

Contents

| | | |
|----------|--|-----------|
| 1 | Introduction and Fundamentals of Pinhole Scintigraphy | 1 |
| 1.1 | A History of Nuclear Bone Imaging | 4 |
| 1.2 | Histology and Physiology of Bone | 6 |
| 1.3 | Mechanism of Bone Adsorption of ^{99m}Tc Radiopharmaceuticals | 7 |
| 1.4 | Bone Imaging Radiopharmaceuticals | 7 |
| 1.5 | Bone Marrow Scan Radiopharmaceuticals | 8 |
| 1.6 | Fundamentals of Pinhole Scintigraphy | 8 |
| 1.7 | Rationale and Techniques of Pinhole Scintigraphy | 10 |
| | References | 13 |
| 2 | Dual-Head Planar Pinhole Scintigraphy and Pinhole SPECT of Bone | 15 |
| 2.1 | Dual-Head Planar Pinhole Scintigraphy | 15 |
| 2.2 | Pinhole SPECT of Bone | 17 |
| | References | 24 |
| 3 | Clinical Applications | 25 |
| 3.1 | Abnormal Bone Scan | 27 |
| 3.2 | Altered Biodistribution of Radiopharmaceutical | 28 |
| | References | 28 |
| 4 | Normal Pinhole Scintigraphic Anatomy of Bone and Joint | 29 |
| | YONG-WHEE BAHK AND SOO-KYO CHUNG | |
| 4.1 | Skull and Face | 29 |
| 4.2 | Neck | 32 |
| 4.3 | Thoracic Cage | 34 |
| 4.4 | Shoulder | 35 |
| 4.5 | Thoracic and Lumbar Spine | 36 |
| 4.6 | Sacrum and Sacroiliac Joints | 40 |
| 4.7 | Pelvis and Hip | 41 |
| 4.8 | Limbs | 45 |
| 4.8.1 | Upper Limbs | 45 |
| 4.8.2 | Lower Limbs | 46 |
| | References | 51 |

| | | |
|----------|--|------------|
| 5 | Normal Variants and Artifacts | 53 |
| | MYUNG-HEE SOHN AND YONG-WHEE BAHK | |
| 5.1 | Normal Variants | 53 |
| 5.1.1 | Skull | 53 |
| 5.1.2 | Neck | 57 |
| 5.1.3 | Thorax | 62 |
| 5.1.4 | Spine and Abdomen | 62 |
| 5.1.5 | Pelvis | 62 |
| 5.1.6 | Limbs | 62 |
| 5.1.7 | Navicular Accessory Bone | 64 |
| 5.1.8 | Urogenital System | 66 |
| 5.2 | Artifacts | 67 |
| 5.2.1 | Radiopharmaceuticals | 67 |
| 5.2.2 | Injection and Tourniquet Artifacts | 67 |
| 5.2.3 | Radioactivity Attenuation Artifacts | 70 |
| 5.2.4 | Soiling | 71 |
| | References | 71 |
| 6 | Infective and Inflammatory Diseases of Bone | 73 |
| 6.1 | Acute Osteomyelitis | 73 |
| 6.1.1 | Pathogenesis | 73 |
| 6.1.2 | Radiographic Manifestations | 74 |
| 6.1.3 | Pinhole Scintigraphic Manifestations | 76 |
| 6.2 | Subacute and Chronic Osteomyelitis | 77 |
| 6.3 | Acute and Chronic Infective Osteitis and Cortical Abscess ... | 83 |
| 6.4 | Acute Infective Periostitis | 86 |
| 6.5 | Special Forms of Osteomyelitis | 86 |
| 6.5.1 | Neonatal and Infantile Osteomyelitis | 86 |
| 6.5.2 | Sclerosing Osteomyelitis of Garre' | 88 |
| 6.5.3 | Brodie's Abscess | 89 |
| 6.5.4 | Osteomyelitis in Flat and Irregular Bones | 89 |
| 6.5.5 | Osteomyelitis in Diabetic Foot | 92 |
| 6.5.6 | Osteomyelitis of the Spine | 92 |
| 6.6 | Tuberculosis of Bone | 95 |
| 6.7 | ¹¹¹ In- and ^{99m} Tc-Leukocyte and ⁶⁷ Ga Citrate Scintigraphy in Skeletal Infections | 99 |
| | References | 102 |
| 7 | Noninfective Osteitides | 103 |
| 7.1 | Osteitis Condensans Ilii | 103 |
| 7.2 | Osteitis Pubis | 105 |
| 7.3 | Condensing Osteitis of the Clavicle | 106 |
| 7.4 | Sternocostoclavicular Hyperostosis | 108 |
| 7.5 | Infantile Cortical Hyperostosis (Caffey's Disease) | 111 |
| 7.6 | Osteitis Deformans (Paget's Disease of Bone) | 111 |

