om, for detailed information on orthopedics books, visit our website www.ejaypee.com, for detailed information on orthopedics books

Essential Orthopedics
Principles & Practice

Volume 1

- Complete incorporation of AI, ML, and Industry 5.0 principles across all disorders
- Exhaustive coverage from basic science to technology-integrated management
- Concept Boxes for advanced topics
- Dedicated clinical practice points for Spine and Upper Extremity



Dr. Wise
Innovative & Genius
AI Chatbot
access code inside

Manish Kumar Varshney

4TH EDITION

JAYPEE

JAYPEE BROTHERS

Contents

VOLUME 1

SECTION 1 Bone Anatomy, Physiology, Pathology, and Related Diseases

1. Bone as a Living Organ: Structure, Development, Physiology, and Systemic Metabolism 3

Manish Kumar Varshney

- Bone Structure *3*
- Functions of Bone *5*
- Classification of Bone by Appearance *5*
- Gross Anatomical Regions *7*
- Microscopic Anatomy *7*
- Cellular Elements of Bone *8*
- Blood Supply of Bone *15*
- Nerve Supply of Bone *17*
- Bone Development *18*
- Structure of Physis (Growth Plate) *20*
- Composition and Structure of Bone Matrix *23*
- Process of Bone Mineralization *27*
- Bone Remodeling *29*
- Regulation of Bone Metabolism *32*
- Endocrinopathies and Bone Involvement *36*
- Bone in Health and Disease *39*
- Systemic Biology of Bone (Holistic Vision of Bone Biology) *44*

2. Fracture Repair, Bone Grafting, and Bone Banking 52

Manish Kumar Varshney

- Definition and Classification *52*
- Physiology of Fracture Repair *55*
- Important Determinants of Fracture Repair *65*
- Laws Associated with Fracture Repair and Bone Remodeling *67*
- Combined Interpretation of Concepts *72*
- Bone Banking *88*

3. Metabolic Diseases of Bone.....92

Manish Kumar Varshney

Osteoporosis *92*

- Definition *93*
- Operational Definition of Osteoporosis *93*
- Problem Statement, Prevalence, and Incidence *94*
- Natural History of Bone Mass Changes in Human Body, Operational Definition of Osteoporosis, and Its Classification *96*
- Classification of Osteoporosis *97*
- Genetics of Osteoporosis *100*
- Analysis of Bone Mineral Density *100*
- Risk Factors for Low Bone Mineral Density and Fracture Risk Assessment *106*
- Diagnosis of Osteoporosis *112*
- Prevention and Treatment of Osteoporosis *114*
- Nonpharmacological Management: Foundation of Care *114*
- Pharmacological Therapy *115*
- Antiresorptive Agents *116*
- Adverse Effects and Therapeutic Monitoring *125*
- Management of Treatment Failure *127*
- Modern Treatment Strategy: Sequencing and Combination *128*
- Future Directions: Precision Medicine and Beyond *128*
- Surgical Management of Fragility Fractures *131*
- Atypical Forms of Osteoporosis *135*

Diseases of Osteoclastic Dysfunction *138*

- Paget's Disease of Bone *138*
- Osteopetrosis (Marble Bone Disease, Albers–Schönberg Disease) *140*

Bone Mineral and Vitamin D Disorders *144*

- Rickets and Related Disorders *144*
- Nutritional Deficiency of Vitamin D *146*
- Secondary Vitamin D Deficiency *147*
- Calcium Deficiency Rickets *147*
- Vitamin D-dependent Rickets Types 1, 2, and 3: Description and Differentiation *148*
- Rickets in Chronic Kidney Disease (Renal Osteodystrophy) *152*
- Hypophosphatasia *152*
- Osteomalacia *154*
- Scurvy *156*
- Fluorosis *157*

Inborn Errors of Metabolism Affecting Bones *158*

- Gaucher's Disease *158*
- Mucopolysaccharidoses *160*

JAYPEE BROTHERS

4. **Infections of Bone (Typical and Atypical) and Surgical Site Infection 163**
Manish Kumar Varshney
- History and Epidemiology: A Modern Context *164*
- Osteomyelitis: A Modern Paradigm Shift from Infection to Biofilm Disease *164*
- Pathogenesis *167*
- Diagnosis *177*
- Modern Diagnostic Algorithm *184*
- Principles of Therapy *184*
- Adjuvants and Innovative Strategies for Managing Osteomyelitis *202*
- Complications of Osteomyelitis *202*
- Prevention of Exogenous Bone Infection *203*
- Some Special Forms of Osteomyelitis *205*
- Actinomycosis *212*
- Mycetoma (Maduramycosis) *214*
- Surgical Site Infection *216*

5. **Orthopedic Oncology (Bone Tumors and Metastasis) and Heterotopic Ossification 219**
Manish Kumar Varshney
- Staging *219*
- Clinical Evaluation *223*
- Physical Examination *224*
- Radiological Evaluation *225*
- Grading of Bone Tumors *234*
- Laboratory Evaluation and Molecular Diagnostics *237*
- Treatment *241*
- Adjuvant Therapy *251*
- Radiotherapy *253*
- Benign and Malignant Bone Neoplasms *256*
- Cartilage Forming Lesions *288*
- Fibrous Lesions *302*
- Giant Cell Tumor *304*
- Benign Fibrous Histiocytoma *310*
- Undifferentiated Pleomorphic Sarcoma Previously Malignant Fibrous Histiocytoma *310*
- Plasma Cell Myeloma *311*
- Langerhans Cell Histiocytosis/Eosinophilic Granuloma *315*
- Malignant Lymphoma of Bone (Primary Bone Lymphoma) *316*
- Ewing's Sarcoma *318*
- Fibrous Dysplasia *321*
- Osteofibrous Dysplasia (Campanacci's Disease) *324*
- Adamantinoma *326*
- Chordoma *327*
- Vascular Lesions of Bone *328*
- Metastatic Disease of Bone *333*
- Musculoskeletal Soft-Tissue Tumors *349*
- Tumor and Tumor-like Conditions of Fibroblasts/Myofibroblasts *349*
- Common Fibrous Tumors of Infancy and Childhood *351*
- Heterotopic Ossification *356*

6. **Osteonecrosis and Osteochondrosis 366**
Manish Kumar Varshney
- Osteonecrosis *366*
- Osteonecrosis of Femoral Head *372*
- Osteonecrosis of the Distal Femur (Femoral Condyles) *393*
- Osteonecrosis of Talus *398*
- Kienböck's Disease (Lunatomalacia) *411*
- Osteonecrosis of Scaphoid and Preiser's Disease *422*
- Osteochondrosis *428*
- Osteochondritis Dissecans of the Talus *435*
- Caisson Disease *438*

SECTION 2 Joint: Structure, Function, and Related Disorders

7. **Joints of Skeleton, Synovial Joint Structure and Function 445**
Manish Kumar Varshney
- Definition *445*
- Functions *445*
- Joint Classification *445*
- Kinematic Classification and Movements at Different Types of Synovial Joints *448*
- Synovial Joint *450*
- Differentiation of Inflammatory, Noninflammatory, and Infectious Effusion *454*
- Traumatic Arthrotomy *455*

8. **Disorders of Synovium..... 458**
Manish Kumar Varshney
- Synovial Proliferative and Neoplastic Disorders *458*
- Iatrogenic and Post-surgical Synovial Pathologies *472*
- Metabolic and Systemic Synovial Involvement *477*

9. **Articular Cartilage: Structure, Function, Injury, and Management 486**
Manish Kumar Varshney
- Structure and Composition *486*
- Zonal Organization and Biomechanical Function *487*
- Biomechanical Properties *488*
- The Extracellular Matrix *489*
- Metabolism and Regulation *491*
- Biomechanics of Articular Cartilage *492*
- Lubrication and Wear (Synovial Joint Lubrication) *494*
- Effects of Injury *495*
- Osteochondritis Dissecans *496*
- Methods to Repair or Reconstruct Focal Cartilage Defects *501*
- Scaffolds *513*
- Particulated Juvenile Cartilage: The DeNovo® NT Platform *514*
- Gene Therapy in Cartilage Tissue Engineering *516*
- Chondrocyte Culture and Coculture System *518*
- Arthritis *521*

JAYPEE BROTHERS

10. Joint Disorders Including Inflammatory and Noninflammatory Arthritis and Infective Arthritides (Including Mycobacterial Infection and Prosthetic Joint Infection) 521

Manish Kumar Varshney

- Arthritis *521*

Osteoarthritis (Osteoarthrosis, Arthrosis, and Degenerative Joint Disease) *521*

- Etiopathobiology *521*
- Epidemiology *523*
- Etiology *523*
- Pathophysiology and Pathogenesis: A Dynamic Failure of the Osteochondral Unit *526*
- Microstructural Progression of Osteoarthritis *527*
- Tissue Biomarkers of Osteoarthritis *528*
- Clinical Features and Diagnosis *529*
- Clinical Staging of Osteoarthritis *530*
- Investigations *531*
- Differential Diagnosis *532*
- Acute Complications of Osteoarthritis *534*
- Variants of Primary Osteoarthritis *534*
- Chondromalacia Patellae (Chondropathy) *536*
- Treatment of Osteoarthritis *537*
- Arthroscopic Debridement: A Narrowed Indication *539*
- Osteotomy: The Principle of Joint Preservation *539*

Total Knee Arthroplasty *550*

- History *551*
- Contemporary Knee Designs *551*
- Goals of Total Knee Replacement *553*
- Principles of Total Knee Replacement *553*
- Complications of Total Knee Replacement *563*

Contemporary Interventional Techniques to Manage Chronic Knee Pain *566*

Calcium Pyrophosphate Dihydrate Crystal Deposition Disease (CPPD Disease or Arthropathy, Pseudogout, Chondrocalcinosis, and Pyrophosphate Arthropathy) *567*

- Calcium Pyrophosphate Dihydrate Crystal Deposition Disease *567*

Hemophilic Arthropathy *576*

- Pathogenesis and Natural History *576*
- Clinical Features *577*
- Extra-articular Manifestations *577*
- Radiology *579*
- Conventional Radiography: Core Findings and Staging *579*
- Treatment *581*

Ochronosis (Alkaptonuria) *582*

- Pathophysiology *583*
- Clinical Features *584*
- Diagnostic Evaluation *585*
- Treatment *585*

Rheumatoid Arthritis *586*

- Etiology *587*
- Pathogenesis *587*
- Serological Biomarkers *588*
- Other Laboratory Abnormalities *589*
- Clinical Features and Diagnosis *589*
- Differential Diagnosis *591*
- Treatment *591*

Seronegative Spondyloarthropathies *600*

- Ankylosing Spondylitis (Marie–Strumpell Disease, Morbus Bechterew Disease) *600*
- Psoriatic Arthritis *609*
- Enteropathic Arthritis, Reactive Arthritis, and Undifferentiated and Juvenile-Onset Spondyloarthropathy *612*
- Neuropathic Arthropathy [Charcot's Joints, Charcot's Arthropathy, Charcot's Neuroarthropathy] *613*

Septic Arthritis *618*

- Septic Arthritis of Hip in Children and Its Sequel *623*
- Differential Diagnosis of Septic Arthritis of Hip *625*
- Complications and Sequelae *627*
- Late Sequel of the Septic Arthritis Hip in Infants *627*
- Classification Systems for Sequelae *627*
- Principles of Reconstructive Surgery *629*
- Description of Reconstructive Procedures *630*
- Management Algorithms *632*

Prosthetic Joint Infection *632*

- Classification *632*
- Microbiology and Pathophysiology *633*
- Diagnosis *634*
- Laboratory Evaluation *634*
- Histologic and Scoring Criteria *634*
- Imaging *636*
- Treatment *637*

Mycobacterial (Tubercular) Arthritis *640*

- Microbiology *640*
- Pathology and Pathogenesis *641*
- Clinical Types of Tubercular Arthritis *641*
- Clinical Features *641*
- Radiologic Findings *642*
- Diagnosis *642*
- Treatment *644*
- Essential First-Line Drugs *647*
- Tuberculosis of Hip Joint *648*

Human Immunodeficiency Virus-Associated Musculoskeletal Conditions *655*

- Overview *655*
- Bacterial and Fungal Arthritis *655*
- Atypical Mycobacterial Infections *655*
- Human Immunodeficiency Virus-Associated Arthritides *655*
- Osteonecrosis *656*
- Painful Articular Syndrome *656*
- Other Manifestations *656*
- Spirochetal Arthritis (Syphilitic) *656*

