PREVENTION, DIAGNOSIS, AND TREATMENT OF ATYPICAL FEMUR FRACTURES

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1/16/20
Most common first line treatment for prevention of osteoporotic fractures

- Age-adjusted incidence of hip fracture decreased 24% women, 20% men since approval bisphosphonates 1995

- Longer implant survival knee and hip arthroplasty
Bisphosphonates

- 2005 Case reports low trauma subtrochanteric femur fractures
- ~ 0.5% of all femur fractures
- ASBMR Task Force data
  - 3.2 to 50 cases per 100,000 person years short term use (<5 years)
  - ~113 cases per 100,000 person years long term use (>5 years)
Epidemiology

- Duration of bisphosphonate use
- Glucocorticoid use
- Asian race
- Higher BMI
Pathogenesis

- Strong & prolonged inhibition deregulates normal bone turnover inducing bone remineralization
- Increases bone rigidity “frozen bone” and micro crack accumulation
- May progress to “fatigue fractures”

- Bisphosphonates, RANK ligand inhibitors, or independent of both
Fracture must be located along the femoral diaphysis from just distal to the lesser trochanter to just proximal to the supracondylar flare.

Associated with no trauma or minimal trauma, as in a fall from a standing height or less.

Fracture line originates at the lateral cortex and is substantially transverse in orientation, although it may become oblique as it progresses medially across the femur.
Definition (Major Features)

- Noncomminuted or minimally comminuted
- Complete fractures extend through both cortices and may be associated with a medial spike; incomplete fractures only involve the lateral cortex
- Localized periosteal or endosteal thickening of lateral cortex at the fracture site (beaking or flaring)
Definition (Minor Features)

- Generalized increase in cortical thickness of the femoral diaphysis
- Unilateral or bilateral prodromal symptoms such as pain
- Bilateral incomplete or complete femoral diaphysis fractures
- Delayed fracture healing
Case reports emerging Miura et al Case Reports in Surgery 2019 found 13 articles of 26 cases.

Leclerc et al JBMR 2018 found prevalence of APFF among PFF 8.3%.
- Strong association with BP p=0.007
- Transverse fracture, periosteal thickening of lateral cortex, unicortical fracture and prodrome associated
- Type of implant, implant positioning and femoral geometry did not appear to be risks APFF vs PFF
Bisphosphonate holiday balance against osteoporotic fracture risk

- Remember 0.5% of all femur fractures are AFF
- Increased risk with longer duration of use
- Drug holiday, AFF risk decreases by approx. 70% per year since prior use
FLEX (Fracture Intervention Trial Long-term Extension) Black et al JAMA 2006

- No difference nonvertebral fractures in subjects continued alendronate an additional 5 years compared to subjects on initial 5 years only
- But increased risk clinical vertebral fractures in subjects who stopped after initial 5 years
HORIZON-Pivotal Fracture Trial, Black et al
JBMR 2012
- 3 years of zoledronate randomized to 3 additional years or placebo
- Discontinuation not associated with increased risk of nonvertebral fractures
- But found increased morphometric vertebral fractures
Adams et al JBMR 2018 Retrospective cohort
Over 39,000 women: BP holiday (>12 months no use) vs persistent use (>50% adherence) vs nonpersistent use (<50% adherence)
Overall BP holiday >12 months after ≥3 years of use were not at greater risk of any osteoporotic fracture compared to ongoing users
MUST determine an individuals overall risk before undergoing holiday
Treatment

- X-ray contralateral side (MRI if pain)
- Stop bisphosphonate (incomplete at least 10% chance of progression)
- Surgical intervention
- Anabolics (studies mainly on teriparatide)
  - May reduce bone turnover and stimulate new bone formation
  - Multiple small studies may help fracture healing, reduce pain and increase hip function
Fix-IT (Fracture Improvement with Teriparatide)

- Greenspan et al Osteoporosis Int 2018
- Randomized 13 women AFF to immediate teriparatide (approx. 2 weeks after acute fracture and repair) vs delayed teriparatide (6 months from fracture)
- Both groups 12 months teriparatide
- All received calcium and vit D
- Followed radiographic healing and BMD
Fix-IT

