Index

Note: Page numbers in italic denote figures, those in bold denote tables.
Prepared by Nigel d’Auvergne.

3D imaging, 197, 206–207, 410–411, 412
see also cone beam computed tomography

AAE Endodontic Case Difficulty Assessment Form and
guidelines, 213–214
abscess see acute apical abscess; apical abscess; marginal
(periodontal) abscess
access cavity, 195–202
canal location, 195–196
clinical procedure, 198
cone beam computed tomography (CBCT) images, 196
as a diagnostic step, 201–202
evaluation criteria, 197
medicolegal considerations, 429
mineralized pulp chambers, 200–201
minimally invasive access cavities, 198–200
perforation during access cavity preparation, 186, 187, 196,
201, 289, 430
preparation, 197–202
radiographic images, 196
rubber dam isolation, timing in relation to access cavity
preparation, 186–187, 187, 196
access opening through crowns and restorations, 344, 345
access preparation, aseptic working field, 186–187
access to the apical area, 347
access to the root tip, surgical endodontics, 368–369
accidents see medicolegal considerations
acute apical abscess, 3
apical periodontitis, 118, 146, 179–180
acute dental pain
analgesics, 183
antibiotics, 182
apical periodontitis, 173
management, 182–183
psychological perspective, 182
adaptive immunity, bacterial invasion, 68–69
adult learning, independent practice, 454–461
AFP (atypical facial pain), 398–399
airway obstruction emergencies, 442, 443, 445, 445
allergic responses that may compromise systemic health,
445–446
alpha- and beta-phase gutta-percha, 285
alveolar fracture, 408, 422
intra-alveolar root fractures, 409, 419–420
analgesics, acute dental pain, 183
anamnesis, in endodontic diagnosis, 53, 143, 171, 173–174,
179
anatomical considerations, local anesthesia, 386
anatomy
anatomical variations in teeth, 211–213
mandibular anterior teeth, 212–213
mandibular molars, 209, 210, 213
mandibular premolars, 213, 214
maxillary anterior teeth, 211, 212
maxillary molars, 212, 213
maxillary premolars, 211–212
root canal system anatomy, 206–211
anesthesia, local see local anesthesia
anterior superior alveolar nerve block (nasopalatine nerve
block), local anesthesia, 384–385
antibiotic-containing solutions, irrigation, 236
antibiotics
apical periodontitis, lack of effectiveness in treating, 332
biofilm elimination, 137
dentendodontic emergencies, 172
irreversible pulpitis, lack of effectiveness, 182
intracanal medicaments, 241
prophylactic, 361
resistance to, 136
severe infections, 443
antigen presentation, apical periodontitis, 104
antimicrobial properties
calcium hydroxide, non-setting, 240
chlorhexidine digluconate, 235
root canal filling materials, 249–250, 257, 258, 260–261, 262,
264, 270
sodium hypochlorite (NaOCl), 232–233, 356–357
antimicrobial retreatment strategies, 356–357
antimicrobial treatment, nonsurgical retreatment, 354–357
AO (atypical odontalgia), 399
apical abscess, 3, 105, 118, 146, 179–180
endodontic emergencies, 176
apical cyst
cyst formation mechanisms, 109
pocket cysts (bay cysts), 106
true cysts, 106
apical gauging, root canal instrumentation, 217
apical granuloma, apical periodontitis, 104–106, 106, 107, 109,
111–112
apical inflammatory conditions, clinical diagnosis, 156
apical obstructions, root canal instrumentation, 351–352
apical periodontitis, 3, 5, 103–119, 146
acute apical abscess, 3, 118, 146, 179–180
acute pain, 173
acute (symptomatic) apical periodontitis, 164
antigen presentation, 104
apical periodontitis (Continued)
apical abscess, 3, 105, 118, 179–180
apical cyst, 105–107, 108
apical granuloma, 104–106, 106, 107, 109, 111–112
asymptomatic (chronic) apical periodontitis, 3, 117–118, 152
bacteria/host equilibrium, 111–113
bacterial coaggregation, 111
bacterial elimination, 107
bacterial front line, 107–110
bacteria persisting after root canal treatment, 129
bacteria signs and symptoms association, 129–131
bacteriological status of teeth, 163
bone resorption, 103, 110–112, 112
bone tissue response, 147–148
case study, 164
cellulitis, 118–119, 180
chronic apical abscess, 3, 108–109, 118, 119
clinical diagnosis, 143–165
clinical manifestations, 103–104, 117–119
complement functions, 109
condensing osteitis, 119
dendritic cell function, 105
diagnosis, 143–165
diagnosis and treatment options, 163–165
diagnostic challenges, 153–154
diagnostic procedures, 143
diagnostic terminology, 117–119
diagnostic procedures, 143
diagnostic terminology, 117–119
endodontic flare-up, 113–114
endodontic infections, 154–161, 162
endodontic pathogens, 131
epithelial cell proliferation, 104–105
healing, 113, 114–115, 153, 164
histology/radiology correlation, 150
images interpretation, 150
immunoglobulin specificity, 114
infecting microbiota, 107–114
infections in root-filled teeth, 126–128
intraoral swelling, 146
lesion formation, 110–111, 113, 114
microbial infection, 107–114
microbial infection and host response, 143–144
microbial pathogenesis, 128–129
microbial virulence factors, 131
nature of, 103–107
nonsurgical retreatment, 343
percussion and palpation testing, 147, 149
periapical lesions, 104, 105
perfusion, 126–128
persistent or secondary, 343
phagocytosis evasion, 111
polymorphonuclear leukocytes (PMNs), 105, 107, 109
pulp testing, 147
radiographic features, 147–153
radiographic methods, 148–150
radiology/histology correlation, 150
symptomatic apical periodontitis, 3, 118, 164, 179–180
symptoms, 103–104
T-cell function, 105, 112
apical pressure, irrigation, 237
apical root canal, irrigation, 236–237
apical surgery, periapical lesions, 116–117
apoptosis
dentin-pulp complex, 17
odontoblasts, 17
arrest of dental development, trauma, 415–416
articaine, local anesthesia, 382
aseptic working field, 185–192, 214
see also rubber dam isolation
access preparation, 186–187
advantages, 186
aseptic working procedures, 190–192
disinfection of the working field, 189–190
evidence, 185
history, 185
tooth isolation, 185–192
working aseptically, 191
asymptomatic apical periodontitis, 3, 117–118, 152
asymptomatic periapical lesions, endodontic retreatment, 332
atypical facial pain (AFP), 398–399
atypical odontalgia (AO), 399
avascular necrosis, trauma, 409
avulsion, trauma, 408, 421–422
bacteria/host equilibrium, apical periodontitis, 111–113
bacterial cluster formation, apical cyst, 109–110
bacterial coaggregation, apical periodontitis, 111
bacterial invasion and innate and adaptive immunity, dentin
lesions cavitation, 68–69
bacterial leakage
dentin-pulp complex, 28–29
pulpal responses to bacterial leakage at tooth/restoration
interfaces, 29, 89, 90, 124, 171
root canal fillings, 252–253
treatment outcome and, 323
bacteria persisting after root canal treatment, apical
periodontitis, 129
bacteria signs and symptoms association, apical periodontitis,
129–131
bacteriological status of teeth, apical periodontitis, 163
balanced force motion, hand instrumentation technique,
221–222
bay cysts (pocket cysts), 106, 109
beneficence
defining, 429
medicolegal considerations, 427
best practice, defining, 427
biofilms, sodium hypochlorite (NaOCl), 232–233
biofilms in root canals
antibiofilm strategies, 137–138, 232
ecological determinants of the endodontic microflora, 136
extraradicular biofilms, 133–134, 135
heterogeneity, 136
microbial interactions, 134–136
microbial resistance to antimicrobials, 136–137
microbiology, 131–138
sodium hypochlorite (NaOCl), 232–233
bleeding management, surgical endodontics, 370–371
blockage prevention, root canal instrumentation, 225–226
blood flow, dental pulp, 19–22
bonding technique, surgical endodontics, 372–373
bone formation and remodeling, periapical lesions, 117
bone-healing
follow-up surgery, 375
Rud–Molven criteria, 375
surgical endodontics, 375
bone resorption
apical periodontitis, 103, 110–112, 112, 113
trauma, 411
bone tissue response, apical periodontitis, 147–148
bridges and crowns, removing, 344
broken instruments
medicolegal considerations, 429, 433
removing, 348, 349–350, 351
bupivacaine, local anesthesia, 383
business considerations see independent practice; medicolegal considerations
calcium hydroxide (Ca(OH)₂)
intracanal medicament, 231, 240–241
pulpectomy, 95
vital pulp treatment, 89, 90
calcium hydroxide sealers, 263–264
antimicrobial properties, 264
biological properties, 263–264
composition, 263
handling properties, 264
root-end closure, 264
technical properties/leakage, 263
toxicity, 263–264
canal complexity, unsuccessful initial treatment, 327–328
canal drying, root canal filling techniques, 281
canal negotiation, 202–203
canal terminus, 202–203
coronal flaring, 202
pre-flaring, 202
working length, 202–203
candor
defining, 429
medicolegal considerations, 429, 431
caries pathology and management, 61–76
carious tissue removal, 69
deep caries management, 3, 72–76
deep and extremely deep carious lesions, 69
dentin lesions cavitation, 67–71
enamel–dentin lesions, 63, 65–67
enamel lesions without clinical cavitation, 63, 64–65
environmental biofilm hypothesis, 61–63
history of untreated caries, 62
natural history of dental caries, 72
carrier devices, root canal filling techniques, 287–288
case study
apical periodontitis, 164
broken tooth, 57
discolored crown, 58
endodontic emergencies, 177
independent practice, 456, 458
instrument fracture, 432, 433
medicolegal considerations, 432, 433
pain conditions, 395, 395
pulpitis, 177
pulp vitality assessment, 54
tooth-related pain, 56
cast cores, materials, 310
cavitation, dentin lesions see dentin lesions cavitation
CBCT see cone beam computed tomography
cellular composition, dental pulp, 17–18
cellulitis
apical periodontitis, 118–119
symptomatic apical periodontitis, 180
cemento-osseous dysplasia, endodontic infections, 160
cements/sealers see sealers/cements
central nervous system mechanisms, dentinal and pulpal pain, 45
ceramics, core materials, 310
cemetes, core materials, 310
cervical (extracanal invasive) resorption, trauma, 412–413
CE sign, root canal filling materials, 250
chemical tissue trauma, emergencies in need of urgent referral, 441–443
chlorhexidine digluconate (CHX)
disinfection, 235
intracanal medicament, 241
irrigation, 235
chronic apical abscess, 3, 108–109
apical periodontitis, 118, 119
citric acid, smear layer removal, 234–235
clinical diagnosis
see also diagnosis
apical inflammatory conditions, 156
apical periodontitis, 143–165
pulp necrosis, 143–165
clinical epidemiology
measuring endodontic disease and treatment outcome, 315–323
terminology, 316
clinical examination
endodontic retreatment, 331
trauma, 417
clinically healthy pulp, diagnostic classification, 58–59
clinical manifestations
apical periodontitis, 103–104
inflammation, 51–52, 52
periapical disease, 52
pulpal disease, 52
clinical problems and solutions, 2–6
cohort studies, endodontic research, 317–318
cold lateral compaction, root canal filling technique, 282, 283–284
cold techniques, root canal filling techniques, 281–285, 283–284
collagen, dental pulp, 18
combination products, irrigation, 236
combinations of warm and cold condensation, root canal filling technique, 288–289
communication, patient, medicolegal considerations, 431–433
competence, independent practice, 457–458
competence, independent practice, 457–458
complaints
see also medicolegal considerations
complaints procedures, 430
learning from, 433
complex oro-facial pain conditions, 397
composite core materials, 310
condensing osteitis, 3, 119
cone beam computed tomography (CBCT), 212–214, 279
access cavity, 196
cystic lesions, 108
neuropathies, 437, 438, 438
periapical lesions, 105, 442
radiographic methods, 148–150, 151
root canal system, 207
trauma, 151, 412
continuous reaming motion, engine-driven Ni-Ti instrument systems, 222–223
cores and posts in restoring root canal-treated teeth, 300, 302, 304–308, 308 removing, 344–347
coronal and crown–root fractures, trauma, 418–419
coronal and radicular access, root canal instrumentation, 214, 215
coronal sealing, rubber dam isolation, 191–192

