

fourth edition

2

ORTHOPAEDICS

Principles & Their Application

SAMUEL L.TUREK

Fourth Edition

Orthopaedics

Principles and Their Application

VOLUME 2



J. B. Lippincott Company
Philadelphia

*London, Mexico City, New York,
St. Louis, São Paulo, Sydney*

Sponsoring Editor: Darlene D. Pedersen
Manuscript Editor: Delois Patterson
Indexer: Ann Cassar
Art Director: Maria S. Karkucinski
Designer: Patrick Turner
Production Supervisor: N. Carol Kerr
Production Assistant: George V. Gordon
Compositor: Monotype Composition Company, Inc.
Printer/Binder: Halliday Lithograph

FOURTH EDITION

The author and publisher have exerted every effort to ensure that drug selection and dosage set forth in this text are in accord with current recommendations and practice at the time of publication. However, in view of ongoing research, changes in government regulations, and the constant flow of information relating to drug therapy and drug reactions, the reader is urged to check the package insert for each drug for any change in indications and dosage and for added warnings and precautions. This is particularly important when the recommended agent is a new or infrequently employed drug.

Copyright © 1984, by J. B. Lippincott Company. Copyright © 1977, 1967, 1959 by J. B. Lippincott Company. All rights reserved. No part of this book may be used or reproduced in any manner whatsoever without written permission except for brief quotations embodied in critical articles and reviews. Printed in the United States of America. For information write J. B. Lippincott Company, East Washington Square, Philadelphia, Pennsylvania 19105.

3 5 6 4 2

Library of Congress Cataloging in Publication Data

Turek, Samuel L.
Orthopaedics : principles and their application.

Includes bibliographies and index.
1. Orthopedia. I. Title. [DNLM: 1. Orthopedics.
WE 168 T9340]
RD731.T8 1983 617'.3 82-24961
ISBN 0-397-50604-X

Samuel L. Turek, M.D.

Attending Orthopaedic Surgeon

Mount Sinai Medical Center and Miami Heart Institute

Miami Beach, Florida

Formerly, Clinical Assistant Professor

Department of Orthopaedics and Rehabilitation

University of Miami School of Medicine

Miami, Florida

Formerly Chief, Department of Orthopaedic Surgery

St. Francis Hospital

Miami Beach, Florida

Contents

VOLUME I

Part One The Basic Sciences

1	Development of the Skeleton	3
	Cartilage 3	
	Bone 3	
	Joints 6	
	Morphogenesis of the Axial Skeleton 6	
	Morphogenesis of the Appendicular Skeleton 9	
2	Histology of Cartilage	14
	Hyaline Cartilage 14	
	Elastic Cartilage 15	
	Fibrocartilage 15	
	Histogenesis of Cartilage 16	
	Cartilage Changes in Growth 17	
	Adult Articular Cartilage 17	
	The Chondrocytes 19	
	Ultrastructural Characteristics of Cartilage 20	
	Repair of Articular Cartilage 25	
3	Histology and Histopathology of Bone	30
	<i>Section I: Histology of Bone 30</i>	
	Types of Bone 30	
	Structure of Bone 30	
	Components of Bone 33	

Histogenesis of Bone	34
Endochondral (Intracartilaginous) Ossification	35
Intramembranous Ossification	37
Remodeling of Bone	39
Ultrastructural Characteristics of Bone	41
Biologic Considerations	45

Section II: Histopathology of Bone 46

Osteoprogenitor Cell Principle	46
The Osteogenic Cell	49
The Bone Induction Principle	50
Repair of Simple Fracture of a Long Bone	54
Delayed Union and Nonunion	59
Bone Transplantation	67
Avascular Necrosis of Bone	79
Dysbaric Osteonecrosis	81
Hypercorticism Osteonecrosis	84
Organ Transplant Osteonecrosis	86
Cadaver Bone Allografts—Bone Banks	86
Effects of Ionizing Radiation on Bone	90

4 Histology of Skeletal Muscle 101

Microanatomy	101
Structure of Muscle Fibers	102
Components of Sarcoplasm	110

5 Collagen 113

Function of Collagen	113
Structure of Collagen Molecule	113
Formation of Collagen Fibrils	117
Cross-Linking in Collagen	118
Bone Collagen	119
Collagen of Articular Cartilage	122
Collagenase	123
Hydroxyproline Excretion: An Indicator of Collagen Metabolism	130