Gout ("Podagra"), Rich Man's Disease, and Disease of the Kings *656*

- Historical and Conceptual Overview *656*
- Epidemiology and Demographics *657*

JAYPEE BROTHERS

- Role of Hyperuricemia *657*
- Clinical Features *659*
- Diagnosis *660*
- Radiology *661*
- Differential Diagnosis *662*
- Treatment *662*

Nondestructive and Nonproductive Arthropathies *664*

- Systemic Lupus Erythematosus *664*
- Systemic Sclerosis (Scleroderma) *664*
- Ehlers–Danlos Syndrome *665*
- Acute Rheumatic Fever *665*

SECTION 3 Basic Sciences

11. Biostatistics, Ethics, and Research Methods 669

Manish Kumar Varshney

- Evidence-Based Medicine *669*
- Basic Terminologies and Definitions *671*
- Statistical Inference and Decision Analysis *671*
- Measurement Scales *671*
- Derived Data *672*
- Censored Data *673*
- Bias and Confounding in Clinical Research *673*
- Confounding *674*
- Biostatistics *675*
- Randomized Controlled Trial Principles and Procedure *677*
- Sampling *681*
- Randomization *681*
- Blinding and Bias Control in Orthopedic Clinical Trials *682*
- Data Collection and Quality Control in Orthopedic Studies *682*
- Descriptive Statistics *683*
- Concept of Probability and Distribution *686*
- Parametric and Nonparametric Tests *687*
- Analysis of Continuous Variables in Orthopedics *689*
- Nonparametric Analysis (Analysis of Categorical Variable) *691*
- Hypothesis Testing (The *P*-Value Approach) *694*
- Reporting Standards and Research Methodology *695*
- Levels of Evidence *697*
- Some Essentials for Young Investigators and Researchers *698*

12. Biomechanics in Orthopedics: General Principles 702

Manish Kumar Varshney

- Statics *703*
- Deformable Body Mechanics *705*
- Dynamics *707*
- Instant Center of Rotation *707*

13. Biomaterials and Bioengineering in Orthopedics and their Application 710

Manish Kumar Varshney

- Biological Properties: From Inertness to Immunomodulatory Bioactivity *710*
- Mechanical Properties: Computational Prediction and Adaptive Performance *710*
- Evolution of Orthopedic Biomaterials: From Inert to Regenerative and Responsive *711*
- Metals and their Alloys: Engineering Metallic-Microenvironment Interface *712*
- Polymers: From Bearings to Bioresorbable Scaffolds *713*
- Ceramics: Engineering Precision for Bearing Surfaces *714*
- Composites: Synergistic Materials for Mimicking Nature *715*
- Osteointegration of Biomaterials: From Passive to Active Biointegration *715*
- Bioengineering Principles in Orthopedics *715*
- Applications in Orthopedics *717*
- Clinical Considerations *720*
- Emerging Frontiers *720*
- Standards and Governance for Orthopedic Biomaterials *721*

14. Tribology and Bearing Surfaces 723

Manish Kumar Varshney

- Historical Perspective *723*
- Problem Statement *724*
- Tribology of Articulating Surfaces *725*
- Bearing Surfaces for Total Hip Arthroplasty *737*
- Polyethylene: The Foundation of Modern Bearing Surfaces *740*
- Metal-on-Metal Bearings: A Tribological and Biological Case Study *743*
- Ceramic Bearings: The Pinnacle of Wear Resistance *745*
- New Horizons in Bearing Surfaces *747*

15. Poly(Methyl Methacrylate) (Plexiglass, Bone Cement, and Acrylic Bone Cement) 752

Manish Kumar Varshney

- History of Development of Bone Cement *752*
- Effect of Various Factors on Cement Polymerization and Mantle Integrity *755*
- Advancements in Cement Mixing and Delivery *755*
- Evolution and Modern Principles of Cementing Techniques *756*
- Assessment of Cement Mantle Quality *757*
- Physical Properties of Cement *758*
- Adverse Effects/Complications of Bone Cement *759*
- Advancements and Future Directions in Bone Cement Technology *761*

JAYPEE BROTHERS

16. Regenerative Medicine and Stem Cell Research in Orthopedics..... 764
Manish Kumar Varshney
- Fundamental Concepts *764*
- Sources and Harvesting of Stem Cells *765*
- Mechanisms of Action *766*
- Biomaterials and Scaffolds in Regenerative Orthopedics *766*
- Preclinical Models and Experimental Evidence *767*
- Clinical Applications in Orthopedics *767*
- Current Clinical Trials and Evidence *770*
- Ethical, Legal, and Regulatory Considerations *770*
- Challenges and Limitations *770*
- Future Directions *770*
- Stem Cell Banking and Societal Integration *771*

17. Nanofiber Electrospinning and Three-Dimensional Printing: Emerging Paradigms in Orthopedic Tissue Engineering..... 774
Manish Kumar Varshney
- Nanofiber Electrospinning: Mimicking the Native Extracellular Matrix *774*
- Three-Dimensional Bioprinting: Precise Construction of Complex Tissues *775*
- Integrating Electrospinning and 3D Printing: From Scaffold Design to Clinical Translation *777*
- Clinical Translation and Current Applications in Orthopedics *778*
- Future Directions and the Convergence of Technologies *779*

18. Gene Therapy in Orthopedics 781
Manish Kumar Varshney
- Use of Different Vectors and Strategies for Gene Transfer in Orthopedics *781*
- Newer Approach: Nanoparticles and Nanotechnology *785*
- Gene Therapy Using RNA Interference *787*
- New Vectors and Strategies for Stable and Safe Gene Modification *787*
- Targeted Gene Delivery *789*
- Gene Therapy Applications for the Musculoskeletal System *790*

19. Wound Ballistics 793
Manish Kumar Varshney
- Classification *794*
- Modern Principles of Management *796*
- Joint Injury and Lead Toxicity *797*
- Blast Injuries *797*
- International Humanitarian Law *799*

20. Wound Healing and Principles of Wound Care..... 801
Manish Kumar Varshney
- Coagulation *801*
- Inflammatory Phase *802*
- Proliferative Phase *802*
- Remodeling Phase *803*
- Factors Affecting Wound Healing *803*
- Coverage of Surgical or Injury Wound *804*
- Primary Methods of Wound Closure *804*
- Flap-Based Wound Closure *805*
- Skin Substitutes and Bioengineered Coverage Materials *805*
- Fillet Flaps *805*
- Negative Pressure Wound Therapy (VAC®) *806*
- Choice of Suture Material *808*
- Wound Dressings and Dressing Materials *810*
- Managing Wound Contracture: Z-Plasty *810*
- Soft-Tissue Coverage in Orthopedics *812*
- Rotational Myocutaneous Flaps: Orthopedic Workhorse *821*
- Reconstruction of Proximal Third Leg *822*
- Reconstruction of Soft-Tissue Defects in Middle Third Region of Leg *824*
- Reconstruction of Distal Third Region of Leg *827*
- Fasciocutaneous Flaps: Distal Leg Workhorses *828*
- Evolving Paradigm: Free Tissue Transfer *828*
- Microvascular Free Flaps *829*
- Anterolateral Thigh Flap *835*
- Groin Flap (Mcgregor and Jackson, 1972) *836*
- Dorsalis Pedis Flap *837*
- Advanced Flap Categories *837*
- Pressure Sores (Bed Sores, Pressure Ulcers) *839*
- Comprehensive Management Strategies *840*
- Surgical Management and Reconstructive Principles *842*

21. Gait 845
Manish Kumar Varshney
- Definition *845*
- The Gait Cycle: Traditional and Contemporary Models *846*
- Instrumented Gait Analysis and Quantitative Assessment *850*
- Factors Affecting Gait *853*
- Clinical Examination and Types of Pathological Gait *855*
- Pathological Gait Patterns: Mechanisms and Compensation *856*

22. Tourniquet in Orthopedics 865
Manish Kumar Varshney
- Types of Tourniquets in Current Practice *865*
- Principles of Safe Tourniquet Application *865*
- Application Technique and Anatomical Considerations *867*
- Determining Optimal Tourniquet Pressure *867*
- Tourniquet duration and Ischemic Tolerance *868*
- Systemic Effects of Tourniquet Application *869*
- Local Tissue Effects and Injury Mechanisms *870*
- Ischemia-Reperfusion Injury *871*
- Complications of Tourniquet Use *871*

JAYPEE BROTHERS

- Tourniquet Pain and Tourniquet-Induced Hypertension *873*
- Contraindications and Special Considerations *873*
- Drug Kinetics and Tourniquet Use *873*
- Digital Tourniquets *874*
- Alternatives to Tourniquet Use *874*
- Emerging Technologies and Future Directions *874*

23. Preoperative Evaluation, Patient Optimization, and Pain Management in Orthopedic Patient 876

Manish Kumar Varshney

- Surgical Stress Response and Types of Anesthesia *876*
- Pre- and Perioperative Risk Assessment *877*
- Combined Risk Assessment *877*
- Presurgical Evaluation *878*

Patient Optimization *878*

- Obesity: A Sentinel Peril in Orthopedics *878*
- Diabetes *883*
- Malnutrition *884*
- Tobacco Use *884*
- Alcohol and Drug Abuse *885*
- Rheumatological Diseases *885*

Pain Management in Orthopedic Patient *886*

- Definition *886*
- Types of Pain *886*
- Neurobiology of Pain Transmission and Modulation *887*
- Gate Control Theory–Historical Foundation and Modern Evolution *887*
- Postoperative Pain and its Management *888*
- Methods for Postoperative Pain Control *891*
- Drugs Used for Postoperative Pain Control *893*
- Foot and Ankle Surgery *896*

24. Polytrauma, Mass Casualties, and Disaster..... 899

Manish Kumar Varshney

- Definitions *899*
- Epidemiology *901*
- Etiology and Pathophysiology *901*
- Initial Assessment and Triage *903*
- Principles of Management of Orthopedic Injury Damage Control Orthopedics *905*
- Modern Hybrid Concepts in Polytrauma Orthopedics *908*
- Definitive Management *909*
- Complications *912*
- Principles of Managing Disasters *912*
- Medical Response Teams and Field Hospital Innovation *915*
- Hospital Preparedness and Surge Capacity *916*
- Scene Safety and Hazard-Specific Response *916*
- Evacuation and Continuity of Care *916*

25. Role of Radiology and Radiomics in Orthopedics and Radiation Hazard 917

Manish Kumar Varshney

- Conventional Radiography *917*
- Computed Tomography *921*
- Role of Ultrasonography in Orthopedics *924*
- Role of Magnetic Resonance Imaging in Orthopedics *932*
- Role of Isotope Bone Scan and Positron Emission Tomography Scan in Orthopedics *944*
- Radiomics in Musculoskeletal Imaging: Quantitative Image Phenotyping *948*
- Radiation Hazard and Personnel Safety *951*

SECTION 4 Surgical and Medical Complications in Orthopedics

26. Venous Thromboembolism: Prophylaxis and Treatment..... 957

Manish Kumar Varshney

- Definitions *957*
- Epidemiology *957*
- Pathophysiology: Beyond Virchow's Triad *958*
- Anatomy and Pathophysiology *958*
- Development of Thrombosis and Balancing Mechanisms *959*
- Pathogenesis of Deep Venous Thrombosis: From Stasis to "Inflammothrombosis" *959*
- Etiology and Risk Factors for Deep Vein Thrombosis *962*
- Clinical Features *963*
- Diagnosis *965*
- Potential Complications of Deep Vein Thrombosis *967*
- Differential Diagnosis *971*
- Treatment of Deep Vein Thrombosis *971*
- Pharmacologic Management: From Anticoagulation to Thrombolysis *971*
- Prophylaxis of Deep Venous Thrombosis *977*
- Procedure-Specific Guidelines and Perioperative Integration *982*
- Perioperative Management of Anticoagulation *984*
- Upper Extremity Deep Vein Thrombosis *985*

27. Compartment Syndrome 992

Manish Kumar Varshney

- Etiopathogenesis *993*
- Clinical Evaluation *998*
- Natural History and Diagnosis *1001*
- Measurement of Intracompartmental Pressure *1003*
- Differential Diagnosis *1005*
- Management Principles *1005*
- Surgical Technique *1008*

JAYPEE BROTHERS

- Concurrent Fracture Stabilization: Damage Control Philosophy *1010*
- Chronic Compartment Syndrome *1011*
- Compartment Syndrome in Children *1017*

28. Fat Embolism Syndrome 1021

Manish Kumar Varshney

- Historical Perspective *1021*
- Epidemiology and Risk Stratification *1021*
- Pathophysiology: An Integrated Contemporary Model *1022*
- Clinical Presentation and Diagnostic Evaluation *1022*
- Management: A Contemporary Evidence-Based Hierarchy *1023*
- Prognosis and Long-Term Outcomes *1024*