cracked tooth case study, 57
cross-sectional studies, endodontic research, 317
crown-down sequence, engine-driven Ni-Ti instrument systems, 222
crown–root and coronal fractures, trauma, 418–419
crowns and bridges, removing, 344
curettage of the soft-tissue lesion, surgical endodontics, 369, 370
cycles to failure, root canal instrumentation, 227
cysts and tumors of the jaws, endodontic infections, 161, 162
cytokicity, root canal filling materials, 250–251
decision-making dentist’s perspective, 330–338
endodontic retreatment, 330–339, 330
patient’s perspective, 338–339
pulpal diagnosis, 49–59
deep caries management, 3, 72–76
clinical pulp diagnosis, 75–76
histological picture of pulp inflammation, 70–71
radiographic definitions, 67, 69–70, 71
selective caries removal, 74–75
stepwise caries removal, 74, 75
strategies, 72–74
terminology, 73–74
treatment protocol, 74–76
dendritic cell function, apical periodontitis, 105
dens invaginatus, endodontic infections, 154, 157
dental amalgam, restoration of endodontically treated teeth, 296, 300, 308
dental development arrest, trauma, 415–416
dental history, endodontic retreatment, 330, 331
dental materials, neural injury, 437–440, 438
dental pulp, 17–22
blood flow, 19–22

cellular composition, 17–18

collagen, 18
dentinal repair, 21
eextracellular matrix, 18–19
fibroblasts, 17
glycoproteins, 19
glycosaminoglycans, 19
immune cells, 17–18

immune responses, 20
lymphatics, 22
nerves, 19
neurogenic inflammation, 19, 24–25, 40–43
neuropeptides role, 20, 21
progenitor cells, 18
proteoglycans, 19
resting blood flow, 22
secondary odontoblast-like cells, 18
stem cells, 18, 21
sympathetic nervous system, 20
vascular supply, 19–22
dental trauma see trauma
dentin and pulp pain, 33–46
see also nerves
central nervous system mechanisms, 45
dentin hypersensitivity, 44–45
function of intradental sensory nerves, 36–38
hydrodynamic mechanism in pulp A-fiber activation, 38–40, 39
morphology of intradental sensory innervation, 33–36
nerve fibers classification, 33
nociceptor activation, local control, 44
pain symptoms, 45–46
pulpal diagnosis, 45–46
sensitivity of dentin, 38–40
dentinal fluid protective roles, dentin-pulp complex, 26–28
dentinal repair, dental pulp, 21
dentin-bonding systems, vital pulp treatment, 90
dentin conditioning:
root canal filling techniques, 278–281
smear layer and debris, 278–280
dentin hypersensitivity, 44–45
dentin lesions cavitation bacterial invasion and innate and adaptive immunity, 68–69
caries-induced inflammation, 69
cariogenic activity, 69, 70
lateral spread along the enamel–dentin junction and toward the pulp, 67–68
soft tissue inflammation, 69
dentin-pulp complex, 11–29
apoptosis, 17
bacterial leakage, 28–29
classification of dentin, 14
clinical implications of dentin microstructure, 14–15
dental treatment procedures, 26
dentinal fluid, protective roles, 26–28
dentinal tubules, 11–17, 13
external injuries, 25–29
immune responses, 22–25
inflammation, 24–25
neurovascular responses, 28
nondestructive stimuli responses, 25
odontoblasts, 11–17
odontoblasts and tertiary dentin, 16–17
preparation trauma, 28
pulpal responses to bacterial leakage at tooth/ restoration interfaces, 29
restorative materials effects, 29
restorative procedures, 26
dentin-root canal filling interface, 277–281
dentin wettability, root canal filling techniques, 280
dentist’s perspective, decision-making, endodontic retreatment, 330–338