6 Physiology and Mineralization of Bone 136

Section I: Physiology of Bone 136

Biochemistry	136
Basic Physiologic Processes	138
Factors Affecting the Fate of Bone Minerals	140
Phosphorus	142
Calcium	142
Fate of Phosphorus and Calcium	143

Magnesium	144
Vitamins	144
Glands of Internal Secretion	147
Enzymes	163

Section II: Mineralization of Bone 164

Theories of Mineralization	164
Bone Formation, Resorption and Mineralization	172

Section III: Blood Supply of Long Bones 180

The Mature Long Bone	180
Effects of Diaphyseal Fracture	184

7 Physiology of Cartilage 191

Normal Articular Cartilage	191
Metabolic Studies of Articular Cartilage	199
Biomechanical Functions of Articular Cartilage	199
Mechanical Functions of Articular Cartilage	201
Factors Affecting Articular Cartilage	207

8 Biophysical Properties of Bone and Cartilage 216

Electrical Properties of Bone	216
Mechanisms of Electrically Induced Osteogenesis	219
Piezoelectrical Property of Collagen	221

***Part Two
General Orthopaedic Conditions***

9 Metabolic Bone Disease and Related Dysfunction of the Parathyroid Glands 255

Factors Affecting Calcium Metabolism	225
Parathyroid Glands	226
Primary Hyperparathyroidism	228
Hypoparathyroidism	232
Pseudohypoparathyroidism	232
Low Phosphorus Rickets and Osteomalacia	233
Calcium-Deficiency Diseases	233

Malabsorption Syndrome	243
Hypophosphatasia	244
Scurvy	244
Gout	246
Ochronotic Arthritis	251
Osteoporosis	253

10 Bone Infections 258

Acute Osteomyelitis	258
Chronic Osteomyelitis	262
Sclerosing Osteomyelitis of Garré	266
Tuberculosis of Bones and Joints	266
Syphilis of Bones and Joints	273
Mycotic Infections	276
Salmonella Osteomyelitis	281
Brucellar Spondylitis	281

11 Congenital Deformities 283

Section I: Etiology 283

Genetic Factor	283
Factor of Embryonic Trauma	283
Teratogenesis	283
Congenital Skeletal Limb Deficiencies	284

Section II: Upper Extremity 285

Congenital High Scapula	285
Cleidocranial Dysostosis	287
Congenital Anomalies of the Hand	289
Congenital Absence of the Radius	291
Congenital Radioulnar Synostosis	291
Congenital Humeroradial Synostosis	292

Section III: Lower Extremity 292

Congenital Dislocation of the Hip	292
Congenital Clubfoot	313
Congenital Metatarsus Adducto varus	325
Congenital Hallux Varus	328
Congenital Overlapping Little Toe	328
Congenital Dislocation of the Knee	329
Congenital Coxa Vara	329
Congenital Pseudarthrosis of the Tibia	331
Congenital Absence of the Fibula	335
Congenital Absence of the Tibia	337
Congenital Torsion in the Lower Extremity	338
Congenital Dislocation of the Patella	339
Multipartite Patella	341

Congenital Flatfoot	341
Congenital Vertical Talus	342
Congenital Angulation of the Tibia	346
Proximal Femoral Focal Deficiency	347

Section IV: The Spine 352

Congenital Torticollis	352
Klippel-Feil Syndrome	354
Congenital Absence of Spinal Segments	356

Section V: General Defects 356

Polydactyly	356
Amyoplasia Congenita	357
Congenital Constricting Bands	357
Ainhum	358
Congenital Hyperlaxity of Joints	358

12 Developmental Conditions 362

Osteogenesis Imperfecta	362
Chondro-Osteodystrophy	365
Dysplasia Epiphysialis Multiplex	367
Dysplasia Epiphysialis Punctata	369
Osteopetrosis	369
Melorheostosis	370
Dyschondroplasia	372
Hereditary Multiple Exostoses	373
Achondroplasia	375
Osteopoikilosis	376
Engelmann's Disease	377
Pycnodynatosis	378

13 Diseases of Joints 382

Synovial Fluid	382
Classification of Diseases Affecting Joints	383
Degenerative Joint Disease	384
Rheumatoid Arthritis	401
Juvenile Rheumatoid Arthritis	416
The Rheumatoid Variants	428
Palindromic Rheumatism	439
Neuroarthropathy	439
Suppurative Arthritis	442
Gonococcal Arthritis	444
Hemophilic Arthritis	444
Traumatic Arthritis	451
Alterations in Composition and Function of Synovial Tissues Related to Tumor Formation	452
Pigmented Villonodular Synovitis	453
Hemangioma of a Joint	454