29. Acute Respiratory Distress Syndrome 1026

Manish Kumar Varshney

- Evolution of Definition and Phenotyping *1026*
- Pathophysiology *1027*
- Etiology *1028*
- Presentation and Physical Findings *1028*
- Workup *1028*
- Differential Diagnosis *1029*
- Treatment *1029*
- Prevention *1030*

30. Systemic Inflammatory Response Syndrome and Multiorgan Dysfunction 1031

Manish Kumar Varshney

- Pathophysiology *1032*
- Multi-Hit Theory *1033*
- Clinical Examination and Work-up *1033*
- Treatment: A Phased, Phenotype-Driven Approach *1034*
- Complications *1034*

Multiple Organ Dysfunction Syndrome (Multiple Organ Failure and Multisystem Organ Failure) *1034*

- Definition *1034*
- Etiology *1035*
- Pathophysiology *1036*
- Clinical Presentation and Organ-Specific Manifestations *1036*
- Diagnostic Strategy *1037*
- Prevention: The Orthopedic Surgeon's Primary Role *1037*
- Treatment Principles: Support, Source Control, and Immunomodulation *1037*
- Prognosis and the Role of Predictive Analytics *1038*

31. Shock 1040

Manish Kumar Varshney

- Classification and Pathophysiology: From Macrocirculation to Cellular Dysoxia *1041*
- Clinical Manifestations and Advanced Assessment *1043*
- Management: A Phased, Physiology-Driven Resuscitation Algorithm *1043*
- Monitoring and Endpoints of Resuscitation: Beyond Vital Signs *1045*

32. Transfusion Medicine 1048

Manish Kumar Varshney

- Blood Group Systems *1048*
- Detection of Blood Group Antibodies *1050*
- Blood and Blood Products *1050*
- Clinical Use of Blood and Blood Components *1051*
- Adverse Reactions to Blood Transfusion *1054*
- Patient Blood Management: The Three-Pillar Framework *1055*
- Viscoelastic Hemostatic Assays in Orthopedic Surgery *1055*
- Alternatives To Blood Component Therapy *1058*
- Blood Substitutes *1060*

33. Complex Regional Pain Syndrome 1062

Manish Kumar Varshney

- Definition *1062*
- History and Nomenclature *1062*
- Epidemiology *1063*
- Types of Complex Regional Pain Syndrome *1063*
- Pathophysiology *1064*
- Symptoms/Clinical Presentation *1065*
- Diagnosis *1066*
- Differential Diagnosis of Complex Regional Pain *1068*
- Treatment *1068*
- Prognosis *1070*
- Complex Regional Pain Syndrome in Children *1072*

34. Neurogenic Lower Urinary Tract Dysfunction 1073

Manish Kumar Varshney

- Definition *1073*
- Anatomy and Neuroanatomy of Lower Urinary Tract *1073*
- Pathophysiology and Etiology *1074*
- Classification *1075*
- Investigations *1075*
- Treatment and Management *1076*
- Prognosis and Follow-up *1077*
- Pediatric Considerations *1077*
- Prevention *1077*

35. Necrotizing Fasciitis 1078

Manish Kumar Varshney

- Etiology *1078*
- Pathophysiology *1079*
- Clinical Features and Diagnostics *1079*
- Treatment *1081*
- Prognosis *1081*
- Prevention *1082*

JAYPEE BROTHERS

36. Thoracic Outlet Syndrome 1083
Manish Kumar Varshney
- History *1083*
- Definition *1083*
- Anatomy *1083*
- Epidemiology *1084*
- Etiology and Pathophysiology *1084*
- Clinical Presentation *1084*
- Physical Examination *1085*
- Differential Diagnoses for Thoracic Outlet Syndrome *1086*
- Diagnostic Work-up *1086*
- Treatment *1087*
- Complications *1087*

37. Nonunions and Malunions 1089
Manish Kumar Varshney
- Epidemiology and Burden of Nonunion *1090*
- Pathogenesis *1091*
- Systemic and Local Risk Factors *1092*
- Mechanisms of Healing Failure *1092*
- Pathogenesis Linked to Nonunion Type *1092*
- Diagnosis *1093*
- Clinical Assessment *1093*
- Investigations for Nonunion *1094*
- Classification, Staging, and Scoring *1095*
- Classification *1096*
- Scoring *1097*
- Treatment *1098*
- Emerging and Advanced Therapies *1103*
- Nonunions with Retained Implants *1103*
- The Principle of Distraction Osteogenesis and its Application to Nonunion of Long Bones *1104*
- Scaphoid Fracture and Nonunion *1110*
- Scaphoid Nonunion *1119*
- Femoral Neck Nonunion *1128*
- Pathogenesis of Nonunion: A Multifactorial Etiology *1129*
- Definition of Nonunion *1130*
- Diagnosis and Imaging of Femoral Nonunion *1130*
- Classification *1131*
- Malunion *1139*
- Malunited Femoral Shaft Fracture *1150*
- Malunion Distal Radius Fracture *1156*
- Complications *1159*
- Cubitus Varus Deformity *1159*

VOLUME 2

SECTION 5 Pediatric Orthopedics

38. Congenital, Genetic, Syndromic, and Miscellaneous Disorders 1171
Manish Kumar Varshney
- The Diagnostic Shift: From Phenotype to Genotype *1172*
- Technological Integration and Future Directions *1172*
- Torticollis *1173*
- Ehlers–Danlos Syndrome *1179*
- Osteogenesis Imperfecta *1183*
- Marfan Syndrome *1189*
- Trisomy 21 (Down Syndrome) *1193*
- Turner Syndrome *1195*
- Disorders Caused by Abnormalities in Tumor-Related Genes *1197*
- Fibroblast Growth Factor Receptor 3 Skeletal Dysplasia Spectrum *1199*
- Disorders Related to Type II Collagen Abnormalities *1203*
- Disorders Caused by Abnormalities in Genes Important in Normal Skeletal Development *1206*
- Disorders Caused by Abnormalities in Genes that Play a Role in the Processing of Proteins *1208*
- Other Skeletal Dysplasias *1209*
- Some Miscellaneous Syndromes *1210*
- Pterygia Syndrome *1217*
- Fetal Alcohol Syndrome *1218*
- Genetic Imprinting Disorders and Related Syndromes *1219*
- Beckwith–Wiedemann Syndrome *1220*
- Trichorhinophalangeal Syndromes I and II *1220*
- Progeria (Hutchinson–Gilford Syndrome) *1221*
- Rubinstein–Taybi Syndrome *1222*
- Congenital Constriction Band Syndrome *1223*
- Sclerosing Bone Dysplasias and Related Disorders *1225*

39. Poliomyelitis and Postpoliomyelitis Sequelae 1231
Manish Kumar Varshney
- Pathology *1231*
- Clinical Features of an Acute Attack of Polio *1233*
- Management: A Staged, Principle-Based Approach *1234*
- General Rules for Tendon Transfer in Foot *1237*
- Paralysis of Specific Muscle and Muscle Groups and Functiolesia (Modified from Peabody) *1237*
- Paralysis of Inversion *1237*
- Paralysis of Dorsiflexion and Inversion (Tibialis Anterior, Tibialis Posterior, and Toe Extensors) *1238*
- Paralysis of Dorsiflexion, Inversion, and Eversion *1239*
- Paralysis of Plantar Flexion (Triceps Surae) *1239*

JAYPEE BROTHERS

- Stabilization of Joints of Foot and Ankle *1240*
- Claw Toes *1241*
- Dorsal Bunion *1243*
- Cavus Deformity and Claw Toes *1244*
- Talipes Equinus *1247*
- Talipes Equinovarus *1251*
- Talipes Cavovarus *1252*
- Talipes Equinovalgus *1252*
- Talipes Calcaneus *1253*

40. Cerebral Palsy and Inherited Neuromuscular Disorders 1255

Manish Kumar Varshney

- Cerebral Palsy *1255*
- Classification of Activity Limitation and Assessment *1257*
- Clinical Assessment of a Cerebral Palsy Child *1260*
- Principles of Management of Child with Cerebral Palsy *1261*
- Treatment for Spasticity in Cerebral Palsy *1262*
- Management of Hip Deformities in Cerebral Palsy *1263*
- Management of the Knee in Spastic Diplegia *1266*
- Management of Foot and Ankle in Cerebral Palsy *1268*
- Management of the Upper Extremity in Cerebral Palsy *1271*
- Management of Spinal Deformity in Cerebral Palsy *1273*
- Single-Event Multilevel Surgery *1276*

Inherited Neuromuscular Disorders *1276*

- Duchenne Muscular Dystrophy *1276*
- Spinal Muscular Atrophy *1279*
- Charcot–Marie–Tooth Disease *1279*
- Friedreich Ataxia *1280*

41. Anomalies of Pediatric Lower Limb 1283

Manish Kumar Varshney

- Development of Lower Limb *1283*
- Congenital Femoral Deficiency *1284*
- Rotational and Angular Alignment of Lower Limb, Common Pathologies and Principles of Correction of Deformity in Children *1288*
- Angular Deformities of Lower Limb *1294*
- Principles of Management *1304*
- Genu Varum *1309*
- Tibia Vara *1315*
- Genu Valgum (Knock-Knees) *1321*
- Congenital Angular Deformities of Tibia and Fibula *1327*
- Congenital Pseudoarthrosis of Tibia *1328*
- Congenital Deficiencies of the Tibia (Tibial Hemimelia) *1334*
- Fibular Hemimelia (Congenital Longitudinal Deficiency of the Fibula) *1335*
- Congenital Dislocation of the Knee *1337*
- Leg-Length Discrepancy *1342*
- Patellar Instability *1360*
- Congenital Vertical Talus (Convex Pes Valgus and Rigid Rocker Bottom Flatfoot) *1373*
- Polydactyly *1378*
- Macrodactyly (Banana Toes) *1378*
- Lesser Toe Abnormalities *1379*
- Cleft Foot (Ectrodactyly, Lobster Foot, and Partial Adactyly) *1381*
- Congenital Metatarsus Adductus (Metatarsus Varus, Metatarsus Adductovarus) *1384*
- Tarsal Coalition *1388*
- Skewfoot (Z-Foot, Serpentine Foot, Metatarsus Adductovarus, and Congenital Metatarsus Varus) *1392*
- Cavovarus Foot *1393*
- Flexible Flatfoot *1395*
- Accessory Navicular (OS Tibiale Externum, Navicular Secundum, and Prehallux) *1399*

42. Pediatric Hip-Joint Disorders 1404

Manish Kumar Varshney

- Coxa Vara *1404*
- Slipped Capital Femoral Epiphysis (Slipped Upper Femoral Epiphysis) *1408*
- Perthes' Disease *1415*
- Dysplastic Development of Hip (Developmental Dysplasia of Hip, Congenital Dysplasia of Hip, and Congenital Dislocation of Hip) *1430*

43. Clubfoot: Congenital Talipes Equinovarus 1452

Manish Kumar Varshney

- Definition *1452*
- Epidemiology *1453*
- Historical Perspective *1453*
- Etiology *1453*
- Clinical Examination and Characteristic Findings *1455*
- Pathoanatomy *1456*
- Radiological Assessment and Advanced Imaging *1457*
- Some Definitions *1458*
- Types of Congenital Talipes Equinovarus *1459*
- Classification of Congenital Talipes Equinovarus *1459*
- Treatment *1461*
- Bracing for Congenital Talipes Equinovarus: The Science and Technology of Sustained Correction *1465*
- Modified Ponseti Manipulation for Atypical Congenital Talipes Equinovarus *1467*
- Surgical Management of Clubfoot *1469*
- Treatment of Resistant Deformity and Relapsed Congenital Talipes Equinovarus *1475*

44. Anomalies of Pediatric Upper Limb 1478

Manish Kumar Varshney

- Embryology and Molecular Pathobiology of Limb Development *1478*
- Classification and Contemporary Diagnostic Paradigms *1479*

JAYPEE BROTHERS

- Birth-Related Brachial Plexus Palsy *1479*
- Sprengel Deformity (Congenital Elevation of Scapula) *1488*
- Glenoid Hypoplasia *1490*
- Congenital Pseudarthrosis of the Clavicle *1491*
- Congenital Radial Head Dislocation *1492*
- Congenital Proximal Radioulnar Synostosis *1496*
- Radial Longitudinal Deficiency *1497*
- Madelung's Deformity *1502*
- Central Deficiency *1505*
- Syndactyly *1506*
- Polydactyly *1509*
- Camptodactyly (Bent Finger) *1510*
- Clinodactyly *1511*
- Thumb Hypoplasia or Aplasia *1512*
- Congenital Trigger Thumb or Digits *1515*