DETI (Dutch Endodontic Treatment Index), 214
diagnosis
see also pulpal diagnosis
accuracy, 50–51
apical inflammatory conditions, 156
apical periodontitis, 143–165
defining, 49–50
diagnostic methodology, 53–55
endodontic diagnosis, 162–165
evaluation of diagnostic information, 49–50
learning needs, 455
medicolegal considerations, 429, 431
observer variation in periapical radiographic diagnosis, 50
pulp necrosis, 143–165
pulp vitality assessment, 53–55
strategy, 51
wrong diagnosis, medicolegal considerations, 429

diagnosis and treatment options, apical periodontitis, 3, 4
163–165
diagnostic challenges, apical periodontitis, 153–154
diagnostic characteristics, pulp necrosis, 3, 156
diagnostic classification, pulpal diagnosis, 3, 58–59
diagnostic considerations, endodontic emergencies, 171, 172
diagnostic dilemmas, 6, 422
diagnostic methodology
evaluation of reported pain, 55–56
evaluation of tooth discolorations, 58
provocation/inhibition of pain, 56–58
pulp vitality assessment, 53–55

diagnostic process, pain conditions, 395–397
diagnostic quandaries
pulp review/removal, 422–424
trauma, 422–424
diagnostic terminology
apical periodontitis, 117–119
endodontic conditions, 3–6
differential diagnosis, endodontic infections, 159–161, 162
discolored crown
case study, 58
pulpal diagnosis, 58
disinfection, 231–241
see also aseptic working field; irrigation
calcium hydroxide (Ca(OH)₂), 240–241
chlorhexidine digluconate (CHX), 235, 241
hydrogen peroxide (H₂O₂), 235
intracanal medicaments, 240–241
iodine potassium iodide (IKI), 235–236
microorganism eradication, 231
rubber dam, 191
working field, 189–190
Dutch Endodontic Treatment Index (DETI), 214

EDTA, smear layer removal, 234–235
EGTA, smear layer removal, 234–235
electrical test, pulp vitality assessment, 54–55
electrocoagulation, hemostasis, 371
electronic apex locator, working length, 216, 217
electronic pulp testing, 423
emergencies, endodontic see endodontic emergencies
emergencies in need of urgent referral, 435–446

airway obstruction, 442, 443, 445, 445
allergic responses that may compromise systemic health,
445–446
chemical tissue trauma, 441–443
inhalation or aspiration of dental instruments or materials,
445
neurological injuries resulting from endodontic procedures
and materials, 435–440
neurological injuries resulting from periapical inflammation,
440–441
reporting adverse events, 445–446
severe odontogenic infections that may compromise
systemic health, 443–444
severe or persistent pain, 445
susicion of locally aggressive or neoplastic lesions, 444–445
employers, independent practice, 460
evermal–dentin lesions, 65–67
dentin demineralization, 65–66
dentin hypermineralization prior to demineralization of
dentin, 65–66
odontoblasts, 65
superficial lesions, 65
tertiary dentinogenesis and lesion activity, 66–67
enamel lesions without clinical cavitation, 63, 64–65
EndoActivator, irrigation, 238
endodontic complications after trauma, 405–424
endodontic conditions, diagnostic terminology, 3–6
endodontic diagnosis, 162–165
clinical–radiological features, 162–163
extent of infection, 162–163
integrated approach, 162–165
endodontic emergencies, 171–183
see also pain conditions
acute dental pain, 182–183
acute pain from apical periodontitis, 173
acute pain from pulpitis, 173
apical abscess, 176
case study, 177
diagnostic considerations, 171, 172
emergency principles, 171
emergency pulpotomy, 178
etiology, 171–181
idiopathic tooth pain, 182
marginal (periodontal) abscess, 181
neuropathic pain, 182
pain clinical assessment, 173
pain history, 171, 172
pathogenesis, 171–181
posttreatment emergency, 180–181
pulpotomy, 178
reasons, 175
referred pain, 181–182
strategy for emergency treatment, 172
treatment modalities, 172
endodontic infections, 154–161, 162
apical periodontitis, 154–161, 162
cemento-osseous dysplasia, 160
cysts and tumors of the jaws, 161, 162
dens invaginatus, 154, 157
endodontic infections (Continued)
dental trauma, 154
differential diagnosis, 159–161, 162
dentate–periodontal lesions, 154–158, 158
maxillary sinus involvement, 158–159
normal structures, 160
orofacial pain conditions, 160–161
osteomyelitis, 159–160
root fractures, 154, 157
root resorption, 158, 159
sinusitis, 159
tissue reactions, 163
tumors of the jaws, 161, 162
endodontic instruments
see also root canal instrumentation
engine-driven Ni-Ti instrument systems, 217, 219–224
Gates–Glider burs, 218, 218
neuropathies caused by, 437–440
Ni-Ti instrument systems, engine-driven, 217, 219–224
root canal instrumentation, 217–224
Self-Adjusting File (SAF), 221, 227
stainless-steel hand files, 217–224, 223–224
traditional systems, 217–218
endodontic pathogens, apical periodontitis, 131
endodontic–periodontal lesions, 154–158, 158
endodontic research, study designs, 317–318
endodontic retreatment
4, 5, 6, 327–339
see also nonsurgical retreatment
asymptomatic periapical lesions, 332
clinical examination, 331
decision-making, 330–339, 330
dental history, 330, 331
extraction, indications, 333–334
indications for nonsurgical retreatment, 334
indications for operative intervention, 333–338
indications for surgical retreatment, 334–338
medical history, 330, 331
microsurgical classification, 335
nonsurgical retreatment, 3, 4, 6, 334
perforations and resorptions, 338, 339
praxis concept, 332, 333
radiographic examination, 331
reasons for retreatment, 329
resorptions and perforations, 338, 339
signs and symptoms, 332–333
special tests, 331
surgical retreatment, 3, 4, 6, 334–338
unsuccessful initial treatment, 327–329
variation in management of endodontic failures, 332
endodontic treatment and disease, radiologic evaluation, 155
Endodontic Treatment Classification Form (ETC), 214
engine-driven Ni-Ti enlargement, root canal instrumentation, 217
engine-driven Ni-Ti instrument systems, 217, 219–224
reciprocation, 223, 227
vs stainless-steel hand files, 223–224
origin in infected root canals, 128
environment, working see aseptic working field
environmental biofilm hypothesis, 61–63
environmental pollution, dental amalgam, 308
epinephrine-containing agents, local anesthesia, 381, 382–383,
episteme, 1
epithelial cell proliferation, apical periodontitis, 104–105
epoxy resin sealers, 261–263
antimicrobial properties, 262
biological properties, 262, 263
composition, 261
handling properties, 262–263
technical properties/leakage, 261–262
toxicity, 262, 263
errors see medicolegal considerations
ETC (Endodontic Treatment Classification Form), 214
ethical considerations, 427
see also medicolegal considerations
eugenol see zinc oxide–eugenol sealers
evidence-based medicine, treatment outcome, 316
experimental studies, endodontic research, 318
external injuries, dentin-pulp complex, 25–29
extracanal invasive (cervical) resorption, trauma, 412–413
extracellular matrix, dental pulp, 18–19
extraradicular infection, unsuccessful initial treatment, 327
extrusive luxation, 408, 420–421
fibroblasts, dental pulp, 17
filing motions, hand instrumentation technique, 221–222
final root canal preparation, root canal instrumentation, 217
flap design, surgical endodontics, 363, 365
flap elevation and retraction, surgical endodontics, 368, 369
flap repositioning and suturing, surgical endodontics, 373–374
follow-up
neurological injury, 437, 440
non-surgical treatment, 150, 315, 330
pulp capping, pulpotomy, 89
trauma, 417, 418–421
forceps, rubber dam isolation, 187–188
fracture predilection, root-treated teeth, 295–296, 297–298
fractures
see also instrument fracture; luxations; root fractures
alveolar fracture, 408, 409, 419–420, 422
coronal and crown–root fractures, 418–419
pulp revascularization, 408
root canal treatment, 418–419
trauma, 406, 407, 418–420
functional pain, 394–395
Gates–Glider burs, 218, 218
GentleWave, irrigation, 239–240
glycoproteins, dental pulp, 19
glycosaminoglycans, dental pulp, 19
gutta-percha
alpha- and beta-phase gutta-percha, 285
antimicrobial properties, 257
biological properties, 256–257
composition, 254–255
cones, 253–255
exploring sinus tracts and periodontal pockets, 147, 149
handling properties, 257
injectable, 286–287
master cone fit, 282
Index 469

removing, 347
root canal filling materials, 249, 250, 253–257
root canal filling techniques, 282, 285, 286–287
technical properties, 255–256