Osteochondromatosis 455
Synovioma 457

14 Orthopaedic Neurology 464

Section I: Neurodiagnosis 464

Anatomy of the Spinal Cord 464
Neurologic Diagnosis 470
Electrodiagnosis 473
Localization of Spinal Cord Lesion 480

Section II: Miscellaneous Affections of the Nervous System 481

Spinal Cord Tumors 481
Cauda Equina Tumors 483
Filum Terminale Syndrome 483
Spinal Muscular Atrophies of Unknown Etiology 484
Peripheral Nerves 488

Section III: Poliomyelitis and Related Affections 515

Etiology 515
Epidemiology 515
Relationship of Coxsackieviruses 515
Pathology 516
Clinical Picture 516
Differential Diagnosis 517
Prognosis 517
Complications 518
Treatment 518
Reconstructive Surgery 521

Section IV: Cerebral Palsy 560

Etiology 560
Clinical Picture 560
Evaluation of Mental Status 560
Clinicopathologic Types 560
Treatment 561

15 Tumors of Bone 596

Classification 596
Histogenesis 596
Osteoma 597
Osteochondroma 598
Chondroma 599

Chondrosarcoma	602
Chondromyxoid Fibroma	611
Chondroblastoma	614
Benign Giant-Cell Tumor	615
Subperiosteal Giant-Cell Tumor	621
Aneurysmal Bone Cyst	621
Unicameral Bone Cyst	622
Osteogenic Sarcoma	625
Osteoid Osteoma	637
Benign Osteoblastoma	638
Parosteal Osteogenic Sarcoma	640
Ewing's Sarcoma	644
Fibrosarcoma	645
Histiocytic Lymphoma	647
Multiple Myeloma	648
Liposarcoma	652
Adamantinoma	652
Chordoma	653
Hemangioma of Bone	655
Hemangioendothelioma	657
Identification of Endothelial Tissues	657

16 Secondary Tumors of Bones 664

Characteristics	664
Direct Nonmetastatic Invasion From Contiguous Growths	664
Bone Metastases	665
The Primary Tumors	670

17 Diseases of Muscle 678

Histopathology of Skeletal Muscle	678
Tumors of Skeletal Muscle	679
Cavernous Hemangioma of Striated Muscle	679
Traumatic Conditions of Muscle	680
Myositis Ossificans Progressiva	684
Compartment Syndrome	684
Ischemic Necrosis of Muscle	698
Myositis	699
Inflammatory Myositis of Unknown Etiology	702
Muscular Dystrophies	705
Muscular Fibrodystrophy	708
Congenital Myotonia	709
Familial Periodic Paralysis	709
Arthrogryposis Multiplex Congenita	710
Myasthenia Gravis	711

18 Fibrous Diseases 716

Fibrous Dysplasia of Bone	716
Nonosteogenic Fibroma of Bone	721

CONTENTS

Congenital Neurofibromatosis 722
Collagen Diseases 728

19 Unclassified Diseases of Bone 734

Paget's Disease 734
Infantile Cortical Hyperostosis 743
Sarcoidosis 744
Tumors of Hematopoietic Tissues 747
Histiocytic Lymphoma 761
Tumors Invading Bone From Overlying
Structures 761

20 Peripheral Vascular Disease 766

Diagnosis of Vascular Disease of the Extremities 766
Special Tests of Peripheral Circulation 770
Vascular Function Studies 776
Arteriosclerosis Obliterans 783
Chronic Aorto-Iliac Occlusion 785
Thromboangiitis Obliterans 788
Treatment of Chronic Occlusive Arterial Disease 790
Angiospastic Conditions 793
Conditions Characterized by Vasodilatation 801
Acute Arterial Injuries 802
Arterial Aneurysm 803
Arteriovenous Fistula 806
Glomus Tumor 807
Periarteritis Nodosa 808
Therapeutic Sympathetic Paralysis 811
Anticoagulant Therapy 821
Differential Diagnosis of Arterial Obstruction in an
Extremity 823

Index

VOLUME 2

Part Three Regional Orthopaedic Conditions

21 The Cervical Spine 829

Cervical Sprain 829
Cervical Disk Lesions 833

Studies on Progressive Structural Changes in the Cervical Spine	839
Discogenic Pain	839
Degenerative Joint Disease	854
Rheumatoid Arthritis	858
Syndrome of the Greater Occipital Nerve	861
Vertebral Artery Syndrome	862
Cervical Spinal Cord Injury	864
Torticollis	869
Craniovertebral Region	870