SECTION 6 Sports Medicine

45. Sports Medicine: Knee 1519

Manish Kumar Varshney

- Knee Arthroscopy in Sports Medicine *1519*
- Functional Anatomy *1524*
- Cruciate Ligaments *1532*
- Patellofemoral Articulation *1539*
- Joint Reaction Forces and Biomechanics *1541*
- Biomechanics of Knee Joint *1543*
- Knee Instability *1547*
- Tibial Collateral Ligament Injury *1555*
- Lateral Collateral Ligament Injury *1558*
- Anterior Cruciate Ligament Injury *1559*
- Posterior Cruciate Ligament Injury *1567*
- Posterolateral Corner Injuries *1572*
- Combined Ligament Injuries and Knee Dislocation *1575*
- Meniscal Lesions *1576*
- Pathophysiology and Pathoanatomy *1576*
- Sports-Related Peroneal Nerve Injury *1583*
- Bursitis *1585*
- Infrapatellar Fat Pad Syndrome (Hoffa's Disease, Hoffa's Fat Pad Syndrome, and Liposynovitis Prepatellaris) *1588*
- Patellofemoral Pain Syndrome and Anterior Knee Pain *1589*
- Patellar Tendinitis (Jumper's Knee) *1592*
- Patellar Tendon Rupture *1593*
- Quadriceps Tendon Disorders *1595*
- Runner's Knee (Iliotibial Band Friction Syndrome and PES Anserinus Tendinitis or Bursitis) *1600*
- Sinding–Larsen–Johansson Disease (Larsen–Johansson Syndrome and Sinding–Larsen Disease) *1601*
- Osgood–Schlatter Disease *1601*

46. Osteotomies around the Knee Joint: A Sports Medicine and Knee Preservation Perspective 1605

Manish Kumar Varshney

- Functional Anatomy and Sports Biomechanics of the Athletic Knee *1605*
- Biomechanical Rationale: Osteotomy as a Risk Modifier *1606*
- Indications and Patient's Selection in Sports Medicine *1606*
- Preoperative Evaluation and Sports-Specific Planning *1607*
- Deformity Analysis and Digital Surgical Planning *1607*
- Surgical Techniques: A Sports-Focused Approach *1608*
- Osteotomy Combined with Sports Knee Procedures *1610*
- Rehabilitation and Return-to-Sport Optimization *1611*
- Outcomes, Controversies, and Future Directions *1612*

47. Sports Medicine: Foot, Ankle, and Leg 1613

Manish Kumar Varshney

- Achilles Tendon *1613*
- Posterior Tibialis Tendinopathy and Progressive Collapsing Foot Deformity *1618*
- Peroneal Tendon Disease *1620*
- Stress Fractures—Bone Stress Injuries of Leg and Foot *1621*
- Medial Tibial Stress Syndrome *1628*
- Proximal Plantar Fasciopathy (Plantar Fasciitis, Plantar Fasciosis, Calcaneal Plantar Enthesopathy) *1630*
- Posterior Ankle Impingement Syndrome *1633*

48. Sports Medicine: Hip and Thigh 1637

Manish Kumar Varshney

- Hip Arthroscopy: Principles and Evolution *1637*
- Acetabular Labral Tears *1641*
- Femoroacetabular Impingement (Acetabular Rim Syndrome, Cervicoacetabular Impingement) *1652*
- Snapping Hip (Coxa Saltans) *1662*
- Piriformis Syndrome (Deep Gluteal Syndrome, Pelvic Outlet Syndrome, and Infrapiriform Foramen Syndrome) *1666*
- Meralgia Paresthetica (Bernhardt–Roth Syndrome and Lateral Cutaneous Nerve Neuralgia) *1671*
- Trochanteric Bursitis (Greater Trochanteric Pain Syndrome) *1674*
- Osteitis Pubis *1677*
- Groin Pain (Athletic Pubalgia and Sports Hernia) *1681*
- Hip Stress Fractures *1683*
- Future Directions *1687*

49. Sports Medicine: Elbow 1688

Manish Kumar Varshney

- Elbow Arthroscopy *1688*
- Terrible Triad Injury of Elbow (Hotchkiss Triad, 1996) *1691*

JAYPEE BROTHERS

50. Sports Medicine: Hand Injuries 1696
Manish Kumar Varshney
- Flexor Digitorum Profundus Avulsion (Jersey Finger) *1696*
- Mallet Finger *1698*
- Boxer's Knuckle (Boxer's Fracture) *1699*
- Jammed Finger *1701*

51. Head Injuries in Sports 1704
Manish Kumar Varshney
- Pathophysiology *1704*
- Spectrum of Head Injuries *1704*
- Concussion (Commotio Cerebri) *1706*

52. Doping (Drugs and Legal Aspects) 1711
Manish Kumar Varshney
- Historical Evolution and Foundation of Modern Ethical Paradigm *1711*
- Legal-Regulatory Architecture: World Anti-Doping Code *1711*
- Prohibited List: Science, Risk, and Categorization *1712*
- Modern Testing Regimen: From Chemical Detection to Biological Intelligence *1713*
- Sanctions, due Process, and Global Landscape of Enforcement *1713*
- Future Challenges and Evolving Frontiers *1713*

53. Skeletal Muscle: Structure and Function 1715
Manish Kumar Varshney
- Cytology *1715*
- Motor Unit *1717*
- Sarcoplasmic Reticulum *1717*
- Structural Proteins of Muscle *1718*
- Sliding Filament Model of Contraction *1718*
- Muscle Twitch and Tetanus *1718*
- Fiber Types and Muscle Adaptability *1720*
- Length-Tension Relationship *1720*
- Force-Velocity Relationship *1721*
- Muscular Training, Conditioning, and Strengthening *1721*
- Advanced Concepts and Periodization *1724*
- Conclusion: A Synthesis for the Modern Practitioner *1724*

SECTION 7 Regional Orthopedics: Shoulder

54. Shoulder: Functional Anatomy 1727
Manish Kumar Varshney
- Shoulder Joint *1727*
- Stabilization Hierarchy: Static and Dynamic Systems *1727*
- Biomechanical Integration: The Kinetic Chain in Sports *1729*
- Functional Muscle Groups: Beyond Simple Action Lists *1729*
- Critical Spaces: The Subacromial and Quadrilateral Spaces *1730*
- Arthroscopic Correlations: The Surgeon's Perspective *1730*
- Sports-Specific Anatomical Considerations *1731*
- Rotator Cuff *1731*
- Rotator interval: A Critical Stabilization Complex *1732*
- Microstructural Anatomy: The Five-Layer Model and Sports Adaptations *1732*
- Vascular Anatomy: Dispelling the "Critical Zone" Myth *1734*
- Pathoanatomy in Athletes: Beyond Simple Impingement *1734*
- Clinical Implications for the Sports Medicine Specialist *1735*
- Long Head of Biceps Tendon and Its Clinical Significance *1735*
- Functional Anatomy: The Biceps-Labral Complex *1736*

55. Biomechanics of Shoulder Joint 1738
Manish Kumar Varshney
- Glenoid Labrum *1738*
- Clinical Pathomechanics: A Unified View *1741*
- Scapulohumeral Rhythm *1741*
- Force Couple Mechanism on Humeral Head *1742*

56. Clinical Evaluation of Shoulder 1745
Manish Kumar Varshney
- Age *1745*
- Gender and Systemic Considerations *1745*
- Deconstructing Pain: Quality, Pattern, and Provocation *1746*
- Assessing Instability *1746*
- Synthesis and Modernization *1746*
- Physical Examination *1746*
- Special Tests *1747*

57. Imaging of Shoulder Joint 1758
Manish Kumar Varshney
- Core Imaging Modalities and their Roles *1758*
- Imaging for Shoulder Instability *1758*
- Imaging for Rotator-Cuff Pathology *1769*

58. Rotator Cuff Disease 1776
Manish Kumar Varshney
- Subacromial Impingement Syndrome *1776*
- Rotator Cuff Tears *1780*
- Treatment of Subacromial Impingement Syndrome and Rotator Cuff Lesions *1785*

59. Shoulder Instability 1793
Manish Kumar Varshney
- Defining the Spectrum: From Laxity to Dislocation *1794*

JAYPEE BROTHERS

- Anterior Instability *1795*
- Posterior Shoulder Instability *1809*
- Multidirectional Instability *1812*
- Scapular Dyskinesia and Its Management (Altered Scapulohumeral Rhythm) *1815*
- Superior Labrum Anterior and Posterior Lesion and internal Impingement *1818*

60. Calcific Tendinopathy 1822
Manish Kumar Varshney
- Etiopathogenesis and Pathobiology *1822*
- Natural History of Disease *1822*
- Clinical Presentation and Evolution *1823*
- Radiologic Appearance and Classification *1823*
- Treatment *1823*

61. Lesions of Biceps Tendon 1827
Manish Kumar Varshney
- Bicipital Tendinosis *1827*
- Subluxating Biceps Tendon *1828*
- Rupture of the Long Head of Biceps *1829*

62. Atraumatic Osteolysis of the Distal Clavicle (Idiopathic Clavicle Osteolysis, Wrestlers Syndrome, and Weightlifters Shoulder) 1832
Manish Kumar Varshney
- Pathogenesis and Molecular Biology *1832*
- Pathoanatomy *1833*
- Clinical Presentation *1833*
- Differential Diagnosis *1833*
- Diagnostic Imaging *1834*
- Treatment *1835*
- Outcomes and Prognosis *1837*
- Special Considerations *1837*
- Prevention Strategies *1838*
- Future Directions *1838*

63. The Stiff Shoulder 1839
Manish Kumar Varshney
- Adhesive Capsulitis *1839*
- Pathobiology and Etiology *1839*
- Clinical Course *1840*
- Diagnosis *1840*
- Differential Diagnosis *1841*
- Imaging *1841*
- Treatment: A Staged, Patient-Centered Algorithm *1841*

64. Hemorrhagic Shoulder (Milwaukee Shoulder, L'épaule Sénile Hémorragique) 1843
Manish Kumar Varshney
- Epidemiology *1843*
- Pathogenesis *1843*
- Pathoanatomy *1844*
- Clinical Features and Radiology *1844*
- Diagnosis *1845*
- Differential Diagnosis *1845*
- Treatment *1845*

65. Osteoarthritis of Shoulder Joint 1846
Manish Kumar Varshney
- Pathoanatomy and Classification *1847*
- Clinical Features *1847*
- Differential Diagnosis *1847*
- Radiology *1847*
- Treatment *1848*
- Arthrodesis of Shoulder Joint *1850*
- Arthroplasty of Shoulder Joint *1851*
- Reverse Total Shoulder Arthroplasty: Principles and Evolution *1852*

66. Scapular Instability 1858
Manish Kumar Varshney
- Etiology and Classification *1858*
- Clinical Evaluation *1859*
- Treatment *1859*
- Prognosis and Outcomes *1860*

67. Suprascapular Nerve Syndrome 1861
Manish Kumar Varshney
- Anatomy *1861*
- Etiology *1861*
- Clinical Presentation and Diagnosis *1862*
- Differential Diagnosis *1862*
- Treatment *1863*

68. Tuberculosis of Shoulder Joint 1864
Manish Kumar Varshney
- Pathoanatomy and Clinical Forms *1864*
- Clinical Features *1866*
- Radiology *1866*
- Differential Diagnosis *1867*
- Diagnosis *1867*
- Treatment *1868*

SECTION 8 Regional Orthopedics: Hand and Upper Extremity (Except Shoulder)

69. Elbow Anatomy and Biomechanics 1873
Manish Kumar Varshney
- Bony Architecture and Inherent Stability *1873*
- Ligamentous Anatomy and Evolving Concept of Isometry *1874*
- Hierarchy of Elbow Stabilizers: A Dynamic Model *1875*
- Functions of Elbow *1877*
- Movements at Elbow Joint *1878*
- Constraints and Stability: A Force-Dependent Hierarchy *1878*
- Biomechanics of Throw *1879*

JAYPEE BROTHERS

70. Tendon Disorders of Elbow..... 1881

Manish Kumar Varshney

Lateral Elbow Tendinopathy [Extensor Carpi Radialis Brevis Tendinosis, Lateral Epicondylitis, and Extensor Angiofibroblastic Tendinosis] ***1881***