| | | |
|----------|---|-----|
| 7.7 | Odontogenous Osteitis of the Mandible (Periapical Abscess) | 111 |
| 7.8 | Radiation Osteitis (Osteonecrosis) | 113 |
| | References | 115 |
| 8 | Diseases of Joints and Soft-Tissue Infections | 117 |
| 8.1 | Sterile and Sympathetic Arthritis | 119 |
| 8.1.1 | Transient Synovitis of the Hip | 119 |
| 8.1.2 | Sympathetic Synovitis | 121 |
| 8.1.3 | Sterile Traumatic Synovitis | 124 |
| 8.1.4 | Synovitis in Renal Transplantation and Prolonged Hemodialysis | 124 |
| 8.2 | Infective Arthritis | 125 |
| 8.2.1 | Pyogenic Arthritis (Pyarthrosis) | 125 |
| 8.2.2 | Pyarthrosis and Abscess of the Sacroiliac Joint | 128 |
| 8.2.3 | Tuberculous Arthritis of Peripheral Joints | 131 |
| 8.3 | Soft-Tissue Infections | 135 |
| 8.3.1 | Subcutaneous Tissue Infections | 135 |
| 8.3.2 | Decubitus Ulcer (Bedsore) | 137 |
| | References | 138 |
| 9 | Degenerative Joint Diseases | 139 |
| 9.1 | Sacroiliac Joint | 144 |
| 9.2 | Hip | 145 |
| 9.3 | Knee | 146 |
| 9.4 | Patella | 149 |
| 9.4.1 | Patellar (Femoropatellar) Osteoarthritis | 149 |
| 9.4.2 | Chondromalacia Patellae | 149 |
| 9.5 | Ankle and Tarsal Joints | 151 |
| 9.6 | Shoulder | 153 |
| 9.6.1 | Acromioclavicular Joint | 153 |
| 9.6.2 | Glenohumeral Joint | 154 |
| 9.7 | Sternum | 156 |
| 9.7.1 | Sternoclavicular Joint | 156 |
| 9.7.2 | Manubriosternal Joint | 157 |
| 9.8 | Elbow | 157 |
| 9.9 | Wrist and Carpal Joints | 159 |
| 9.10 | Spine | 162 |
| 9.11 | Other Common Sites of Osteoarthritis | 169 |
| 9.11.1 | Symphysis Pubis | 169 |
| 9.11.2 | Metatarsal Sesamoid Bones | 169 |
| 9.11.3 | Navicular Accessory Bone | 169 |
| 9.12 | Generalized Osteoarthritis | 171 |
| 9.13 | Degeneration-Related Disorders of the Spine | 173 |
| 9.13.1 | Diffuse Idiopathic Skeletal Hyperostosis | 173 |
| 9.13.2 | Ossification of the Posterior Longitudinal Ligament | 174 |
| 9.13.3 | Schmorl's Cartilaginous Node | 177 |