22 Cervicobrachial Region **890**

Thoracic Outlet Syndromes	890
Cervical Rib	899
Scalenus Anticus Syndrome	903
Hyperabduction Syndrome	904
Differential Diagnosis of Neurovascular Compression Syndromes	905
Classification of Disorders Producing Neurovascular Signs and Symptoms in the Upper Extremity	906
Brachial Plexus Injuries	907
Obstetric Paralysis	914

23 The Shoulder **920**

Surgical Anatomy	920
Arm-Trunk Mechanism	921
Examination of the Shoulder	922
Lesions of the Rotator Cuff	924
Calcified Deposits in the Rotator Cuff	928
Biceps Tendon Lesions	929
Frozen Shoulder	932
Dislocation of the Shoulder	936
Suprascapular Nerve Entrapment	950
Scapulocostal Syndrome	951
Snapping Scapula	952
Sternoclavicular Joint	953
Acromioclavicular Joint	955
Rheumatoid Disease of the Shoulder	960
Tuberculosis of the Shoulder	962
Visceral Causes of Shoulder Pain	964

24 The Elbow **967**

Surgical Anatomy	967
Tennis Elbow	971
Elbow Sprain	973
Pulled Elbow	973
Recurrent Dislocation	973
Old Unreduced Dislocation	974
Rupture of the Biceps Insertion at the Elbow	975
Rheumatoid Arthritis	976
Tuberculosis	980

Osteochondritis Dissecans 981
Myositis Ossificans 983

25 The Hand 985

Surgical Anatomy 985
Reconstruction of the Hand 992
Thumb Tendons 1009
The Intrinsic Muscles 1015
Treatment of Hand Injuries 1033
Tendon Rupture 1034
Finger Deformities Associated With Alterations of Extensor Apparatus 1035
Dislocation of Tendon 1044
Traumatic Tenosynovitis 1044
Rheumatoid Arthritis 1046
Chronic Infection of the Hand 1060
Dupuytren's Contracture 1063
Calcific Deposits in the Hand and the Wrist 1073
Congenital Arteriovenous Fistula 1073
Benign Giant Cell Tumor of Tendon Sheath 1074
Acro-Osteolysis 1075
Dislocation of the Metacarpophalangeal Joint of the Finger 1077
Aneurysms 1078

26 The Wrist 1083

The Carpal Tunnel Syndrome 1083
Ganglion 1087
Rheumatoid Arthritis and Tenosynovitis of the Wrist 1088
Distal Radioulnar Joint 1090
Madelung's Deformity 1093
Degenerative Arthritis of the Distal Radiolunar Joint 1094
Traumatic Necrosis and Degeneration of Carpal Bones 1095
The Carpal Scaphoid: Nonunion and Aseptic Necrosis 1098
Sprain of the Pisiform-Triquetral Joint 1101
Osteoarthritis of the Trapeziometacarpal Joint 1103

27 The Hip 1109

Surgical Anatomy 1109
Mechanics of the Hip Joint 1123
Osteoarthritis of the Hip Joint 1124
Total Hip Replacement 1141
Cup Arthroplasty 1175
Salvage Operations 1180
Denervation of the Hip 1186
Arthrodesis of the Hip 1188

Femoral Head Prosthesis	1190
Osteonecrosis of Femoral Head	1194
Avascular Necrosis of the Femoral Head	1196
Idiopathic Avascular Necrosis of the Femoral Head	1198
Slipped Femoral Capital Epiphysis	1204
Coxa Plana	1219
Femoral Torsion	1236
Osteotomy at the Hip	1237
Pigmented Villonodular Synovitis of the Hip Joint	1240
Transient Synovitis of the Hip	1242
Calcified Tendinitis of the Hip Joint	1242
Protrusio Acetabuli	1243
Bursitis About the Hip	1245
Snapping Hip	1246
Intermittent Claudication of the Hip	1246
Tuberculosis of the Hip	1246
Paralytic Dislocation of the Hip	1251