hand instrumentation techniques, 221–222
HCSCs see hydraulic calcium silicate cements
hemostasis
chemicals, 371
electrocoagulation, 371
local anesthetic vasoconstriction, 370
pressure application, 370
proper and gentle operation technique, 370
resorbable agents, 371
suctioning, 370
surgical endodontics, 370–371
histological picture of pulp inflammation, deep caries
management, 70–71
hydraulic calcium silicate cements (HCSCs), 268–272
bioactivity, 270
biological properties, 270
composition, 268–269
handling properties, 270–271
technical properties, 269–270
toxicity, 270, 271
vital pulp treatment, 90–91
hydrogels, regenerative endodontics, 272
hydrogen peroxide (H\textsubscript{2}O\textsubscript{2})
  disinfection, 235
  irrigation, 235
hyperplastic pulpitis 80
hypersensitive dentin, 44–45
IANB (inferior alveolar nerve block)
  local anesthesia, 382, 385, 386, 387, 388, 436–437
  nerve injury, 435–437
infiltrations, local anesthesia, 385
infused pulp
  clinical evidence, 125
  microbiology, 123–138
inflammation
  caries-induced inflammation, 69
  clinical manifestations, 51–52, 52
  crucial prerequisite for repair and regeneration, 24
  dentin-pulp complex, 24–25
  histological picture of pulp inflammation, 70–71
  inflammatory mediators, 41–42
  morphological vs functional changes of pulpal nerves in
    inflammation, 42–43
  nerves, 40–43
  neurogenic inflammation, 19, 24–25, 40–43
  periapical inflammation, 51–52, 440–441
  pulpal inflammation, 19, 24–25, 40–43, 51–52
  soft tissue inflammation, 69
  vascular events, 24–25
  inflammatory (infection-related) root resorption, trauma, 411–412
inflammatory pain, 393–394
informed consent
  see also medicolegal considerations
defining, 429
infraorbital nerve block, local anesthesia, 384
injectable gutta-percha, 286–287
innate immunity, bacterial invasion, 68–69
instrumentation
  see endodontic instruments; root canal instrumentation
instrument fracture
  broken instruments, removing, 348, 349–350, 351
  case study, 432, 433
  medicolegal considerations, 429, 432, 433
  prevention, 226–227
  root canal instrumentation, 224–225, 226–227
  instrument swallowed/inhaled
    emergencies in need of urgent referral, 445
    medicolegal considerations, 429–430
    insurance
  see also medicolegal considerations
    professional indemnity/malpractice insurance, 430–431
index

internal inflammatory root resorption, trauma, 412–413
intra-alveolar root fractures, 409, 419–420
intracanal medicaments, 240–241
intrapulpal injection, local anesthesia, 390, 391
intraosseous injection, local anesthesia, 389, 390, 391
intraradicular conditioning, 278–281
intraradicular infection, unsuccessful initial treatment, 327
intraseptal anesthesia, local anesthesia, 389–390
intrusive luxation, 408, 420–421
iodine potassium iodide (IKI)
  disinfection, 235–236
  irrigation, 235–236
irreversible pulpitis, 3, 176, 178
irrigation, 231–241
  see also disinfection
  activation of irrigant flow, 237–238
  antibiotic-containing solutions, 236
  apical pressure, 237
  apical root canal, 236–237
  chlorhexidine digluconate (CHX), 235
  combination products, 236
  EndoActivator, 238
  GentleWave, 239–240
  hydrogen peroxide ($H_2O_2$), 235
  iodine potassium iodide (IKI), 235–236
  irrigant properties, 236
  key properties, 232
  lasers, 238–239
  microorganism eradication, 231
  MTAD (a mixture of tetracycline isomer, acid, and detergent), 1–2, 236
  Photon Induced Photoacoustic Streaming (PIPS™), 238–239
  ProUltra PiezoFlow ultrasound system, 239
  QMiX, 236
  root canal irrigation, 231–241
  safe and effective, 235
  SmearClear, 236
  SmearOff, 236
  sodium hypochlorite (NaOCl), 231, 232–235, 356–357
  sonic and ultrasonic cleaning, 238, 239–240, 239
  syringe-needle irrigation, 237–238
  Tetraclean, 236
  ultrasonic cleaning, 238, 239–240, 239
  wide-spectrum sound energy, 239–240
  isthmuses, root-end preparation, 371, 372
keratocystic odontogenic tumor, 161, 162
key terms
  diagnostic, 3
  medicolegal, 429
  transition to independent practice, 453
lasers, irrigation, 238–239
lateral luxation, 408, 420–421
leakage/sealing, root canal filling materials, 252–253
learning, self-directed learning, independent practice, 454–461
learning from complaints and mistakes, medicolegal considerations, 433
ledges, root canal instrumentation, 347, 352, 354
ledging prevention, root canal instrumentation, 226
legal considerations see medicolegal considerations
lidocaine, local anesthesia, 382, 387
limited reach vs unwanted dentin removal, root canal instrumentation, 224
local anesthesia, 381–391
  anatomical considerations, 386
  anterior superior alveolar nerve block (nasopalatine nerve block), 384–385
  articaine, 382
  bupivacaine, 383
  challenging, 387–388
  complications, 391
  difficulties, 386–387
  effectiveness assessment, 383
  emergencies in need of urgent referral, 435–437
  epinephrine-containing agents, 381, 382–383, 387
  failure to secure anesthesia, 385
  fundamentals, 381, 382, 382
  hemostasis, 370
  IANB (inferior alveolar nerve block), 386
  inferior alveolar nerve block (IANB), 382, 385, 386, 387, 388, 436–437
  infiltrations, 385
  infrabony infection, 389
  intrapulpal injection, 390, 391
  intraseptal anesthesia, 389–390
  lidocaine, 382, 387
  local anesthetic-related neuropathies, 435–437
  mandibular infiltrations, 388
  mandibular nerve blocks, 387–388
  mandibular teeth, 385
  maxillary nerve blocks, 387–388
  maxillary teeth, 383–385
  maximum safe doses, 391
  mepivacaine, 382–383, 387
  nasopalatine nerve block (anterior superior alveolar nerve block), 384–385
  nerve blocks, 385
  neurological injuries, 435–437
  neurosensory assessment, 436
  periodontal ligament injections, 388–389
  pH influence, 382
  physiological considerations: inflammation, 386–387
  posterior superior alveolar nerve block, 383–384
  prilocaine, 383, 387
  pulpitis, 386–387
  sedation, 390–391
  sensitization, 386–387
  standard methods, 383–385
  supplementary injections, 388–390
  surgical endodontics, 363
  trigeminal nerve injuries, 382
  luxations, 406–411, 408
  see also fractures
  classification, 406
  clinical features, 406
  concussion and subluxation, 420
  extrusive luxation, 408, 420–421
  intrusive luxation, 408, 420–421
  lateral luxation, 408, 420–421
  risks of complication, 406
  splinting, 420–422
  trauma, 420–422
lymphatics, 22
maleic acid, smear layer removal, 234–235
malignancy, emergencies in need of urgent referral, 444–445
malpractice
see also medicolegal considerations
defining, 429
mandibular anterior teeth, anatomy, 212–213
mandibular infiltrations, local anesthesia, 388
mandibular molars, anatomy, 209, 210, 213
mandibular nerve blocks, local anesthesia, 387–388
mandibular premolars, anatomy, 213, 214
mandibular teeth, local anesthesia, 385
marginal (periodontal) abscess, 181
master cone fit
gutta-percha, 282
root canal filling technique, 282
materials
see also root canal filling materials
bioactive capping materials, vital pulp treatment, 91–92
capping materials, vital pulp treatment, 89–92
cast cores, 310
ceramics, 310
cermets, 310
composite, 310
core materials, prosthodontic reconstruction, 310
hydrogels, 272
post materials, 303–304
regenerative endodontics, 272
reimplantation, 271–272
retrograde fillings during root-end surgery, 271–272
tissue–biomaterial interaction and pulp healing, vital pulp treatment, 91–92
maxillary anterior teeth, anatomy, 211, 212
maxillary molars, anatomy, 212, 213
maxillary nerve blocks, local anesthesia, 388
maxillary premolars, anatomy, 211–212
maxillary sinus involvement, endodontic infections, 158–159
maxillary teeth, local anesthesia, 383–385
mechanical tests, pulp vitality assessment, 53–54
medical history, endodontic retreatment, 330, 331
medicament accident, medicolegal considerations, 430
medical history, endodontic research, 318
metal or plastic carriers, removing, 348–349
methacrylate-based sealers, 264–267
biological properties, 267
composition, 265, 266
handling properties, 267
technical properties/lack of leakage, 265–267
toxicity, 267
methylprednisolone injection
acute pulpitis, 178
pulpitis, 178
microbial infection, apical periodontitis, 107–114
microbial pathogenesis, apical periodontitis, 128–129
microbial reduction by instrumentation, 232
microbial virulence factors, apical periodontitis, 131
microbiology
bacteria persisting after root canal treatment, 129
bacteria signs and symptoms association, 129–131
biofilms in root canals, 131–138
biological evidence, 131–133
clinical evidence, 124–126
historical background, 123–124
inflamed pulp, 123–138
necrotic pulp, 123–138
root canal biofilms, 127–128
root-filled teeth, 127–128
routes of microbial entry to the pulpal space, 124–125, 124
microbiota
‘failed’ root canal treatment, 356
infecting microbiota, apical periodontitis, 107–114
root canal microbiota, 123–124, 127
root-filled teeth, 354–356
microorganism eradication, root canal system, 231
see also disinfection; irrigation
migraine/neurovascular orofacial pain, 401
mineralized pulp chambers, access cavity, 200–201
mineral trioxide aggregate (MTA)
see also hydraulic calcium silicate cements (HCSCs)
perforation repair, 354
pulp capping, 84, 92
mishaps see medicolegal considerations
missed canals, root canal instrumentation, 352–353, 355
modified double flared approach
hand instrumentation technique, 221
root canal instrumentation, 214–215, 216, 217, 221
molecular identification, root canal bacteria, 130
motivation to succeed, independent practice, 455–457
MTA see mineral trioxide aggregate
MTAD (a mixture of tetracycline isomer, acid, and detergent), irrigation, 1–2, 236

