Non-union

Evaluation and correct diagnosis essential steps for a successful treatment

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Not all the non-unions are the same!

Only a correct analysis and diagnosis of the each case will lead to a correct treatment!

Learning outcomes

- Definition
- Classical classification non unions
  - Hypertrophic
  - Atrophic
- Paley classification
- Other factors associated with non-union
  - Infection
  - Patient associated factors
- Non-union scoring system

Definition

Non-union:

- A fracture that
  - is a minimum of **9 months** post occurrence is not healed
  - has not shown radiographic progression for **3 months**

(FDA 1986)

- A fracture that has no possibility of healing without further intervention

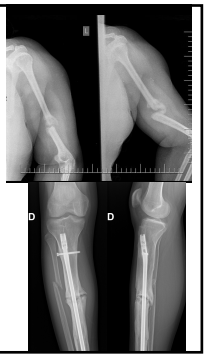
Judet, Muller, Weber, Cech classification(1976)

- Hypertrophic (hypervascular)
- Atrophic (avascular)

Hypertrophic non-union

- Vascularized
- Callus formation present on x-ray
- Elephant's foot - abundant callus
- Horse's hoof - less abundant callus

Typically only needs **stability** to consolidate!



Atrophic non-union

- Avascular
- No evidence of callous formation on x-ray
- Needs **biology** to consolidate

Biological enhancement of tibial diaphyseal aseptic non-unions: the efficacy of autologous bone grafting, BMPs and reaming by-products.
Kanakaris NK[1], Paliobeis C, Nlanidakis N, Giannoudis PV
Injury. 2007 May;38 Suppl 2:565-75.
Recent biological trends in management of fracture non-union.
Emara KM[1], Diab RA[1], Emara AK[1].
World J Orthop. 2015 Sep 18;6(8):623-8. doi: 10.5312/wjo.v6.i8.623. eCollection 2015 Sep 18.

Paley classification

- Mobility
- Deformity
- Bone defect
- Shortening

Paley et al.classification of non-union

Type A nonunions (<1 cm of bone loss)
A1, lax (mobile)
A2, stiff (nonmobile)
A2-1, no deformity
A2-2, fixed deformity.
Type B nonunions (>1 cm of bone loss)
B1, bony defect, no shortening
B2, shortening, no bony defect;
B3, bony defect and shortening.

Infection

"Of all prognostic factors in tibia fracture care, that implying the worst prognosis was infection"

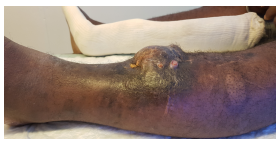
Nicoll E.A. CORR 1974

Always think of **infection** when treating a non-union!

Infection

Confirmatory criteria

- Fistula
- Sinus
- Wound breakdown
- Purulent drainage



Fracture-related infection: A consensus on definition from an international expert group.
Metsemakers WJ[1], Morgenstern M[2], McNally MA[3], Moriarty TF[4], McFadyen I[5], Scarborough M[6], Athanasou NA[7], Ochsner PE[8], Kuehl R[9], Raschke M[10], Borens O[11], Xie Z[12], Velkes S[13], Hungerer S[14], Kates SL[15], Zalavras C[16], Giannoudis PV[17], Richards RG[18], Verhofstad MHJ[19].
Injury. 2018 Mar;49(3):505-510. doi: 10.1016/j.injury.2017.08.040. Epub 2017 Aug 24.

Infection

Suggestive criteria

- Clinical signs
- Radiological signs
- New onset of joint infusion
- Elevated serum inflammatory markers
- Persistent or increasing wound drainage

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Injury. 2018 Mar;49(3):505-510. doi: 10.1016/j.injury.2017.08.040. Epub 2017 Aug 24.

Infection

- Occult infection!
- Deep tissues samples should be obtained
- Multiple cultures
- Sonication of osteosynthesis material
- **Identify the bacteria**
- Multidisciplinary team approach

Infection

- Dead bone-sequestrum
- Osteolysis –gap
- Loosening on the implant-motion
- Chronical osteomyelitis

Patient associated factors

- History of injury and prior treatment
- Medical history and co-morbidities
- Physical examination
- Imaging modalities
- Patient needs, goals, expectations

History of injury and prior treatment

- Date and nature of original injury (high or low energy)
- Open or closed injury?
- Important soft tissue lesions?
- Prior surgical procedures
- Drainage or wound healing difficulties?
- Prior infection? Bacteria identified? Antibiotics?
- Written timeline in complex cases

Medical histories and co-morbidities

- Diabetes, endocrinopathies, vitamin D
- Nutrition status
- **Smoking(1)**
- Medications
  - AINS
  - Steroids
  - Bisphosphonates

(1)Do smokers have greater risk of delayed and non-union after fracture, osteotomy and arthrodesis? A systematic review with meta-analysis.
Pearson RG[1], Clement RG[1], Edwards KL[1], Scammell BE[1]
BMJ Open. 2016 Nov 14;6(11):e010303. doi: 10.1136/bmjopen-2015-010303.

Clinical examination

- Pain
- Abnormal mobility
- Local exam
  - Skin quality, prior incisions, skin grafts or flaps
  - Erythema or drainage
- Range of motion of adjacent joints
- Neurovascular status
- Deformity-length, axis and rotation

Imaging

- Plain radiographs usually enough for the diagnosis
- Serial X-rays from injury to present are extremely helpful
- CT Scan
  - confirm the diagnosis
  - can bring supplementary informations
    - Articular or peri-articular non-unions
    - 3D anatomy
- Scintigraphy
  - Classification
  - Marked leucocytes-infection

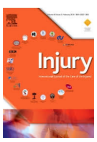
Patient Evaluation – Goals & Expectations

- What are the patient's expectations and needs?
  - Pain relief
  - Abnormal movement
  - Deformity or shortening
- Explain the risks
  - Neurovascular structures (ex. radial nerve in humerus nonunion)
  - Failure of treatment

Non-union scoring system

Classification of non-union: need for a new scoring system?

Calori GM[1], Phillips M, Jeetle S, Tagliabue L, Giannoudis PV.
Injury. 2008 Sep;39 Suppl 2:S59-63. doi: 10.1016/S0020-1383(08)70016-0.



Take home messages

- Different non-unions require different treatment strategies
- Always think of infection when treating a non-union
- Know your patient and your lesion
- Scoring systems are available for complex cases