| | | |
|-----------|--|------------|
| 9.13.4 | Limbus Vertebra | 177 |
| 9.13.5 | Spondylolysis | 179 |
| 9.13.6 | Spondylolisthesis | 181 |
| | References | 181 |
| 10 | Rheumatoid Arthritis | 183 |
| 10.1 | Hand (Fingers) | 187 |
| 10.2 | Wrist | 189 |
| 10.3 | Elbow | 192 |
| 10.4 | Shoulder | 193 |
| 10.5 | Sternum | 196 |
| 10.6 | Foot | 198 |
| 10.7 | Ankle and Tarsus | 198 |
| 10.8 | Knee | 201 |
| 10.9 | Hip | 203 |
| 10.10 | Sacroiliac Joint | 205 |
| 10.11 | Spine | 205 |
| 10.12 | Temporomandibular Joint | 207 |
| 10.13 | Insufficiency Fracture in Rheumatoid Arthritis | 210 |
| 10.14 | Juvenile Rheumatoid Arthritis | 210 |
| 10.15 | Nuclear Angiography in Rheumatoid Arthritis | 212 |
| 10.16 | Molecular Imaging in Rheumatoid Arthritis | 213 |
| 10.17 | ^{99m} Tc-FDG PET-CT in Rheumatoid Arthritis | 213 |
| | References | 215 |
| 11 | Seronegative Spondyloarthropathies | 217 |
| 11.1 | Ankylosing Spondylitis | 218 |
| 11.2 | Reiter's Syndrome | 223 |
| 11.3 | Psoriatic Arthritis | 231 |
| 11.4 | Enteropathic Arthropathies | 234 |
| | References | 235 |
| 12 | Other Rheumatic Osteoarthropathies and Soft-Tissue Rheumatism Syndromes | 237 |
| 12.1 | Sjögren's Syndrome | 239 |
| 12.2 | Behçet's Syndrome | 239 |
| 12.3 | Systemic Lupus Erythematosus | 243 |
| 12.4 | Gouty Arthritis | 245 |
| 12.5 | Charcot's Joint or Neuroarthropathy | 250 |
| 12.6 | Secondary Hypertrophic Osteoarthropathy | 250 |
| 12.7 | Periarticular Soft-Tissue Rheumatism Syndromes | 252 |
| 12.7.1 | Plantar Fasciitis | 257 |
| 12.7.2 | Degenerative Rheumatic Enthesopathy | 258 |
| 12.8 | Muscular and Musculotendinous Rheumatism Syndromes | 261 |
| 12.8.1 | Myositis Ossificans | 261 |

| | | |
|-----------|---|------------|
| 12.8.2 | Rhabdomyolysis | 263 |
| 12.8.3 | Musculotendinous Unit Strain or Injuries | 266 |
| 12.8.4 | Distal Femoral Cortical Irregularity | 267 |
| | References | 270 |
| 13 | Osteochondroses and Related Diseases | 271 |
| 13.1 | Legg-Calvé-Perthes Disease (Capital Femoral Epiphysis) ... | 271 |
| 13.2 | Friedrich's Disease (Medial Clavicular End) | 273 |
| 13.3 | Freiberg's Infraction (Metatarsal Head) | 274 |
| 13.4 | Osteonecrosis of the First Metatarsal Sesamoid | 275 |
| 13.5 | Scheuermann's Disease (Vertebral Secondary Ossification Center) | 276 |
| 13.6 | Sever's Disease (Calcaneal Apophysis) | 276 |
| 13.7 | Slipped Capital Femoral Epiphysis | 279 |
| 13.8 | Osteochondritis Dissecans | 280 |
| 13.9 | Tietze's Disease | 282 |
| | References | 283 |
| 14 | Vascular Bone Disorders | 285 |
| 14.1 | Avascular Osteonecrosis and Bone Infarction | 285 |
| 14.2 | Avascular Necrosis in Chronic Alcoholism | 287 |
| 14.3 | Vascularity-Related Osteoporosis | 290 |
| 14.4 | Reflex Sympathetic Dystrophy | 292 |
| 14.5 | Transient Regional Osteoporosis | 296 |
| 14.6 | Transient Osteoporosis with Bone Marrow Edema | 297 |
| 14.7 | Transient Indolent Bone Tracer Uptake | 298 |
| 14.8 | Periostitis in Vascular Insufficiency | 299 |
| | References | 301 |
| 15 | Metabolic Bone Diseases and Drug-Induced Osteoporosis | 303 |
| 15.1 | Involutional Osteoporosis | 305 |
| 15.2 | Disuse and Immobilization Osteoporosis | 307 |
| 15.3 | Osteodystrophy Associated with Hyperparathyroidism and Brown Tumor | 309 |
| 15.4 | Drug-Induced Osteoporosis | 312 |
| 15.5 | Rickets and Osteomalacia | 314 |
| | References | 317 |
| 16 | Traumatic, Surgical, and Sports Injuries of the Skeleton | 319 |
| 16.1 | Bone Fractures | 319 |
| 16.2 | Joint Sprain | 322 |
| 16.3 | Bone Contusion (Occult Intraosseous Fracture) | 328 |
| 16.4 | Stress Fractures and Related Peri- and Endosteal Reaction .. | 330 |