nasopalatine nerve block (anterior superior alveolar nerve block), local anesthesia, 384–385

necrotic pulp, 5
clinical evidence, 125–126
diagnostic classification, 59
microbiology, 123–138
pulpal diagnosis, 59

negligence
see also medicolegal considerations
defining, 429

neoplastic lesions, emergencies in need of urgent referral, 444–445

nerve blocks, local anesthesia, 385

nerve fibers classification, 33, 34
neurogenic inflammation, 19, 24–25, 40–43
nociceptor activation, local control, 44
odontoblasts as receptor cells, 40
peripheral neural changes, 41
sensitivity of dentin, 38–40
tissue injury responses, 40–41

neural injury
dental materials, 437–440, 438
root canal treatment, 437–440, 438
neurogenic inflammation, dental pulp, 19, 24–25, 40–43
neurogenic vasodilatation, 41

neurological injuries
endodontic procedures and materials, 435–440
local anesthetic-related, 435
periapical inflammation, 440–441
neuropathic pain, 394, 397–398
endodontic emergencies, 182
management of persistent neuropathic pain, 440
neuropeptides role, dental pulp, 20, 21
neurosensory assessment, local anesthesia, 436
neurovascular orofacial pain/migraine, 401
neurovascular responses, dentin-pulp complex, 28
Ni-Ti instrument systems, engine-driven, 217, 219–221
non-endodontic tooth pain, 181–182
non-inflammatory root resorption, trauma, 413–415
nonmaleficence
defining, 429
medicolegal considerations, 427
non-odontogenic pain, endodontic emergencies, 182
nonsurgical retreatment, 3, 4, 6, 343–358
see also endodontic retreatment
access opening through crowns and restorations, 344, 345
access to the apical area, 347
antimicrobial retreatment strategies, 356–357
antimicrobial treatment, 354–357
apical periodontitis, persistent or secondary, 343
broken instruments, removing, 348, 349–350, 351
cores and posts, removing, 344–347
critical steps, 344
crowns and bridges, removing, 344
gutta-percha, removing, 347
indications, 334, 343–358
metal or plastic carriers, removing, 348–349
periapical healing, 357
preventive retreatment, 343–344
prognosis, 357
root canal instrumentation, 350–354
sealers/cements/pastes, removing, 348
silver cones, removing, 348
tooth survival, 357

normal anatomical structures, radiographic interpretation, 160
normal apical tissues, 3
normal pulp, 3

objectives of endodontic treatment, 2
occlusal loading, prosthodontic reconstruction, 298–299
odontoblasts
apoptosis, 17
dentin-pulp complex, 11–17
enamel–dentin lesions, 65
multifunctions, 15
odontoblast cycle, 13, 13
odontoblast process, 15–16
pulpal immune defense, 15
as receptor cells, 40
total, 15–16
primary dentin, 16–17
odontogenic pain, endodontic emergencies, 182
orofacial pain conditions, endodontic infections, 160–161
osteomyelitis, endodontic infections, 159–160
osteoprogenitor cells, periapical lesions, 115
outcome, treatment see treatment outcome

pain clinical assessment, endodontic emergencies, 173
pain conditions, 393–402
see also dental and pulpal pain; endodontic emergencies
acute dental pain, 182–183
acute pain, apical periodontitis, 173
atypical facial pain (AFP), 398–399
atypical odontalgia (AO), 399
case study, 395, 395
complex orofacial pain conditions, 397
diagnostic process, 395–397
functional pain, 394–395
inflammatory pain, 393–394
migraine/neurovascular orofacial pain, 401
neuropathic pain, 394, 397–398
neurovascular orofacial pain/migraine, 401
painful posttraumatic trigeminal neuropathy, 397–398
pain management, 398, 399, 400, 401, 402
pain mechanisms, 393–395
persistent dentoalveolar pain (PDAP), 399
persistent idiopathic facial pain (PIFP), 398–399
pulpal pain, differential diagnosis, 57–58
pulpitis–vital pulp, symptomatic, pain history, 173–174
referred pain – temporomandibular disorder pain, 401–402
sensory nerve action potential (SNAP), 397
temporomandibular disorder pain – referred pain, 401–402
transient pain, 393
trigeminal autonomic cephalalgias, 401
trigeminal neuralgia, 399–400
trigemino-facial blink reflex, 397
unexpected pain, medicolegal considerations, 429
painful posttraumatic trigeminal neuropathy, 397–398
pain history
endodontic emergencies, 171, 172
pulpitis–vital pulp, symptomatic, 173–174
pain management, 398, 399, 400, 401, 402
pain mechanisms, 393–395
pain symptoms
dentinal and pulpal pain, 45–46
pulpal diagnosis, 45–46
paper point evaluation, working length, 216–217
papilla base flap, surgical endodontics, 365
papilla base incision, 366–367
‘parachute’ technique, cores and posts, removing, 345, 346
passive compaction, root canal filling technique, 282
pastes, removing, 348
patient communication, medicolegal considerations, 431–433
patient information
periapical surgery, 374
postoperative measures, 374
surgical endodontics, 374
patient’s best interests, medicolegal considerations, 431–433
patient’s perspective, decision-making, endodontic retreatment, 338–339
PDAP (persistent dentoalveolar pain), 399
perfusion and palpation testing, pulp necrosis, 147, 149, 149
perforation during access cavity preparation, medicolegal considerations, 429
perforation prevention, root canal instrumentation, 226, 227
perforation repair
mineral trioxide aggregate (MTA), 354
root canal instrumentation, 353–354
perforations and resorptions, endodontic retreatment, 338, 339
periapical disease
clinical manifestation, 52
treatment outcome, 319
periapical disease, nature of, unsuccessful initial treatment, 328
periapical healing, nonsurgical retreatment, 357
periapical health and disease, visual descriptors, 155
periapical inflammation, 51–52
neurological injuries, 440–441
pulpal diagnosis, 51–52
periapical lesions
apical periodontitis, 104, 105
apical surgery, 116–117
asymptomatic periapical lesions, 332
bone formation and remodeling, 117
healing, 113, 114–115, 153, 164
normal periapical conditions, 117
osteogenitor cells, 115
perisite, 115–117
radiographic healing, 117
T-cell function, 112
treatment, 114–115
periapical radiographic diagnosis, observer variation, 50
periapical surgery, patient information, 374
periodontal (marginal) abscess, 181
periodontal ligament injections, local anesthesia, 388–389
persistent dentoalveolar pain (PDAP), 399
persistent idiopathic facial pain (PIFP), 398–399
phagocytosis evasion, apical periodontitis, 111
phenolic compounds, intracanal medicaments, 241
pH influence, local anesthesia, 382
Photon Induced Photoacoustic Streaming (PIPS), irrigation, 238–239
phronesis, 1–2
physiological considerations: inflammation, local anesthesia, 386–387
PIFP (persistent idiopathic facial pain), 398–399
PIPS (Photon Induced Photoacoustic Streaming), irrigation, 238–239
planktonic microbes, effects of sodium hypochlorite, 232
PMNs (polymorphonuclear leukocytes), apical periodontitis, 105, 107, 109
pocket cysts (bay cysts), 106, 109
polymorphonuclear leukocytes (PMNs), apical periodontitis, 105, 107, 109
posterior superior alveolar nerve block, local anesthesia, 383–384
postoperative considerations, vital pulp treatment, 96
postoperative measures
patient information, 374
surgical endodontics, 374–375
postoperative recall, pulp-preserving therapies, 89
post placement, 301, 302, 302, 303
posts and cores, removing, 344–347
posts characteristics, 303–306
diaphragm, 306
post diameter, 305
post length, 305
post materials, 303–304, 303
post shape, 304–305
surface configuration, 305–306
post space preparation
cementing posts, 307
clinical outcomes for posts, 307–308
praxis concept, endodontic retreatment, 332, 333
preparation trauma, dentin-pulp complex, 28
preventing procedural mishaps, root canal instrumentation, 225–227
previously initiated treatment, 3
previously treated tooth, 3
prilocaine, local anesthesia, 383, 387
professional indemnity/malpractice insurance, medicolegal considerations, 430–431
progenitor cells, dental pulp, 18
prosthodontic reconstruction, 295–311
anterol teeth, 302–303
core materials, 310
fracture predilection, 295–296, 297–298
intact teeth, 302, 308–309