28 The Knee 1269

Surgical Anatomy	1269
Injuries of the Semilunar Cartilages	1275
Congenital Discoid Menisci	1285
Calcification and Ossification of Menisci	1287
Injury to the Knee Ligaments	1288
Surgical Repair of Combined Acute Ligamentous Ruptures	1323
Reconstruction of Old Combined Ligamentous Injuries	1326
Ruptures of the Quadriceps Apparatus	1330
Dislocation of the Patella	1332
Chondromalacia Patellae	1339
Larsen-Johansson Disease	1346
Traumatic Prepatellar Neuralgia	1347
Osteochondritis Dissecans	1349
Spontaneous Osteonecrosis of the Knee	1351
Osgood-Schlatter Disease	1354
Deformity About the Knee	1355
Genu Valgum	1360
Genu Varum	1362
Tibia Vara	1363
Principles of Treatment of Angular and Torsional Deformities	1366
Genu Recurvatum	1367
Osteoarthritis	1367
Medial and Lateral Compartment Degenerative Arthritis	1371
Total Knee Replacement	1375
Total Condylar Knee Replacement	1382
Tuberculosis of the Knee Joint	1394
Diseases of the Bursae of the Knee Joint	1397
Bursitis in Special Situations	1399
Intraneuronal Cyst of the Common Peroneal Nerve	1401

29	The Foot and the Ankle	1407
	Surgical Anatomy 1407	
	Ankle Sprain 1423	
	Lesion of the Talar Dome 1425	
	Osteoarthritis of the Ankle Joint 1427	
	Tuberculosis of the Foot and Ankle 1429	
	Stenosing Tenosynovitis 1432	
	Rheumatoid Tenosynovitis About the Ankle 1433	
	Tarsal Tunnel Syndrome 1433	
	The Metatarsophalangeal Region 1435	
	Metatarsalgia 1436	
	Osteochondrosis of a Metatarsal Head 1437	
	March Fracture 1439	
	Plantar Digital Neuroma 1440	
	Hallux Valgus 1440	
	Dorsal Bunion 1445	
	Hallux Varus 1446	
	The Longitudinal Arch and Foot Strain 1446	
	Flatfoot 1446	
	Cavus Foot 1450	
	Tarsal Coalition 1462	
	Osteochondrosis of the Tarsal Navicular 1465	
	Sesamoid Bones of the Foot 1466	
	Calluses 1466	
	Warts 1467	
	Hammer Toe 1467	
	Ingrowing Toenail 1467	
	Hallux Rigidus 1468	
	Pain About the Heel 1472	
	Plantar Fibromatosis 1475	
	Accessory Bones of the Foot 1477	
30	The Back	1483
	Surgical Anatomy of the Nerve Roots in the Lower Lumbar Spine 1483	
	Referred Pain from the Back 1484	
	The Intervertebral Disk 1484	
	Lumbar Discogenic Pain 1502	
	Warning About Spinal Cord Tumors 1506	
	Warning About a Vascular Lesion 1506	
	Lumbar Nerve Root Compression by an Exostosis 1507	
	Osteitis Deformans of the Spine 1509	
	Lumbosacral Strain 1512	
	Sprung Back 1516	
	Thoracic Intervertebral Disk Herniation 1519	
	Calcification of Intervertebral Disks 1521	
	Infection of the Intervertebral Disk 1522	
	Spondylolisthesis and Spondylolysis 1524	
	Spina Bifida 1552	
	Meningocele and Meningomyelocele 1559	
	Diastematomyelia 1559	
	Osteohistology of the Normal Vertebra 1560	

Adolescent Kyphosis	1562
Localized Osteochondritis of the Lumbar Spine	1566
Osteoarthritis of the Spine	1567
Ankylosing Spondylitis	1570
Spondylitis of Rheumatoid Arthritis	1575
Osteoporosis of the Spine	1576
Tuberculous Spondylitis	1577
Vertebral Pyogenic Osteomyelitis	1590
Brucellar Spondylitis	1592
Neuroarthropathy of the Spine	1594
Fibrositis	1595
Vertebra Plana	1595
Aspiration Biopsy of Lesions of Vertebral Bodies	1596
Posture: Normal and Abnormal	1598
Scoliosis	1600
Infantile Idiopathic Scoliosis	1636

31 The Pelvis 1657

The Sacroiliac Joint	1657
Sacroiliac Strain	1658
Coccygodynia	1658
Osteitis Pubis	1661
Osteitis Condensans Ilii	1662
Episacroiliac Lipomas	1663
Tuberculosis of the Sacroiliac Joint	1663

Part Four *Special Subjects*

32 Radioactive Isotopes in Clinical Orthopaedics 1669

Aldo N. Serafini, M.D.

Bone Scanning	1669
Regional Radionuclide Measurements	1674
Calcium Kinetic Studies	1675
Total Body Neutron Activation Analysis	1676

33 Amputations 1678

Indications	1678
Principles of Technique	1679
Preoperative Preparation	1680
The Open Amputation	1681