| | | |
|-----------|--|------------|
| 16.5 | Operative Bone Injuries | 333 |
| 16.6 | Postreduction Changes of Joint Subluxation and Dislocation | 334 |
| 16.7 | Arthroplasties and Fixation Devices | 337 |
| 16.8 | Healing of Bone Fracture | 339 |
| 16.9 | Assessment of Vascularized Bone Grafts | 343 |
| 16.10 | Complications of Traumatic Bone Injuries | 345 |
| 16.11 | Sports Injuries to Bone | 349 |
| 16.12 | Sports and Traumatic Injuries to Soft-Tissue Structures | 351 |
| | References | 357 |
| 17 | Malignant Tumors of Bone | 359 |
| | YONG-WHEE BAHK AND WON-JONG BAHK | |
| 17.1 | Metastasis | 359 |
| 17.1.1 | Bone Marrow Scintigraphy in Metastasis | 378 |
| 17.2 | Primary Malignant Bone Tumors | 380 |
| 17.2.1 | Osteosarcoma (Osteogenic Sarcoma) | 380 |
| 17.2.2 | Chondrosarcoma | 382 |
| 17.2.3 | Ewing's Sarcoma | 388 |
| 17.2.4 | Fibrosarcoma | 389 |
| 17.2.5 | Myeloma (Plasma Cell Myeloma) | 393 |
| 17.3 | Leukemias and Lymphomas | 397 |
| 17.4 | Chordoma | 399 |
| 17.5 | Periosteal Leiomyosarcoma | 400 |
| | References | 401 |
| 18 | Benign Tumors and Tumorous Conditions of Bone | 405 |
| 18.1 | Benign Bone Tumors | 405 |
| 18.1.2 | Osteoma | 405 |
| 18.1.3 | Osteoid Osteoma | 407 |
| 18.1.4 | Osteoblastoma | 407 |
| 18.1.5 | Enostosis (Compact Bone Island) | 410 |
| 18.1.6 | Enchondroma | 411 |
| 18.1.7 | Chondroblastoma | 416 |
| 18.1.8 | Fibrous Cortical Defect and Nonossifying Fibroma | 419 |
| 18.1.9 | Osteochondroma (Exostosis) | 422 |
| 18.1.10 | Primary Bone Cysts | 423 |
| 18.1.11 | Aneurysmal Bone Cysts | 426 |
| 18.1.12 | Giant Cell Tumors | 427 |
| 18.1.13 | Vertebral Hemangiomas | 429 |
| 18.1.14 | Periosteal Leiomyoma | 430 |
| 18.2 | Tumorous Conditions of Bone | 431 |
| 18.2.1 | Fibrous (or Fibro-osseous) Dysplasia | 431 |
| 18.2.2 | Fibro-osseous Pseudotumor of the Digits | 433 |
| 18.2.3 | Juxtacortical Fibromatosis (Desmoid Tumor of Soft Tissue) | 434 |
| 18.2.4 | Histiocytosis X (Langerhans Cell Histiocytosis) | 435 |
| 18.2.5 | Paget's Disease of Bone (Osteitis Deformans) | 440 |