Index 473
prosthodontic reconstruction (Continued)
occlusal loading, 298–299
posterior teeth, 308–310
posts characteristics, 303–306
restorability of teeth, 299–300, 301
restoration failure, 310–311
restoration principles, 300–301
root-treated teeth, 295–311
teeth with inadequate retention or resistance, 303
teeth with inadequate tissue for retention without auxiliary aids, 309–310
teeth with MOD (mesio-occluso-distal) cavities, 309
teeth with proximal cavities, 303
teeth with proximo-occlusal cavities, 309
timing of restoration, 301–302

proteoglycans, dental pulp, 19
ProUltra PiezoFlow ultrasound system, irrigation, 239
psychological perspective, acute dental pain, 182
pulp, dental see dental pulp; dentin-pulp complex; vital pulp
treatment
pulpal diagnosis, 3, 49–59, 422–424
accuracy, 50–51
clinically healthy pulp, 58–59
collecting diagnostic information, 52–53
cracked tooth, 57, 177
decision-making, 49–59
dentinal and pulpal pain, 45–46
diagnostic classification, 58–59
diagnostic methodology, 53–55, 56–58
differential diagnosis, 57–58
dischored crown, 58
electronic pulp testing, 423
evaluation of diagnostic information, 49–50
evaluation of reported pain, 55–56
evaluation of tooth discolorations, 58
key literature, 423
necrotic pulp, 59
pain symptoms, 45–46
periapical inflammation, 51–52
pulpal inflammation, 51–52
pulpitis: reversible/irreversible, 59
pulp vitality assessment, 53–55
strategy, 51
temperature changes, 56
tooth-related pain, 56
trauma, 422–424
pulpal disease, clinical manifestation, 52
pulpal immune defense, odontoblasts role, 15
pulpal inflammation, 19, 24–25, 40–43, 51–52
pulpal pain, differential diagnosis, 57–58
pulpal responses to bacterial leakage at tooth/restoration interfaces, dentin-pulp complex, 29
pulp breakdown, trauma, 411–416
pulp canal mineralization, access cavity, 200–201
pulp capping, vital pulp treatment, 3, 4, 5, 81–84, 85, 89–91
direct pulp capping (class I), 82
direct pulp capping (class II), 83
pulpectomy, 3–4, 4
calcium hydroxide (Ca(OH)₂), 95
inter-appointment dressing with calcium hydroxide, 95
objective, 93–94
step-by-step procedure, 95
treatment principles, 94–95, 96
vital pulp treatment, 3, 4, 5, 93–96
wound healing, 95–96
pulp infection, trauma, 411–416
pulpitis, 3
acute pain, 173
case study, 177
irreversible pulpitis, 3, 176, 178
local anesthesia, 386–387
reversible pulpitis, 3, 176, 178
pulpitis: reversible/irreversible, diagnostic classification, 59
pulpitis—vital pulp, symptomatic, 173–177
anamnesis, 173–174
examination, 174–176
pain history, 173–174
pulp necrosis, 3
clinical diagnosis, 143–165
clinical features, 144–145
diagnostic characteristics, 156
diagnostic procedures, 143
gutta-percha, for tracing sinus tracts, 147, 149
microbial infection and host response, 143–144
percussion and palpation testing, 147, 149, 149
pulp testing, 147
pulpotomy
endodontic emergencies, 178
full or “pulp chamber”, 86
vital pulp treatment, 3, 4, 5, 84–87
pulp-preserving therapies, 79
age of patient, 88
clinical procedure, 88–89
controversial treatment?, 92–93
factors of importance, 87–89
integrity of permanent restorations, 89
postoperative recall, 89
size of pulp exposure, 88
pulp polyp, 80
pulp regeneration, 424
pulp revitalization, fractures, 408
pulp review/removal
diagnostic quandaries, 422–424
trauma, 422–424
pulp space mineralized tissue, trauma, 409–411
pulp therapy result factors, unsuccessful initial treatment, 328
pulp vitality assessment, 53–55
case study, 54
clinical use, 54
electrical test, 54–55
mechanical tests, 53–54
thermal tests, 54
punches, rubber dam isolation, 187–188
QMiX, irrigation, 236
radiographic definitions, deep caries management, 67, 69–70, 71
radiographic examination
endodontic retreatment, 331
trauma, 417–418
radiographic features  
apical periodontitis, 147–153  
follow-up methods, 150–153  
images interpretation, 150  
observer variation in periapical radiographic diagnosis, 50  
radiology/histology correlation, 150  
radiographic healing, periapical lesions, 117  
radiographic images  
access cavity, 196  
rubber dam isolation, 191  
radiographic methods  
apical periodontitis, 148–150  
working length, 215–216  
radiologic evaluation, endodontic treatment and disease, 155  
reaming motions, hand instrumentation technique, 221–222  
reciprocation, engine-driven Ni-Ti instruments systems, 223, 227  
reconstruction, prosthodontic see prosthodontic reconstruction  
record-keeping, medicolegal considerations, 433  
rectangular flap, surgical endodontics, 365  
referral, medicolegal considerations, 431  
referred pain – temporomandibular disorder pain, 401–402  
regenerative endodontics, materials, 272  
removing  
broken instruments, 348, 349–350, 351  
cores and posts, 344–347  
crowns and bridges, 344  
gutta-percha, 347  
metal or plastic carriers, 348–349  
sealers/cements/pastes, 348  
silver cones, 348  
reporting adverse events, emergencies in need of urgent referral, 445–446  
research, endodontic, study designs, 317–318  
reshaping the root canal, root canal instrumentation, 350–351, 352  
resorbable agents, hemostasis, 371  
resorption  
see also bone resorption; root resorption  
replacement, 342  
resorptions and perforations, endodontic retreatment, 338, 339  
restoration failure  
cores and posts, 311  
root structure, 311  
superstructure, 311  
tooth structure, 311  
loss of retention, 301, 310–311  
root-treated teeth, 310–311  
structural mechanical failure, 311  
restoration principles  
see also prosthodontic reconstruction  
root-treated teeth, 300–301  
restorative materials effects, dentin-pulp complex, 29  
restorative procedures, dentin-pulp complex, 26  
retreatment see endodontic retreatment; nonsurgical retreatment  
retrograde fillings during root-end surgery, materials, 271–272  
reversible pulpitis, 3, 176, 178  
revitalization and/or regenerative endodontic procedures, 97  
risk factors  
activated irrigation and intracanal medicaments, 322  
age of patient, 320  
aseptic procedures, 321–322  
cleaning and preparation/Instrumentation technique, 322  
complications during treatment, 322  
coronal restoration, 323  
general dental health, 320–321  
general health, 320  
intraoperative risk factors, 321–322  
irrigation, 322  
marginal bone level, 321  
patency, 322  
person-specific risk factors, 319–321  
perioperative diagnosis, 321  
perioperative pain, 321  
perioperative risk factors, 321  
perioperative root filling, 321  
quality of preparation and root filling, 322  
root filling quality, 323  
single visit – multiple visits, 322  
sinus tract, 321  
size of apical preparation, 322  
smoking, 320  
socioeconomic status, 320  
tooth number/type, 321  
tooth-specific risk factors, 321  
treatment outcome, 319–323  
risk management, medicolegal considerations, 431–432  
root canal bacteria, molecular identification, 130  
root canal biofilms, microbiology, 131–138  
root canal disinfection, 3, 4, 5, 231–241  
see also disinfection; irrigation  
root canal filling–dentin interface, 277–281  
root canal filling materials, 248–272  
antimicrobial properties, 257, 260, 262, 264  
biocompatibility, 250–252, 252  
biological properties, 249–250  
cements/sealers, 257–272  
CE sign, 250  
gutta-percha, 249, 250, 253–257  
handling properties, 249, 250  
leakage/sealing, 252–253  
limitations, 248  
purpose, 248  
requirements, 249–253  
sealers/cements, 257–272  
sealing/sealant, 252–253  
selection, 248–249  
technical properties, 249  
toxicity, 250–251  
root canal filling techniques, 277–289  
canal drying, 281  
carrier devices, 287–288  
clinical objectives, 277, 278  
cold lateral compaction, 282, 283–284  
cold techniques, 281–285, 283–284  
combinations of warm and cold condensation, 288–289  
dentin conditioning, 278–281  
dentin wettability, 280  
evidence, limited on relative efficacy, 277, 278  
gutta-percha, 282, 285, 286–287  
intraradicular conditioning, 278–281  
laboratory studies, 277  
master cone fit, 282
Index