- History *1882*
- Etiology *1882*
- Associations *1883*
- Pathogenesis *1883*
- Clinical Features *1884*
- Investigations *1885*
- Treatment *1887*
- Chronic Refractory Tennis Elbow and Salvage Surgery for Lateral Tennis Elbow *1892*

Medial Elbow Tendinopathy (Flexor-Pronator Tendinosis) ***1893***

- Anatomic Substrate and Biomechanical Pathophysiology *1893*
- Pathophysiology: The Continuum Model in Medial Elbow *1894*
- Predisposing Factors and Associated Conditions *1894*
- Clinical Features *1895*
- Differential Diagnosis *1895*
- Investigations: Diagnostic Imaging and Advanced Diagnostics *1895*
- Treatment *1897*
- Operative Management *1899*
- Postoperative Rehabilitation Protocol *1900*
- Complications and their Management *1900*

Biceps Tendon Rupture ***1901***

- Anatomy and Functional Biomechanics *1901*
- Natural History *1902*
- Epidemiology and Risk Stratification *1902*
- Clinical Evaluation: Distinguishing Proximal from Distal *1903*
- Diagnostic Imaging: A Modern, indication-Driven Approach *1903*
- Treatment *1904*
- Partial Ruptures: A Diagnostic and Therapeutic Challenge *1907*
- Postoperative Rehabilitation: Biology-Driven, Approach-Specific Protocol *1908*
- Complications of Distal Biceps Repair, Management of Failed Primary Surgery, and Emerging Innovations *1908*
- Emerging Biologic and Technological Innovations *1910*

Triceps Tendon Rupture ***1911***

- Anatomy and Functional Biomechanics *1911*
- Pathophysiology *1912*
- Clinical Evaluation: Distinguishing Partial from Complete *1913*
- Diagnostic Imaging: Confirmation and Quantification *1913*
- Treatment: An Evidence-Based Algorithm *1914*
- Postoperative Rehabilitation *1916*
- Complications and their Management *1917*
- Emerging Innovations *1917*

71. The Unstable Elbow 1919

Manish Kumar Varshney

- Classification of Elbow Instability *1919*
- Etiology and Risk Factors *1919*
- Pathomechanics *1921*
- Evaluation of the Patient with Chronic instability *1922*
- Differential Diagnosis *1925*
- Management of Elbow Instability *1927*
- Chronic Valgus Elbow Instability *1932*
- Erosive Arthropathies *1939*
- Terrible Triad Injuries *1942*
- Recurrent Dislocation of Elbow *1946*
- Congenital Trochlear Notch Dysplasia *1946*
- Valgus-Extension Overload Syndrome *1946*
- Radiocapitellar Overload Syndrome *1950*
- Posterolateral Rotatory Instability *1952*
- Recurrent Isolated Radial Head Instability *1955*
- Elbow Arthrodesis *1957*

72. Stiff Elbow..... 1962

Manish Kumar Varshney

- Etiopathogenesis: A Multitissue Disease *1962*
- Classification *1963*
- Clinical Features *1965*
- Investigations *1965*
- Management *1966*

Ectopic Ossification Around Elbow ***1971***

- Pathogenesis: The Biological Cascade *1972*
- Classification: Functional and Anatomical *1972*
- Pathoanatomy by Site *1972*
- Management of Heterotopic Ossification *1973*

Elbow Arthroplasty Procedures ***1974***

- Excision Arthroplasty/Debridement Arthroplasty *1974*
- Interposition Arthroplasty *1976*
- Replacement Arthroplasty or Total Elbow Arthroplasty *1978*

73. Hand Anatomy and Function 1981

Manish Kumar Varshney

- Positions of the Hand *1984*
- Anatomy *1984*
- Anatomy of Tendons *1994*

74. Carpal Instability..... 1998

Manish Kumar Varshney

- Definition *1998*
- Radiographic Foundations—Static Malalignment Patterns *1998*
- Pathomechanics—From Static Images to Dynamic Understanding *2000*
- Classification of Carpal Instability *2002*
- Management of Carpal Instability *2005*
- Dissociative Carpal Instability *2005*
- Nondissociative Radiocarpal Instability *2015*
- Carpal Instability Complex *2019*

JAYPEE BROTHERS

75. Common Miscellaneous Conditions of Hand 2025
Manish Kumar Varshney
- De Quervain's Stenosing Tenosynovitis (De Quervain's Tenovaginitis, De Quervain's Disease, Washerwoman's Sprain, and Stenosing Peritendinitis) *2025*
- Intersection Syndrome (Abductor Pollicis Longus Bursitis and Crossover Tendinitis) *2029*
- Trigger Finger (Stenosing Flexor Tenosynovitis) *2032*
- Dupuytren's Contracture *2037*
- First Metacarpophalangeal Joint Ulnar Collateral Ligament injury (Gamekeeper's Thumb and Skier's Thumb) *2046*
- Thumb Carpometacarpal Joint Arthritis (Basal Joint Arthritis) *2050*

76. Distal Radioulnar Joint Disorders and Ulnar Wrist Pain 2059
Manish Kumar Varshney
- Anatomy and Biomechanics *2059*
- Pathology at Distal Radioulnar Joint and Pathogenesis *2061*
- Diagnosis *2062*
- Imaging Studies *2064*
- Classification of Distal Radioulnar Joint Instability *2066*
- Treatment *2066*
- Extensor Carpi Ulnaris Tendon Problems and Extensor Carpi Ulnaris Tendinitis *2078*
- Rheumatoid Affection of Extensor Tendons *2083*
- Ulnocarpal Impaction/Abutment Syndrome and Ulnar Impingement Syndrome *2087*
- Ulnocarpal Impaction Syndrome Secondary to Ulnar Styloid Nonunion *2090*
- Ulnar Impingement Syndrome *2091*

77. Rheumatoid Hand 2094
Manish Kumar Varshney
- General Perspective of Hand Deformities *2094*
- Finger Deformity in Rheumatoid Arthritis *2096*
- Metacarpophalangeal Joint Involvement in Rheumatoid Arthritis *2101*
- Rheumatoid Affection of the Wrist Joint *2103*
- Thumb Deformities in Rheumatoid Arthritis *2105*

78. Infections of the Hand 2110
Manish Kumar Varshney
- General Principles of Treatment of Hand Infections *2110*
- Complications of Hand Infections *2111*
- Nail Bed Infections *2112*
- Felon *2115*
- Bite Wounds of Hand *2117*
- Deep Space Infections *2118*
- Flexor Tenosynovitis (Pyogenic Flexor Tenosynovitis or Suppurative Flexor Tenosynovitis) *2120*

79. Tendon Injuries of Hand and Management 2124
Manish Kumar Varshney
- Historical Perspective *2124*
- Anatomical and Biomechanical Considerations *2125*
- Causes of Tendon Injuries *2129*
- Clinical Features *2130*
- Management of Flexor Tendon Injuries *2132*
- Postoperative Protocol *2137*

80. Volkmann's Ischemic Contracture 2140
Manish Kumar Varshney
- Pathophysiology: The Ischemic Cascade and Tissue Response *2140*
- Classification of Volkmann's Ischemic Contracture *2142*
- Assessment of Patient *2144*
- Differential Diagnosis *2146*
- Timing of Intervention *2147*
- Treatment Options *2148*
- Treatment Based on Tsuge Classification *2150*
- Treatment Based on Zancolli's Classification *2152*

81. Compressive and Entrapment Neuropathies of Upper Limb 2154
Manish Kumar Varshney
- Pathophysiology of Chronic Nerve Compression *2154*
- Carpal Tunnel Syndrome *2155*
- Anterior Interosseous Nerve Compressive Neuropathy (Anterior Interosseous Nerve Syndrome) *2170*
- Pronator Syndrome *2175*
- Cubital Tunnel Syndrome *2176*
- Ulnar Tunnel Syndrome *2183*
- Radial Tunnel Syndrome (Resistant Tennis Elbow/ Supinator Syndrome) *2187*
- Wartenberg's Syndrome (Synonyms: Cheiralgia Paresthetica, Handcuff Neuropathy/Neuropraxia, and Wristlet Watch Neuritis) *2190*
- Posterior Interosseous Nerve Compression Syndrome *2192*

82. Peripheral Nerve Injuries 2196
Manish Kumar Varshney
- Surgical Anatomy of the Peripheral Nervous System *2196*
- Neuron *2197*
- Structure and Function of a Peripheral Nerve *2198*
- Myoneural Junction *2203*
- Neuron Action Potential *2204*
- Blood-Nerve Interface *2206*
- Biomechanical Properties of Peripheral Nerve *2206*
- Peripheral Nerve Injury *2208*
- Clinical Features of Peripheral Nerve Injury *2212*
- Classification of Nerve Injury *2214*
- Diagnosis of Nerve Injury *2216*

JAYPEE BROTHERS

- Management of Nerve Injury *2219*
- Augmentation of Nerve Repair *2222*
- Management of Nerve Defects *2223*
- Special Scenarios *2227*
- Injection Nerve Palsy *2234*
- Individual Upper Limb Nerve Palsies of Upper Limb *2242*
- Combined Nerve Palsies of Upper Limb *2254*

VOLUME 3

SECTION 9 Regional Orthopedics: Hip

83. Surgical and Functional Hip Joint Anatomy 2263

Manish Kumar Varshney

- Anatomy of the Hip *2263*

84. Biomechanics of Hip Joint 2278

Manish Kumar Varshney

- Functional Anatomy *2278*
- Forces Transmitted Across the Hip Joint *2280*
- Complexity of in Vivo Force Measurements *2282*
- Clinical Applications *2284*

85. Surgical Approaches to Hip Joint 2288

Manish Kumar Varshney

- Classification of Approaches to Hip Joint *2288*
- Techniques of Various Surgical Approaches to Hip Joint *2289*

86. Surgical Dislocation of the Hip (Ganz Surgical Dislocation of Hip, Open Dislocation of Hip) 2306

Manish Kumar Varshney

- Vascular Anatomy and Preservation Principles *2307*
- Indications and Patient Selection *2307*
- Surgical Technique: Precision and Innovation *2309*
- Postoperative Management and Rehabilitation *2310*
- Complications: Prevention and Modern Management *2310*
- Contemporary Perspective and Future Directions *2310*

87. Transient Synovitis of Hip (Transitory Coxitis, Acute Transient Epiphysitis, Coxitis Fugax, Coxitis Serosa, Seu Simplex, Phantom Hip Disease, Toxic Synovitis, and Observation Hip) 2312

Manish Kumar Varshney

- Epidemiology *2312*
- Etiology *2312*
- Diagnosis *2312*
- Differential Diagnosis *2314*
- Treatment *2314*
- Natural History and Prognosis *2314*

88. Osteoarthritis of Hip Joint 2317

Manish Kumar Varshney

- Pathogenesis: From Cartilage Degradation to Joint-Wide Dysfunction *2318*
- Risk Factors *2318*
- Natural History and Pathological Progression *2320*
- Classification of Hip Osteoarthritis *2320*
- Clinical Features and Evaluation *2321*
- Imaging Evaluation and Grading *2322*
- Diagnosis of Osteoarthritis Hip *2322*
- Prognosis *2324*
- Management *2324*

89. Protrusio Acetabuli (Otto-Chrobak Pelvis, Otto Pelvis, Arthrokatadysis, Osteoarthritis Deformans, and Osteoarthritic Protrusion of the Acetabulum) 2328

Manish Kumar Varshney

- Historical Considerations *2328*
- Classification *2328*
- Biomechanics of Protrusio *2329*
- Clinical Features *2329*
- Radiographs *2330*
- Laboratory Workup *2331*
- Management of Protrusio *2331*

90. Total Hip Replacement Arthroplasty (Rationale, Design, Complications, and Revision) 2336

Manish Kumar Varshney

- Principles of Total Hip Arthroplasty—Foundational and Modern *2336*
- Current Debates and Evolving Paradigms *2337*
- History of Total Hip Arthroplasty *2337*
- Components of a Modular Hip Prosthesis *2339*

Addressing Niche Controversies *2351*

- Fixation Methods of Prosthesis: Cemented versus Uncemented *2351*
- Cemented Fixation *2351*
- Cementless Fixation *2352*
- Hybrid and Reverse-Hybrid Constructs *2352*
- Acetabular Cup Positioning: From Static Zones to Dynamic Patient-Specific Targets *2354*
- Surgical Approach to Hip: Influence from Beginning *2361*

