Malunion / Nonunion Management: What I Wish Someone Had Told Me Before I Started Doing These Cases

Preoperative assessment and types of nonunions

I. Nonunion types
   a. Hypertrophic
      i. Characterized by good biology, poor stability
      ii. "Horse's hoof" appearance of fracture ends
      iii. Bone formation obvious but persistent gap and/or motion at fracture site
      iv. NEEDS STABILITY
   b. Atrophic
      i. Characterized by poor biology, stability unimportant
      ii. Narrowed/sclerotic ends of fracture without obvious callus formation
      iii. NEEDS BIOLOGY (and may need improved stability as well)
   c. Oligotrophic
      i. Part of a "spectrum of nonunion"…somewhere between atrophic and hypertrophic
      ii. Likely retains biological capacity to heal but healing has not initiated

II. Assessment of nonunions
   a. Infection should always be suspected, especially after open fracture
      i. History of problematic wound, recent drainage, prior infection
      ii. C-reactive protein, erythrocyte sedimentation rate, white blood cell count (N.B. these may be normal even in an infected nonunion)
      iii. (Consider indium-tagged WBC scan)
   b. Patient-dependent factors
      i. Comorbidities (diabetes, vascular disease)
      ii. Tobacco or heavy ethanol use
      iii. NSAIDs or other drugs that can slow bone healing (e.g. corticosteroids)
      iv. Metabolic abnormalities (vitamin D deficiency, hypothyroidism, hypogonadism) – consider metabolic workup
      v. Nutritional abnormalities (malnutrition due to behavior or disease)
      vi. Genetics
   c. Patient-independent factors
      i. Injury characteristics (open fracture, bone loss, soft tissues)
      ii. Surgery characteristics (distraction of fracture site, inadequate fixation)
      iii. Infection (as above)

d. Deformity
    i. Plain radiographs are helpful for measuring maximal angular deformity of long bone nonunions/malunions
    ii. Scanograms for suspected length deficiencies
    iii. CT scan
        1. Fully delineate nonunions or malunions at the articular surface
        2. Bilateral extremity CT scans can assist with diagnosing rotational malunions or nonunions.
e. Prior to any intervention, assess the overall picture
    i. Would the surgical treatment be worse than the disease?
    ii. Has sufficient time elapsed prior to diagnosing a nonunion?
        1. Tibial shaft fractures not healed at nine months…consider waiting longer (12 months)
    iii. Have nonoperative modalities been exhausted?
        1. Optimize nutrition
        2. Bone stimulators (efficacy?)