| | | |
|-----------|---|------------|
| 18.2.6 | Neurofibromatosis (von Recklinghausen's Disease) | 446 |
| 18.2.7 | Enchondromatosis | 446 |
| 18.2.8 | Hereditary Multiple Exostoses | 448 |
| 18.2.9 | Osteopoikilosis | 450 |
| 18.2.10 | Osteopetrosis | 452 |
| | References | 452 |
| 19 | Soft-Tissue Tumors and Tumor-Like Conditions | 457 |
| | References | 467 |
| 20 | Otorhinological Disorders | 469 |
| 20.1 | Rhinosinusitis and Mucocoeles | 469 |
| 20.2 | Granulomatous and Similar Diseases | 472 |
| 20.3 | Maxillary Sinus Carcinoma | 472 |
| 20.4 | Malignant Tumors of the Nasal Cavity | 474 |
| 20.5 | Nasopharyngeal Carcinoma | 476 |
| 20.6 | Inflammatory Diseases of the Mastoidal Bones | 479 |
| | References | 481 |
| 21 | PET-CT in Bone and Joint Diseases | 483 |
| | SUNG-HOON KIM AND YONG-WHEE BAHK | |
| 21.1 | Tumors | 484 |
| 21.1.2 | Primary Tumors of Bone and Soft Tissue | 484 |
| 21.1.3 | Metastatic Bone Tumor | 486 |
| 21.1.3.1 | ¹⁸ F-FDG PET-CT Assessment of Therapeutic Response | 491 |
| 21.1.3.2 | Flare phenomenon | 492 |
| 21.2 | Infectious Diseases | 493 |
| 21.3 | Rheumatoid Arthritis | 495 |
| 21.4 | Fractures | 496 |
| | References | 496 |
| 22 | A Genetic Consideration of Skeletal Disorders | 499 |
| | YONG-WHEE BAHK AND SOO-KYO CHUNG | |
| 22.1 | Essential Bioanatomy of the Musculoskeletal System | 502 |
| 22.2 | ^{99m} Tc-MDP Bone Scintigraphic Techniques | 502 |
| 22.3 | ^{99m} Tc-MDP Bone Scintigraphy in Autosomal and Polygenic Bone Disorders | 502 |
| 22.3.1 | Autosomal Skeletal Disorders | 503 |
| 22.3.1.1 | Albers-Schönberg's Disease | 503 |
| 22.3.1.2 | Hereditary Multiple Exostoses | 503 |
| 22.3.2 | Polygenic Skeletal Disorders | 504 |

| | | |
|------------|---|-----|
| 22.3.2.1 | Rheumatoid Arthritis | 504 |
| 22.3.2.2 | Ankylosing Spondylitis | 506 |
| 22.3.2.3 | Reiter's Syndrome | 506 |
| 22.4 | Other HLA-associated Skeletal Disorders | 507 |
| 22.4.1 | Reactive Arthritis | 508 |
| 22.4.2 | Diffuse Idiopathic Skeletal Hyperostosis (Forestier's Disease) | 508 |
| 22.4.3 | Slipped Capital Femoral Epiphysis | 509 |
| 22.4.4 | Calcific Periarthritis (Hydroxyapatite Crystal Deposition Disease) | 509 |
| 22.5 | Non-genetic Skeletal Disorders | 510 |
| References | | 511 |

Appendix: Basic Physics of Pinhole Scintigraphy 513

TAE SUK SUH AND YONG-WHEE BAHK

| | | |
|------------|--|-----|
| A.1 | Factors Affecting Scintigraphic Imaging | 513 |
| A.1.1 | Radionuclides | 513 |
| A.1.2 | Radioactivity | 513 |
| A.1.3 | Collimator Design | 514 |
| A.1.4 | Scintillation Detector | 514 |
| A.1.5 | Electronic Devices | 515 |
| A.1.6 | Image Display and Recording Devices | 516 |
| A.1.7 | Image Data Processing | 516 |
| A.1.8 | Movement of Patient | 516 |
| A.1.9 | Artifacts | 517 |
| A.2 | Effects of Pinhole Collimator Design | 517 |
| A.2.1 | Spatial Resolution | 517 |
| A.2.2 | Sensitivity | 518 |
| A.2.3 | Measurement of Spatial Resolution | 519 |
| A.2.4 | Measurement of Sensitivity | 520 |
| A.3 | Technical Factors of Pinhole Scintigraphy | 520 |
| A.3.1 | Pinhole Magnification | 520 |
| A.3.2 | Acquisition Time for Various Aperture Sizes | 521 |
| A.3.3 | Acquisition Time for Various Aperture-to-Object Distances | 522 |
| References | | 523 |

Subject Index 525

Combined Scintigraphic and Radiographic Diagnosis of
Bone and Joint Diseases

Bahk, Y.-W.

2007, XX, 538 p. 1398 illus., 16 illus. in color.,

Hardcover

ISBN: 978-3-540-22880-6