procedure	210
γ) Postoperative Care	211
δ) Second Example	212
2. Osteoarthritis of the Knee with Varus and Flexion Deformity	214
3. Osteoarthritis with a Valgus Deformity	218
a) Necessity of Overcorrection	218
b) Choice of Procedure: Femoral or Tibial Osteotomy?	218
c) Previous Techniques	226
d) Distal Femoral Osteotomy with Fixation by Four Steinmann Pins and Two Compression Clamps	227
α) Planning	227
β) Surgical Procedure	230
γ) Postoperative Care	231
δ) Comments and Examples	231
e) Distal Femoral Osteotomy Combined with Anterior Displacement of the Tibial Tuberosity	237
f) Revisions	240
α) Revision After Exaggerated Overcorrection	240
β) Revision After Mis correction	242
4. Bilateral Osteoarthritis with a Valgus Deformity on One Side and a Varus Deformity on the Other Side	244
5. Osteoarthritis with Genu Recurvatum	246
6. Osteoarthritis of the Knee Due to a Distant Deformity	248
7. Rheumatoid Arthritis	254
8. Osteoarthritis of the Knee in Haemophiliacs	256
9. Osteonecrosis of the Medial Condyle of the Femur	258
10. Widespread Osteoarthritis without Deformity	260
11. Histological Confirmation of the Regenerative Process	260
D. Critical Analysis of Patellectomy and Other Procedures on the Patella	262
1. Standard Patellectomy	262
2. Coronal Patellectomy	264
3. Sagittal Osteotomy of the Patella	266
E. Operative Indications	266

<i>Chapter VIII. Results</i>	267
A. Femoro-Tibial Osteoarthritis	269
1. Osteoarthritis with a Varus Deformity	271
a) Valgus Tibial Osteotomy	271
b) Valgus Femoral Osteotomy	273
2. Osteoarthritis with a Valgus Deformity	274
3. Correction of a Deformity at a Distance from the Af- fected Knee	276
4. Complications and Unsatisfactory Results	278
5. Conclusions	279
B. Patello-Femoral Osteoarthritis	279
1. Division of the Lateral Retinaculum	279
2. Anterior Displacement of the Tibial Tuberosity	280
3. Complications of the Anterior Displacement of the Tibial Tuberosity	282
4. Conclusions	283
 <i>Chapter IX. Conclusions</i>	 285
 <i>Appendix. Remarks About the Accuracy of the Calculation of Forces and Stresses in the Knee Joint</i>	 291
A. Introduction	291
1. The Weights	291
2. Formularization	292
3. The Laws	292
4. Direct Personal Measurements	292
B. Analysis of the Influence of the Variation of Time Be- tween Two Successive Phases	293
C. Influence of a Systematic Error of 10% in All the Mea- surements of Braune and Fischer	293
D. Theory of Cumulated Errors, a Variation of 0.2 mm Be- ing Assumed for All the Measurements	294
E. Influence of a Variation of the Weight-Bearing Surfaces	296
F. Influence of an Error in Estimating r	297
G. Direct Measurements	298
H. Conclusion	298
 References	 299
 Subject Index	 305