root canal filling techniques (Continued)

root canal filling–dentin interface, 277–281

in vitro investigations, 277, 278

warm lateral compaction, 285
warm techniques, 285–289
warm vertical compaction, 285–286
wide open apical foramen, 289

root canal infections, clinical features, 145–147, 148

root canal instrumentation, 205–227, 350–354
anatomical variations in teeth, 211–213
apical gauging, 217
apical obstructions, 351–352
blockage prevention, 225–226
coronal and radicular access, 214, 215
cycles to failure, 227
endodontic instruments, 217–221
engine-driven Ni-Ti enlargement, 217
engine-driven Ni-Ti instrument systems, 217, 219–224
final root canal preparation, 217
hand instrumentation techniques, 221–222
initial root canal preparation, 214–217
instrumentation techniques, 221–223
instrument fracture, 224–225
instrument fracture prevention, 226–227
ledges, 347, 352, 354
ledging prevention, 226
limitations, 223–225
limited wall contact vs unwanted dentin removal, 224
missed canals, 352–353, 355
modified double flared approach, 214–215, 216, 217, 221
nonsurgical retreatment, 350–354
perforation prevention, 226, 227
perforation repair, 353–354
preassessment, 213–214
preventing procedural mishaps, 225–227
principles, 205–206
procedural steps, 213–217
reshaping the root canal, 350–351, 352
root canal system anatomy, 206–211
stripping, prevention, 226
working length, 215–217
zipping prevention, 226
root canal irrigation, 231–241

root canal microbiota, 123–124, 127
root canal system, eradication of microorganisms, 231

root canal system anatomy, 206–211
apical configuration, 209, 210
cross-sectional shape and diameter, 208, 209, 210
dentinibility and pathologically induced changes, 209–211
root canal curvature, 207–208
root canal(s) versus root canal system, 206–207

root canal treatment

bacteria persisting after, 129
fractures, 418–419
neral injury, 437–440, 438

root-end closure
calcium hydroxide sealers, 264
retrograde fillings during root-end surgery, 271–272
root-end filling, surgical endodontics, 372–373

root-end preparation

isthmuses, 371, 372
surgical endodontics, 371–372

root-end resection, surgical endodontics, 369, 370

root-filled teeth, microbiology, 127–128

root filling technical aspects, medicolegal considerations, 430

root fracture predilection, root-treated teeth, 295–296, 297–298

root fractures
endodontic infections, 154, 157
intra-alveolar root fractures, 409, 419–420

root resorption
endodontic infections, 158, 159
inflammatory (infection-related), 411–412
internal inflammatory, 412–413, 414, 415
non-inflammatory, 413–415

root-treated teeth
see also prostodontic reconstruction

as abutments, 299, 300
fracture predilection, 295–296, 297–298
restorability of teeth, 299–300, 301
restoration failure, 310–311
restoration principles, 300–301
rubber dam isolation
see also aseptic working field

access cavity, 196
application of the rubber dam, 189
aseptic working field, 185–192
coronal sealing, 191–192
disinfection of the rubber dam, 191
forceps, 187–188
prerequisites, 187
punches, 187–188
radiographic images, 191
rubber dam clamp, 187
rubber dam frame, 188–189
winged technique, 189
wingless technique, 189

Rud–Molven criteria, bone-healing, 375

SAF (Self-Adjusting File), 221, 221

sealers/cements, 257–272
calcium hydroxide sealers, 263–264
epoxy resin sealers, 261–263
hydraulic calcium silicate cements, 268–272
methacrylate-based sealers, 264–267
removing, 348
root canal filling materials, 257–272
silicones, 267–268
zinc oxide–eugenol sealers, 258–261

sealing/leakage, root canal filling materials, 252–253

secondary odontoblast-like cells, dental pulp, 18
sedation, adjunct to local anesthesia, 390–391
selective caries removal, deep caries management, 74–75
selective carious removal, 3, 4
Self-Adjusting File (SAF), 221, 221

self-directed learning, independent practice, 454–461
sensory nerve action potential (SNAP), pain conditions, 397
signs and symptoms, endodontic retreatment, 332–333
silicones
biological properties, 268
composition, 268
handling properties, 268
sealers/cements, 267–268
technical properties/leakage, 268
toxicity, 268
silver cones, removing, 348
single-cone technique, root canal filling technique, 279, 281–282
sinusitis, endodontic infections, 159
skills limits, medicolegal considerations, 431
SmearClear, irrigation, 236
smear layer and debris, dentin conditioning, 278–280
smear layer removal, sodium hypochlorite (NaOCl), 234–235
SmearOff, irrigation, 236
SNAP (sensory nerve action potential), pain conditions, 397
sodium hypochlorite (NaOCl)
antimicrobial properties, 356–357
biofilms, 232–233
biofilms in root canals, 232–233
citric acid, combination, 234–235
EDTA, combination, 234–235
EGTA, combination, 234–235
maleic acid, combination, 234–235
planktonic microbes, action on, 232
potentially harmful effects, 234
smear layer removal, 234–235
tissue dissolution, 233
weaknesses and potential harm, 234
sonic and ultrasonic cleaning, irrigation, 238, 239–240, 239
special tests, endodontic retreatment, 331
splinting
avulsion, 421
intra-alveolar root fractures, 409, 419–420
luxations, 420–422
stainless-steel hand files, 223–224
vs engine-driven Ni-Ti instrument systems, 223–224
stem cells, dental pulp, 18, 21
step-by step procedure
(step I), 83
(step II), 84
pulpotomy, 87
stepwise removal procedure, 71, 72, 73
stepwise carious (tissue) removal, 73, 74
submarginal flap according to Ochsenbein–Luebke, surgical endodontics, 365
submarginal incision, 366
suctioning, hemostasis, 370
sulcular incision, 365–366
supervisors, independent practice, 460
surgical endodontics, 361–375
access to the root tip, 368–369
bleeding management, 370–371
bonding technique, 372–373
bone-healing, 375
complete removal of the soft-tissue lesion, 370
critical steps, 364
curettage of the soft-tissue lesion, 369, 370
flap design, 363, 365
flap elevation and retraction, 368, 369
flap repositioning and suturing, 373–374
follow-up surgery, 375
hemostasis, 370–371
incisions, 365–368
indications, 362
local anesthesia, 363
papilla base flap, 365
papilla base incision, 366–367
patient information, 374
postoperative measures, 374–375
procedure outline, 361–362, 362, 363
rectangular flap, 365
root-end filling, 372–373
root-end preparation, 371–372
root-end resection, 369, 370
submarginal flap according to Ochsenbein–Luebke, 365
submarginal incision, 366
sulcular incision, 365–366
treatment planning, 361–362
triangular flap, 365
vertical incisions, 367–368
surgical retreatment, 3, 4, 6
indications, 334–338
swallowing and aspiration of instruments
emergencies in need of urgent referral, 445
medicolegal considerations, 429–430
prevention, 185
sympathetic nervous system, dental pulp, 20
symptomatic apical periodontitis, 3, 118, 164, 179–180
cellulitis, 180
emergency management, 179–180
pus drainage, 180
synonyms, endodontic diagnostic terms, 3–6
syringe-needle irrigation, 237–238
systematic reviews, endodontic research, 318
systemic health, infections compromising, 443–444
talent fallacy, independent practice, 455–456
T-cell function
apical periodontitis, 105, 112
periapical lesions, 112
technē, 1
technical aspects of primary treatment, unsuccessful initial treatment, 328
temperature changes, pulpal diagnosis, 56
temporomandibular disorder pain – referred pain, 401–402
terminology
beneficence, 429
candor, 429
clinical epidemiology, 316
deep caries management, 73–74
diagnostic, 3–6, 117–119
independent practice, 453
informed consent, 429
nonmaleficence, 429
negligence, 429
Tetraclean, irrigation, 236
thermal tests, pulp vitality assessment, 54
three-dimensional imaging see 3D imaging
tissue dissolution, sodium hypochlorite (NaOCl), 233
tools of treatment, 6–7
tooth anatomy, 195–196
tooth development, 195–196
tooth isolation, aseptic working field, 185–192
Index