JAYPEE BROTHERS

Total Hip Arthroplasty *2362*
- Goals *2362*
- Indications for Total Hip Arthroplasty *2362*
- Contraindications for Hip Arthroplasty *2363*
- Preoperative Planning *2364*
- Templating *2364*
- Spinopelvic Alignment and Dynamic Hip Stability *2366*
- Clinical Results and Possible Complications *2369*
- Complications of Hip Arthroplasty *2369*
- The Critical Role of Bone Health Optimization *2379*
- Revision Hip Arthroplasty *2379*
- Reconstruction of Acetabular and Femoral Bone Defects *2383*
- Impaction Bone Grafting: Principles and Contemporary Role *2385*
- Cement-in-Cement Revision *2386*

91. Osteotomies Around Hip Joint..... 2389
Manish Kumar Varshney
- Definition and Rationale *2389*
- Classification and Types of Proximal Femoral Osteotomies *2390*
- Preoperative Planning and Patient Selection for Hip Osteotomies *2391*
- Intertrochanteric Osteotomy *2392*
- General Operative Technique *2395*
- Various Commonly Performed ITO *2396*
- Curved Varus Osteotomy for Osteonecrosis *2400*
- Pelvic Support Osteotomy *2402*
- Trochanteric Osteotomies *2409*
- Subtrochanteric Osteotomies *2417*
- Femoral Derotational Osteotomy *2417*
- Surgical Planning and Execution *2418*

92. Intertrochanteric Resection Osteotomy/ Arthroplasty of Girdlestone (and its Modifications)..... 2420
Manish Kumar Varshney
- Historical Perspective *2420*
- Indications *2420*
- Surgical Technique: Modified and Bone-Preserving *2421*
- Complications *2422*
- Outcomes and Future Directions *2422*

93. Hip Arthrodesis 2424
Manish Kumar Varshney
- History of the Procedure *2425*
- Biomechanics and Natural History of the Procedure *2427*
- Classification of Hip Arthrodesis Procedures *2428*
- Contraindications for Hip Arthrodesis *2429*
- Surgical Technique of Cobra-Head Plate Arthrodesis *2429*
- Postoperative Course *2431*
- Complications *2431*
- Total Hip Replacement in an Arthrodesed Hip *2432*

SECTION 10 Disorders of Foot and Ankle

94. Anatomy of Ankle and Foot..... 2439
Manish Kumar Varshney
- Bony Architecture of the Talocrural (Ankle) Joint *2439*
- Ligaments of Ankle Joint *2441*
- Foot *2443*
- Functional Synthesis *2444*
- Tendons and Neurovascular Structures Around Ankle *2445*

95. Arches of the Foot 2447
Manish Kumar Varshney
- Bony Architecture of the Arches *2447*
- Modern Biomechanical Synthesis: Beyond the Masonry Concept *2447*
- Maintenance Mechanisms of the Arches *2449*
- Propulsive Action of the Foot *2450*
- Forefoot *2451*
- Sole of the Foot *2451*
- Tripod Action of the Foot *2452*

96. Biomechanics of the Foot and Ankle Joint and Related Examination 2454
Manish Kumar Varshney
- Biomechanics of Ankle Joint Movements *2454*
- Clinical Examination of Foot Motion *2458*
- The Triple Joint Complex and Coupled Motion *2458*

97. Examination of the Foot and Ankle 2460
Manish Kumar Varshney
- Inspection *2460*
- Posture *2461*
- Medial Arch *2461*
- Heels *2461*
- Shoes *2461*
- Palpation *2463*
- Blood Circulation *2465*
- Neurological Examination *2465*
- Measurements *2468*
- Special Tests *2468*

98. Ligament Injuries Around Ankle..... 2469
Manish Kumar Varshney
- Classification *2471*
- Treatment *2473*
- Chronic Ankle Instability after Injury *2476*

99. Tendo-Achilles Rupture 2482
Manish Kumar Varshney
- Epidemiology *2482*
- Anatomical Considerations *2483*
- Mechanism and Rupture Site *2483*
- Risk Factors and Stratification *2484*
- Pathophysiology: Integrated Model *2484*
- Clinical Features *2485*

JAYPEE BROTHERS

- Investigations *2485*
- Classification Systems *2487*
- Outcome Measurement *2487*
- Management *2488*

100. Rheumatoid Affection of Foot, Diabetic Foot Disease, and Neuropathic (Charcot) Foot..... 2495

Manish Kumar Varshney

- Rheumatoid Affection of Foot *2495*

Diabetic Foot Disease and Neuropathic Foot *2500*

- Introduction and Epidemiology *2500*
- Etiology and Pathophysiology *2500*
- Clinical Examination *2501*
- Imaging *2502*
- Diabetic Ulcer *2503*
- Diabetic Foot infection and Its Management *2505*
- Charcot Neuroarthropathy *2507*

101. Deformities of the Hallux and the Lesser Toe 2513

Manish Kumar Varshney

- Bunion or Hallux Valgus *2513*
- Surgical Techniques: Detailed Procedural Considerations *2522*
- Crossover Second Toe *2527*
- Hallux Rigidus *2529*
- Hallux Flexus *2531*

Deformities of the Lesser Toes *2533*

- Hammer Toe *2533*
- Claw Toe *2534*
- Mallet Toe *2536*
- Tailor's Bunion or Bunionette *2536*
- Ingrowing Toenail (Onychocryptosis) *2538*

102. Acquired Flatfoot (Pes Planus) and Posterior Tibial Tendon Dysfunction..... 2540

Manish Kumar Varshney

Acquired Flatfoot (Pes Planus) *2540*

- Pathomechanism *2541*
- Pathoanatomy *2542*
- Symptoms *2542*
- Physical Examination *2542*
- Radiology of Flatfoot *2543*
- Stages of Development of Flatfoot *2545*
- Flexible Pes Planus *2545*
- Rigid Pes Planus *2547*
- Posterior Tibialis Tendon Dysfunction *2548*
- Peroneal Spastic Pes Planus *2550*

103. Pes Cavus and Accompanying Deformities 2553

Manish Kumar Varshney

- Etiology *2553*
- Etiopathogenesis-Based Classification of Pes Cavus *2554*
- Pathogenesis of Deformity *2554*
- Pathoanatomy *2555*
- Examination *2556*
- Types of Deformity *2557*
- Roentgenographic Findings *2557*
- Natural History of Development of Pes Cavus in Paralytic Foot *2558*
- Principles of Treatment *2558*

104. Hindfoot Deformities and Plantar Heel Pain 2563

Manish Kumar Varshney

- Hindfoot Valgus Deformity *2563*
- Hindfoot Varus Deformity *2564*
- Plantar Heel Pain *2565*
- Osseous Etiologies *2570*

105. Tarsal Tunnel Syndrome 2571

Manish Kumar Varshney

- Anatomy *2571*
- Etiology *2572*
- Clinical Features and Examination *2573*
- Investigations *2574*
- Differential Diagnosis *2574*
- Treatment *2574*

106. Foot Drop 2577

Manish Kumar Varshney

- Pathophysiology *2577*
- Clinical Presentation *2578*
- Diagnosis *2579*
- Treatment *2580*
- Complications *2582*

107. Avascular Necrosis of the Metatarsal Head (Freiberg's Disease) 2583

Manish Kumar Varshney

- Etiology and Pathophysiology *2583*
- Clinical Features *2584*
- Investigations *2584*
- Differential Diagnosis *2585*
- Staging by Smillie *2585*
- Treatment *2585*

108. Morton's Metatarsalgia (Morton's Toe and Interdigital Neuroma) 2588

Manish Kumar Varshney

- Pathogenesis *2588*
- Pathoanatomy *2589*
- Clinical Features and Differentials *2589*
- investigations and Diagnosis *2590*
- Treatment *2590*
- Complications *2591*

JAYPEE BROTHERS

SECTION 11 Regional Orthopedics: Spine

109. Anatomy of the Spine and Spinal Cord..... 2595
Manish Kumar Varshney
- Vertebral Column *2595*
- Curvatures of Vertebral Column *2598*
- Vertebral Joints and Ligaments *2599*
- Intervertebral Disk *2602*
- Blood Supply of Spine 2605
- Spinal Cord *2607*
- Structure of Spinal Cord *2610*
- Blood Supply of Spinal Cord *2612*

110. Low Back Pain, Intervertebral Disk Degeneration, Lumbar Spondylosis, and Degenerative Conditions of Cervical Spine 2616
Manish Kumar Varshney

Low Back Pain *2616*
- Investigations *2616*
- The Concept of Pain Generator and Common Recognized Pain Generators in Lumbar Spine *2618*
- Management *2622*

Intervertebral Disk Degeneration *2626*
- Pathoanatomy *2627*
- Degenerative Processes: The Molecular Cascade *2628*
- Functional Changes of the Disk due to Degeneration *2630*
- Pathobiomechanics *2630*
- Production of Pain and Radicular Symptoms in Degenerative Disk Disease *2632*
- Etiology of Disk Degeneration: A Multifactorial Systems Model *2634*
- Pathophysiology of Disk Degeneration *2635*
- Diagnosis of Internal Disk Disruption *2636*
- Treatment of Diskogenic Pain *2639*

Lumbar Spondylosis and Lumbar Degenerative Disk Disease *2644*
- Epidemiology *2644*
- Clinical Features *2644*
- Diagnostic Imaging *2645*
- Treatment *2646*

Degenerative Conditions of Cervical Spine (Cervical Spondylosis, Radiculopathy, and Myelopathy) *2653*
Ossification of the Posterior Longitudinal Ligament *2655*
- Clinical Presentation and Diagnosis *2655*
- Differential Diagnosis *2655*
- Imaging *2655*
- Treatment *2656*

111. Lumbar Disk Herniation and Spinal Stenosis 2661
Manish Kumar Varshney

Lumbar Disk Herniation *2661*
- Definition *2661*
- Pathophysiology *2663*
- Epidemiology *2664*
- Pathoanatomy *2664*
- Natural History *2664*
- Clinical Features *2665*
- Diagnostic Imaging *2668*
- Differential Diagnosis *2668*
- Treatment *2669*
- Failure of Diskectomy (Failed Back) *2671*
- Indications for Fusion with or after Diskectomy *2671*
- Management of Cauda Equina Syndrome *2672*
- Recurrent Lumbar Disk Herniation *2672*
- Disk Herniation in the Pediatric and Adolescent Population *2673*

Lumbar Spinal Stenosis *2673*
- Pathoanatomy *2673*
- Pathophysiology *2675*
- Clinical Features *2675*
- Diagnostic Imaging *2676*
- Treatment *2677*

112. Lumbar Spondylolysis and Spondylolisthesis 2680
Manish Kumar Varshney

Spondylolysis *2680*
- Definition and Spectrum of Pathology *2680*
- Pathophysiology and Etiology *2681*
- Clinical Presentation *2682*
- Natural History *2682*
- Imaging *2682*
- Differential Diagnosis *2683*

Spondylolisthesis *2683*
- Classification System *2683*
- Pathophysiology of Slip Progression *2683*
- Natural History and Risk Factors for Progression *2685*
- Congenital or Dysplastic Spondylolisthesis *2685*
- Isthmic Spondylolisthesis *2687*
- Degenerative Spondylolisthesis *2695*
- Traumatic, Pathologic, and Iatrogenic Spondylolisthesis *2699*

113. Persistent Spinal Pain Syndrome 2701
Manish Kumar Varshney
- Classification and Diagnostic Framework *2701*
- Pathomechanisms: From Peripheral Nociception to Central Sensitization *2702*
- Etiological Categorization of Persistent Spinal Pain Syndrome Type 2 *2704*
- Diagnostic Evaluation *2705*
- Management: Stepwise Multimodal Approach *2707*

114. Nonsurgical Interventional Techniques for Management of Back Pain 2712
Manish Kumar Varshney
- Facet Joint Interventions: Diagnosis and Management of Zygapophyseal Joint Pain *2714*
- Epidural Steroid Injections: Rationale, Technique, and Evolving Standards *2717*

JAYPEE BROTHERS

- Chemical Decompression and Neuromodulation: Ozone and Methylene Blue *2720*
- Advanced Diagnostic and Decompressive Techniques *2723*
- Myofascial Pain Syndrome and Trigger Point Management *2724*
- Basivertebral Nerve Ablation: A Precision Target for Vertebrogenic Pain *2726*
- Gray Ramus Communicans Interventions: Rationale and Technique *2728*
- Spinal Cord Stimulation: Advanced Neuromodulation for Refractory Neuropathic Pain *2729*
- Sacroiliac Joint Pain: Diagnosis and Advanced Interventional Management 2731

115. Spinal Dysraphism (Spina Bifida, Myelocele, Meningomyelocele, Diastematomyelia, and Tethered Cord Syndrome) 2734

Manish Kumar Varshney

- Epidemiology and Prevention *2736*
- Clinical Features and the Diagnostic Paradigm *2736*
- Embryological and Developmental Aspects *2737*
- Anomalies of Development *2740*
- Malformations of Primary Neurulation *2740*
- Malformation during the Second Phase (Canalization, Stages XIII–XX) and the Third Phase (Retrogressive Differentiation, Stages XX Thereafter) *2746*
- Tethered Cord Syndrome *2749*
- Principles of Lifelong Management and Future Directions *2752*

116. Spinal Cord Injury..... 2754

Manish Kumar Varshney

- Evolution of Clinical Principles *2754*
- Etiology *2755*
- Epidemiology *2756*
- Anatomy and Neuroanatomy *2757*
- Mechanisms of injury *2757*
- Pathophysiology of Spinal Cord Injury: An integrated Systems Biology Approach *2759*
- Classification *2765*
- Clinical Manifestations *2768*
- Assessment, Evaluation, and Surgical Decision-Making: A Systematic Trauma Algorithm *2771*
- Therapeutic Intervention *2772*
- Prognosis of Spinal Cord Injury *2777*

117. Spinal Deformity 2780

Manish Kumar Varshney

Scoliosis *2780*

- Classification and Etiology *2780*
- Essential Terminology and Biomechanical Principles *2781*
- Historical Perspective *2784*
- Idiopathic Scoliosis *2786*
- Adolescent Idiopathic Scoliosis *2787*
- Curve Classification: From Descriptive Patterns to 3D Surgical Roadmaps *2797*
- Early-Onset Scoliosis (Age < 8 Years) *2813*
- Congenital Scoliosis *2817*
- Adult Scoliosis and Deformity *2824*
- Neuromuscular Scoliosis *2834*

Sagittal Plane Deformity of Spine *2839*

- Principles of Sagittal Alignment and Measurement *2839*
- Classification and Etiopathology of Kyphotic Deformity *2840*
- The Modern Diagnostic Paradigm: Beyond the Cobb Angle *2841*
- Clinical Forms and Regional Considerations *2841*
- Clinical Evaluation: Bridging Physical Exam and Radiographic Phenotypes *2842*
- Physical Examination: Quantifying Balance and Compensation *2842*
- Radiographic Evaluation: The Quantification of Imbalance *2843*
- The Concept of Compensation versus Imbalance *2843*
- Pathomechanics: The Vicious Cycle of Progression *2844*
- Cervical Kyphosis *2844*
- Thoracic Kyphosis *2848*

118. Diffuse Idiopathic Skeletal Hyperostosis (Forestier Disease, Ankylosing Hyperostosis, Generalized Juxta-articular Ossification of Vertebral Ligaments, and Spondylosis Hyperostotica) 2856

Manish Kumar Varshney

- Molecular Pathogenesis and Etiology *2856*
- Prevalence *2858*
- Clinical Presentation *2858*
- Spinal Manifestations *2858*
- Extraspinal Manifestations *2859*
- Imaging Modalities *2859*
- Differential Diagnosis *2860*
- Treatment *2861*

119. Rheumatoid Affection of Spine..... 2864

Manish Kumar Varshney

- Pathophysiology of Disease Development and Joint Destruction *2864*
- Epidemiology and Natural History *2868*
- Clinical Presentation *2869*
- Diagnostic Evaluation *2870*
- Imaging Evaluation and Prognostic indicators *2873*
- Management of Rheumatoid Spine *2874*

120. Spinal Infections..... 2879

Manish Kumar Varshney

- Tuberculosis of Spine (Pott's Spine, Pott's Disease) *2880*
- Vertebral Pyogenic Osteomyelitis *2904*
- Pyogenic Epidural Abscess *2911*

JAYPEE BROTHERS

121. Miscellaneous Disorders (Vertebra Plana, Computed Tomography-guided Biopsy, and intervertebral Disk Calcification) 2914
Manish Kumar Varshney

Vertebra Plana ***2914***
- Etiology and Differential Diagnosis *2914*
- Clinical Features *2914*
- Diagnostic Evaluation *2915*
- Management *2916*
- Procedure of Balloon Kyphoplasty *2917*

Computed Tomography-Guided Biopsy ***2920***
- Indications *2920*
- Technical Evolution and Procedural Details *2920*
- Complications of Spinal Biopsy: Prevention and Contemporary Management *2922*

Intervertebral Disk Calcification ***2922***
- Pathophysiology and Clinical Significance *2923*
- Etiological Spectrum and Diagnostic Approach *2923*
- Natural History and Management Principles *2924*
- integrating Advanced Analysis *2924*

SECTION 12 Miscellaneous Topics

122. Amputations and Rehabilitation 2927
Manish Kumar Varshney

Amputations ***2927***
- Indications and Principles *2928*
- Surgical Technique *2928*
- Assessment of Healing Potential: Modern Multimodal Approach *2932*
- Dressing Technique *2933*
- Immediate Postoperative Prosthesis and Early Rehabilitation *2934*
- Pain Management *2935*
- Rehabilitation *2936*
- Complications of Amputation Surgery *2937*
- Lower Limb Amputations *2939*
- Rotationplasty *2954*
- Upper Limb Amputations *2958*
- Hand Amputations *2959*

Prostheses ***2987***
- Characteristics of a Good Prosthesis *2987*
- Patient Classification: The Medicare Functional Levels (K-Levels) *2988*
- Lower Limb Prosthesis *2988*
- Socket *2988*
- Gel Liners and Interface Materials *2991*
- Suspension Systems *2991*
- Joints *2993*
- Ankle and Foot *2995*
- Hip Prosthesis *2998*
- Pylon or Shank *3000*
- Prosthesis Prescription by Level *3000*
- Upper Limb Prosthesis *3001*
- Cosmetic Prostheses *3001*
- Body-Powered Prostheses *3001*
- Hybrid Prostheses *3005*
- Prescription by Amputation Level *3005*
- Rehabilitation and Training *3006*
- Orthotics *3007*

123. Replantation 3017
Manish Kumar Varshney
- Patient Selection and Indications *3017*
- Preoperative Management: Preserving the Biological Potential *3018*
- Surgical Technique *3018*
- Postoperative Care and Salvage: The First 72 Hours *3019*
- Outcomes and the Future *3019*

124. Robotics, Computer-Assisted Surgery, and Artificial Intelligence in Orthopedics 3021
Manish Kumar Varshney
- Robotic-Assisted Arthroplasty Surgery *3022*
- Haptic (Semiactive) Robotic Systems *3023*
- Robotic-Assisted Spine Surgery *3026*
- Robotic-Assisted Trauma and Regional Orthopedic Surgery *3027*
- Robotic Surgery: Pitfalls and Limitations *3028*
- Computer-Assisted Orthopedic Surgery and Navigation Systems *3028*
- Artificial intelligence, Machine Learning, and Deep Learning in Orthopedics *3030*
- Diagnostic AI: Imaging and Fracture Analysis *3030*
- Robotic Learning and Surgeon-Adaptive Systems *3032*
- industry 5.0 and Human-Centric Robotic Surgery *3033*
- Computer-Aided Orthopedic Learning and Simulation *3034*
- Three-Dimensional Printing and Patient-Specific Instrumentation *3035*

125. Lasers in Orthopedics 3039
Manish Kumar Varshney
- Therapeutic Lasers (Low Powered Lasers) *3040*
- Surgical Lasers *3041*
- Clinical Applications in Orthopedic Surgery *3042*
- Lasers in the Modern Orthopedic Armamentarium *3042*
- Complications, Pitfalls, and Evidence-Based Perspective *3042*
- Future: AI, Optimization, and Integration *3043*

126. Instruments and Implants 3045
Manish Kumar Varshney
- AWLS *3045*
- Chisels/Osteotomes/Gouges *3045*

JAYPEE BROTHERS

- Bone-Holding Clamps *3046*
- Bone Cutters/Nibblers *3047*
- Periosteal Elevators *3048*
- Curettes *3048*
- Retractor/Levers *3050*
- Cartilage/Tendon instruments *3051*
- General instruments *3053*
- General Trauma instruments *3054*
- Nails *3057*
- Plates *3059*
- Screw *3061*

127. History of Orthopedics 3068

Manish Kumar Varshney

- Ambroise Paré (1510–1590) *3068*
- Nicolas andry (1658–1742): The Father of Orthopedics *3069*
- Percivall Pott (1714–1788): The Surgeon Who Fell from his Horse *3071*
- John Hunter (1728–1793): The Founder of Scientific Surgery *3071*
- Abraham Colles (1773–1843) *3072*
- Antonius Mathijsen (1805–1878): The inventor of Plaster of Paris *3073*
- Hugh Owen Thomas (1834–1891): The Father of British Orthopaedics *3073*
- Sir Robert Jones (1857–1933): The Practical Pioneer *3074*
- Thomas Porter Mcmurray (1888–1949): The Meniscus Man *3074*
- Willis C Campbell (1880–1941): The American Educator *3075*
- Gerhard Küntscher (1900–1972): The Nailer *3075*
- Martin Kirschner (1879–1942): The Wire *3075*
- Sir Reginald Watson-Jones (1902–1972): The Author and Editor *3076*
- Austin T Moore (1899–1963): The First Metallic Hip *3076*
- Gavriil A Ilizarov (1921–1992) *3077*
- Sir John Charnley (1911–1982): The Father of Modern Hip Arthroplasty *3077*
- The Legacy: From Pioneers to Precision *3079*

128. Emerging Terms and Concepts in Orthopedics 3080

Manish Kumar Varshney

- Restorative Medicine and Orthobiologics *3080*
- Metabolomics *3084*
- Multiomics Technologies in Orthopedics: Integrating The Layers of Biological Complexity *3089*
- Proteomics: The Functional Effectors of Disease *3090*
- Transcriptomics: The Dynamic Blueprint *3092*
- Epigenomics: The Regulatory Landscape *3094*
- Radiomics: The Imaging Phenotype *3095*
- Single-Cell and Spatial Technologies: Resolving Heterogeneity *3096*
- Microbiomics: The Host-Microbial Superorganism *3097*
- Multiomics integration: The Systems Approach *3098*
- Challenges and Future Directions *3099*

129. Impact of Obesity and the Role of Bariatric Surgery in Lower Limb Joint Arthroplasty 3102

Manish Kumar Varshney

- Alteration in Lower Limb Biomechanics due to Obesity *3102*
- Joint Arthroplasty Outcome in Obese Patients *3103*
- Impact of Bariatric Surgery on Osteoarthritic Joints *3103*
- Biomechanics after Bariatric Surgery *3103*
- Metabolic Surgery: Procedures, Physiology, and Orthopedic Implications *3105*
- Integrating Metabolic Surgery and Arthroplasty: A Strategic Approach *3105*
- Preoperative Evaluation and Multidisciplinary Management *3106*

130. Nanotechnology in Orthopedics..... 3107

Manish Kumar Varshney

- General Applications of Nanotechnology in Orthopedics *3108*
- Nanomaterials in Bone and Cartilage Tissue Engineering *3112*
- Safety of Nanotechnology *3115*
- Future Perspectives and Conclusion *3115*

131. Orthopedics in Digital Renaissance..... 3117

Manish Kumar Varshney

- Changing Trends in Orthopedics Affected by Digital Renaissance *3117*
- Improving Patient Care End Exploiting the Digital Age by Doctors in Orthopedics *3120*

Trauma Annexures

Annexure 1: Upper Limb Trauma 3125

Manish Kumar Varshney

Annexure 2: Lower Limb Trauma..... 3183

Shafiq Hackla, Manish Kumar Varshney

Annexure 3: Fractures of Axial Skeleton..... 3241

Manish Kumar Varshney

Annexure 4: Neglected Trauma to Bones and Joints 3263

Manish Kumar Varshney, Mohinder Singh Chib

Index **.....3287**

JAYPEE BROTHERS

CHAPTER

124

Robotics, Computer-Assisted Surgery, and Artificial Intelligence in Orthopedics

JAYPEE BROTHERS

INTRODUCTION

The convergence of robotics, computer-assisted surgery (CAS), and artificial intelligence (AI) has fundamentally redefined the landscape of modern orthopedics. Precision, reproducibility, and personalization—once aspirational goals—are increasingly achievable through technology that was, until recently, confined to research laboratories. Orthopedic procedures demand exacting tolerances: a femoral component malpositioned by even a few degrees can alter joint kinematics, accelerate polyethylene wear, and compromise long-term implant survival. It is in this context that technology-assisted surgery has moved from novelty to necessity. As depicted in **Figure 1**, the spectrum of technological integration in orthopedics ranges from passive computer navigation to fully autonomous robotic execution, with a rapidly expanding middle ground of AI-augmented decision support.