tooth-related pain
  case study, 56
  pulpal diagnosis, 56
tooth survival, nonsurgical retreatment, 357
toxicity
  calcium hydroxide sealers, 263–264
  epoxy resin sealers, 262, 263
  hydraulic calcium silicate cements, 270, 271
  methacrylate-based sealers, 267
  root canal filling materials, 250–251
  silicones, 268
  zinc oxide–eugenol sealers, 258–259, 260
transient pain, 393
transition to independent practice, 451–461
trauma, 405–424
  3D imaging, 412
  alveolar fracture, 408, 409, 419–420, 422
  arrest of dental development, 415–416
  avascular pulp necrosis, 409
  avulsion, 408, 421–422
  bone resorption, inflammatory, 411
  cervical (extracanal invasive) resorption, 412–413
  clinical examination, 417
  common dental injuries, 405, 408
  complications, 405–424
  complications, schematic overview, 409
  concussion and subluxation, 420
  cone beam computed tomography (CBCT), 412
  consequences, 405–418
  coronal and crown–root fractures, 418–419
  dental development arrest, 415–416
  diagnostic quandaries, 422–424
  endodontic infections, 154
  extracanal invasive (cervical) resorption, 412–413
  fractures, 406, 407, 418–420
  immediate management, 416–422
  inflammatory (infection-related) root resorption, 411–412
  inflammatory bone resorption, 411
  internal inflammatory root resorption, 412–413, 414, 415
  long-term management, 418–422
  luxations, 420–422
  management, 416–422
  non-inflammatory root resorption, 413–415
  pulp, 406
  pulpal diagnosis, 422–424
  pulp breakdown, 411–416
  pulp infection, 411–416
  pulp regeneration, 424
  pulp space mineralized tissue, 409–411
  radiographic examination, 417–418
  root resorption, inflammatory (infection-related), 411–412
  root resorption, internal inflammatory, 412–413, 414, 415
  root resorption, non-inflammatory, 413–415
  treatment modalities, endodontic emergencies, 172
  treatment options, medicolegal considerations, 431
  treatment outcome, 315–323
  see also endodontic retreatment
  activated irrigation and intracanal medicaments, 322
  age of patient, 320
  aseptic procedures, 321–322
  cleaning and preparation/instrumentation technique, 322
  complications during treatment, 322
coronar restoration, 323
  defining a ‘successful’ outcome, 315–317
  evidence-based medicine, 316
  general dental health, 320–321
  general health, 320
  intraoperative risk factors, 321–322
  irrigation, 322
  measuring endodontic disease and treatment outcome, 315–317
  measuring outcome, 315–317
  outcome dilemma, 6
  patency, 322
  patient-related outcome, 319
  periapical disease, 319
  person-specific risk factors, 319–321
  preoperative diagnosis, 321
  preoperative pain, 321
  preoperative risk factors, 321
  preoperative root filling, 321
  quality of preparation and root filling, 322
  retention of root-filled teeth, 319
  risk factors, 319–323
  root filling quality, 323
  rubber dam isolation, 185
  single visit – multiple visits, 322
  sinus tract, 321
  size of apical preparation, 322
  smoking, 320
  socioeconomic status, 320
  study designs, endodontic research, 317–318
  tooth number/type, 321
  tooth-specific risk factors, 321
treatment procedures
  see also vital pulp treatment
  endodontic disease conditions, 3–6
  nonsurgical retreatment, 3, 4, 6
  treatment protocols
  deep caries management, 74–76
  vital pulp treatment, 81–87
  triangular flap, surgical endodontics, 365
  tricalcium silicate cements see hydraulic calcium silicate cements
  trigeminal autonomic cephalalgias, pain conditions, 401
  trigeminal nerve injuries, 436
  trigeminal neuralgia, pain conditions, 399–400
  trigemino-facial blink reflex, pain conditions, 397
  true cysts, 106, 109
  tumors of the jaws
  differential diagnostic, 161, 162
  needing urgent referral, 444
  ultrasonic cleaning, irrigation, 238, 239–240, 239
  unsuccessful initial treatment
  canal complexity, 327–328
  endodontic retreatment, 327–329
  extraradicular infection, 327
  intraradicular infection, 327
  nature of periapical disease, 328
  operator-related factors, 329
  patient-related factors, 329
  pulp therapy result factors, 328
  technical aspects of the primary treatment, 328
vascular supply, dental pulp, 19–22
vertical incisions, 367–368
visual descriptors, peripapical health and disease, 155
vitality assessment, pulp see pulp vitality assessment
vital pulp, 2–6
vital pulp treatment, 79–98
aims, 79
bioactive capping materials, 91–92
calcium hydroxide (Ca(OH)$_2$), 89, 90
capping materials, 89–92
choosing between pulp-preserving vital pulp therapies and pulpectomy, 96–97
dentin-bonding systems, 90
healing patterns, 89–92
hydraulic calcium silicate cements, 90–91
iatrogenic injury, 80, 81
indications, 80–81
postoperative considerations, 96
principles, 79
pulp capping, 3, 4, 5, 81–84, 85, 89–91
pulpectomy, 3, 4, 5, 93–96
pulpectomy vs pulp-preserving therapies, 96–97
pulpotomy, 3, 4, 5, 84–87
pulp-preserving therapies, 79, 87–89, 92–93
pulp-preserving therapies vs pulpectomy, 96–97
revitalization and/or regenerative endodontic procedures, 97–98
revitalization protocol, 97
tissue–biomaterial interaction and pulp healing, 91–92

treatment concepts, 80–81
treatment protocols, 81–87
warm lateral compaction, root canal filling technique, 285
warm techniques, root canal filling techniques, 285–289
warm vertical compaction, root canal filling technique, 285–286
watch-winding, hand instrumentation technique, 221
wide open apical foramen, root canal filling technique, 289
wide-spectrum sound energy, irrigation, 239–240
working length
canal negotiation, 202–203
electronic apex locator, 216, 217
paper point evaluation, 216–217
radiographic methods, 215–216
root canal instrumentation, 215–217
zinc oxide–eugenol sealers, 258–261
antimicrobial properties, 260–261
biological properties, 258–260
composition, 258
handling properties, 261
technical properties/leakage, 258
toxicity, 258–259, 260
zipping prevention, root canal instrumentation, 226