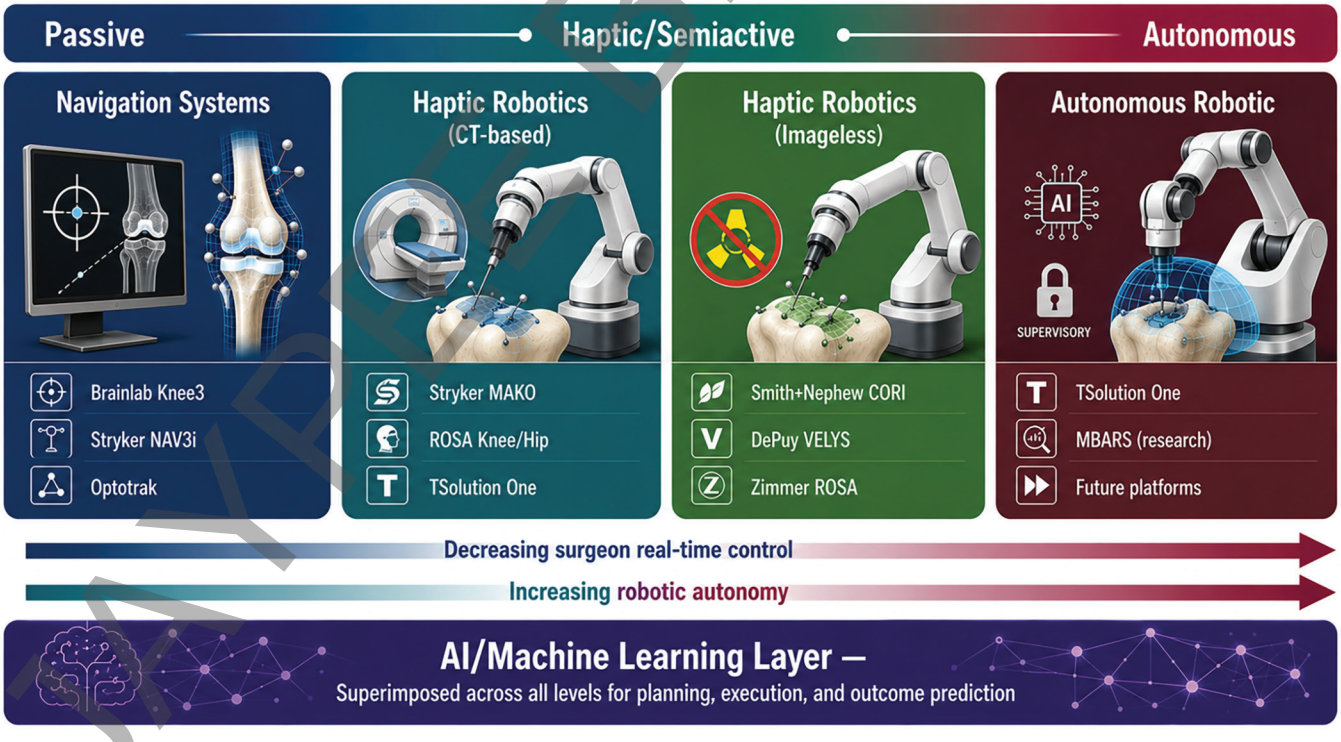


Fig. 1: Spectrum of computer-assisted orthopedic surgery, ranging from passive navigation systems at one end to fully autonomous robotic systems at the other, with haptic/semiactive systems occupying the intermediate zone. Surgeon real-time control progressively decreases, and robotic autonomy progressively increases, from left to right. An artificial intelligence/machine learning layer is superimposed across all levels, contributing to preoperative planning, intraoperative execution, and postoperative outcome prediction irrespective of the underlying system's autonomy class.

TABLE 1: Classification matrix of robotic and computer-assisted orthopedic surgery systems by autonomy and execution mechanism.

Classification axis	*Category*	*Level of surgeon control*	*Orthopedic examples*
Degree of autonomy	Passive/ navigation only	Full (surgeon acts on data)	Stryker NAV3i and Brainlab Knee3
Degree of autonomy	Semiactive (haptic)	Shared (robot constrains)	Stryker MAKO, Smith+Nephew CORI, and Zimmer Biomet ROSA
Degree of autonomy	Autonomous	Supervisory (surgeon initiates/stops)	ThinkSurgical TSolution One
Execution mechanism	Direct resection	Variable	MAKO (burr) and TSolution One (milling)
Execution mechanism	Indirect/jig-assist	Higher	ExcelsiusGPS (spine) and VELYS (TKA)
Execution mechanism	Hybrid	Shared	CORI (burr + digital planning)

BOX 1: Conceptual framework common to all computer-assisted orthopedic surgery (CAOS) systems.

1. **Therapeutic object (TO):** The real anatomical target (e.g., the femur, tibia, or vertebra being operated upon). Intraoperative registration anchors the digital plan to this physical structure.
2. **Virtual object (VO):** The digital counterpart of the TO, generated either preoperatively from CT/MRI data or intraoperatively via fluoroscopy or point-cloud acquisition. In modern systems, deep learning algorithms refine the VO in real time.
3. **Navigator:** The spatial tracking engine that maintains a live, mathematically precise correspondence between the TO and VO throughout the procedure. Optical infrared (IR), electromagnetic (EM), or hybrid tracking modalities are employed. Without robust navigation, the accuracy of even the most sophisticated robotic arm is clinically meaningless.

The word "robot" traces its etymology to the Czech/Polish term *robota*, meaning "forced labor," first coined by playwright Karel Čapek in 1920. The conceptual seed of a mechanical worker had been planted much earlier, implicit in Leonardo da Vinci's mechanical sketches, but the mathematical and computational frameworks required to actualize these concepts remained elusive for centuries. The modern era of AI-enabled machines germinated in 1956 at the Dartmouth Summer Research Project, and it was not until 1985 that this technology first entered the operating theatre when a PUMA 560 robotic arm (Unimation Inc.) was used to perform CT-guided stereotactic neurosurgical biopsy. The orthopedic landmark arrived in 1992 with ROBODOC—the first robot deployed for femoral canal preparation in total hip arthroplasty (THA). The subsequent three decades have witnessed a breathtaking acceleration, transitioning from single-purpose autonomous cutters to multimodal, AI-integrated platforms capable of intraoperative plan modification, outcome prediction, and surgeon coaching.

Contemporary orthopedic robotic and computer-assisted systems are broadly classified on two axes—**(1) the degree of autonomous decision-making** (from passive navigation to autonomous robotic action), and **(2) the mechanism of surgical execution** (direct bone resection versus indirect jig/template placement). These axes yield a matrix of system types summarized in **Table 1**. At the foundation, all such systems share three conceptual building blocks **(Box 1)**: (1) a *therapeutic object (TO)*—the anatomical target; (2) a *virtual object (VO)*—its digital representation; and (3) a *Navigator*—the link that maintains spatial correspondence between TO and VO in real time.

The proposed advantages of technology-assisted orthopedic surgery are well-recognized—more accurate implant placement, improved component alignment, reduced outliers beyond ±3° of the mechanical axis, and enhanced reproducibility across surgeons of varying experience levels. However, the translation of these radiological and technical improvements into demonstrable long-term clinical and functional gains remains an active and evolving area of investigation. The following sections provide a detailed and updated overview of robotic-assisted arthroplasty, spine surgery, trauma applications, computer-assisted orthopedic surgery (CAOS) systems, and the transformative role of AI/machine learning (ML) and Industry 5.0 frameworks in shaping the future of the specialty.

ROBOTIC-ASSISTED ARTHROPLASTY SURGERY

Joint replacement surgery represents the highest-volume application of orthopedic robotics. The clinical rationale is compelling—prosthetic alignment outside accepted mechanical and kinematic thresholds significantly increases the risk of accelerated wear, aseptic loosening, instability, and revision surgery. While experienced surgeons using conventional instrumentation achieve acceptable results, a nontrivial proportion of cases fall outside target ranges—and it is precisely this "tail" of outliers that robotic systems aim to eliminate. **Figure 2** illustrates the workflow common to haptic robotic arthroplasty systems, from preoperative CT-based planning through intraoperative execution.

Robotic systems in orthopedics are best classified by their level of intraoperative autonomy and the nature of their interaction with the surgeon. This framework helps in understanding their distinct capabilities and clinical

JAYPEE BROTHERS

for detailed information on orthopedics books, visit our website **www.ejaypee.com**, for detailed information on orthopedics books, visit

Essential ORTHOPEDICS
Principles & Practice

Salient Features

- The 4th edition of "*Essential Orthopedics: Principles and Practice*", 3 Volumes, is a nearly complete rewrite of the text, incorporating the latest advancements in orthopedic principles and practice, with Artificial Intelligence (AI), Machine Learning (ML), and Industry 5.0-aligned management concepts integrated into every disorder and its management.
- This comprehensive three-volume format spanning more than 3,000 pages ensures exhaustive coverage, from foundational basic science to future-oriented, and technology-integrated orthopedic management.
- Numerous new Tables and dedicated Concept Boxes have been introduced throughout the three volumes to explain updated and emerging concepts, classifications, and management paradigms in a clear, structured, and easy-to-grasp format.
- Difficult and advanced concepts are specifically contained within Concept Boxes, allowing students and clinicians a focused, detailed understanding without being overburdened during regular reading.
- Dedicated clinical practice points are separately included for the Spine and Upper Extremity (excluding Shoulder) sections—regions widely regarded as the most challenging by orthopedic surgeons and residents—bridging theory with real-world clinical decision-making.
- The text is upgraded to reflect the latest prevailing knowledge in orthopedics and is partly heuristic in its integration of AI and ML, making it a valuable and upgraded knowledge resource even for expert clinicians, not just postgraduate trainees.
- Nearly all concepts continue to be described with relevant and high-quality illustrations for rapid comprehension and long-term retention.



Manish Kumar Varshney MS(Orthopedics) AIIMS DNB(Orthopedics) MNAMS MRCS(Glasgow) is the Principal Consultant and Head, Department of Orthopedics, Cygnus Ujala JK Medicity Hospital, Jammu & Kashmir, India, with over two decades of clinical and academic experience in orthopedics since completing his MS (Orthopedics) from the All India Institute of Medical Sciences (AIIMS), New Delhi, in 2004. He has been trained at some of the foremost institutes in the country, including AIIMS, New Delhi and Maulana Azad Medical College, and has assimilated his teaching and clinical experience into several postgraduate orthopedic textbooks, including the three-volume *"Essential Orthopedics: Principles and Practice,"* now in its 4th edition, the widely read compendium "Practical Orthopedic Examination Made Easy," long regarded as one of the most read texts in orthopedics in the country and ever revered "Postgraduate Orthopedics—An Examination Preparatory Manual".

He is also the author of a forthcoming dedicated textbook on Artificial Intelligence (AI) and Machine Learning (ML) in Orthopedics, currently in publication, which comprehensively addresses the application of AI and ML across the full breadth of orthopedic diagnosis, surgical planning, robotics, rehabilitation, and future surgeon-orchestrated care. Reflecting his conviction that orthopedic education must evolve alongside emerging technology, this parallel body of work has directly informed the AI- and ML-integrated content newly woven into every chapter of the present 4th edition, positioning him among the early Indian orthopedic authors to formally systematize this intersection for postgraduate and practicing surgeons alike.

He continues to be a forerunner in guiding postgraduate students through thesis work, grasping core orthopedic principles, and examination preparation. He has been a faculty member in courses organized by the Association for Osteosynthesis (AO) Foundation to help students to understand and apply the principles of trauma surgery. An avid researcher committed to disseminating correct, evidence-based scientific knowledge, he has authored more than 40 national and international research publications and continues to serve as a reviewer for several national and international journals. He has presented extensively at national and international conferences, chaired scientific sessions, and served as a local examiner for the National Board of Examinations (NBE), New Delhi, India. His research has been recognized internationally, including the prestigious "Paul R Manske Award," conferred by the American Society for Surgery of the Hand (ASSH) for the best paper on congenital deficiencies of the upper extremity in 2013, and the "SS Yadav Gold Medal" for his research on aneurysmal bone cysts, which continues to be cited widely by researchers in the field.

JAYPEE BROTHERS

Buy from ejaypee

JAYPEE BROTHERS

Shelving Recommendation
ORTHOPEDICS

ISBN 978-93-7202-731-0

9 789372 027310