- Trend for superior healing with radiographic composite score
- Lesser bone mineral density declines at distal radius
- One implant failure in delayed group
Miyakoshi et al JBMM 2015

- 34 patients with 45 AFFs on oral BP
- 37 complete/incomplete fx treated surgically and 8 incomplete fx conservatively
- All BP stopped upon fracture diagnosis
- 24 no teriparatidate (TPTD)  21 placed on TPTD
- Those surgically repaired time to fracture healing better TPTD treated group (5.4 vs 8.6 months)
Cases and Surgical Timing
Case #1

71 yo female s/p fall down 1-2 stairs

No preceding thigh pain

h/o bisphosphonate use x 7-8 years

Community ambulatory without assistive device
Case #1

- Cephalomedullary fixation of femoral fracture
  - Allows for immediate weight bearing
  - Increased resistance of tension forces compared to a plate/screws
  - Small percutaneous incisions
Immediate postop – beaking lateral cortex

Contralateral femur – beaking lateral cortex without fracture; almost the exact same location as the fractured femur

X-ray the contralateral femur !!
Case #1 – 3 months postop

Right femur – healing uneventfully

Left femur – no progression on x-rays, no pain
Case #1 – 6 months postop

Right femur – healed

Left femur – no progression on x-rays (fx line visible lateral cortex in thickened bone), no pain
Treatment Options: atypical femur stress fractures

- **Nonoperative**
  - Medical
  - Serial x-rays
  - Patient education - pain

- **Operative**
  - Prophylactic cephalomedullary nail
    - Protects atypical area and entire femur in this often elderly population
    - Improves pain control
    - May stimulate healing of stress fractures
Bilateral atypical femur beaking with fracture lines present

Acquiring varus deformity

No pain; uses rollator walker
How to determine who needs prophylactic treatment?

**History** –
- previous fragility fracture or atypical fracture
- previous prophylaxis of another site

**Clinical exam** – pain, deformity, worse with weight bearing, requiring assistive devices secondary to pain

**Radiographs** –
- beaking / radiolucent fracture line extends across femur (“dreaded black line”)
- beaking located on tension side of femur (lateral)
- beaking in subtrochanteric area
- multiple areas of beaking
Banffy et al
- 12 patients with incomplete stress fractures
  - 6 prophylactic nail (shorter hospital stay)
  - 6 NWB → 5 went on to fracture at average of 10 months

Ha at al
- 14 fractures in 11 patients
  - 5 progressed to complete fracture
  - 5 required surgery secondary to intractable pain
If has atypical fracture on one side – obtain preop x-rays of contralateral side

1) can perform IM nailing of fractured side and prophylax contralateral side at same OR setting

2) can perform IM nailing of fractured side; then during same hospital admission, prophylax contralateral side

3) can perform IM nailing of fractured side; wait 6-12 weeks to recover and then prophylax contralateral side
When to prophylax?

If no complete fracture present – controversial

- pain, especially with weight bearing
- increasing requirement of ambulatory aids
- progression on xray of beaking
- fracture line present
- progression of deformity
- Failure of medical treatment / restricted weight bearing
Potential Complications / concerns for prophylaxis

- Iatrogenic femur fracture
- General anesthesia
- Increased fat emboli from reaming and nail insertion (especially if bilateral femur fixation performed at same time)
- Blood loss
Potential complications of no prophylaxis

- **FRACTURE**
- Pain
- Blood loss
- Urgent surgery
- Prolonged recovery
- Preop deformity to femur
- Nonunion
Patient education and tailor continuation of osteoporotic treatment vs holiday based on patient risks

Atypical femur fracture recognition (contralateral)

Stop bisphosphonate

Surgical repair – controversial regarding prophylaxis and timing

“Immediate” anabolic treatment
Adams, AL et al. Bisphosphonate Drug Holiday and Fracture Risk: A Population-Based Cohort Study. JBMR 2018;33(7):1252-1259


Miura, T et al. Two Cases of Periprosthetic Atypical Femoral Fractures in Patients on Long-Term Bisphosphonate Treatment. Case Reports in Surgery 2019

Miyakoshi, N et al. Healing of Bisphosphonate-Associated Atypical Femoral Fractures in Patients with Osteoporosis: A Comparison Between Treatment with and without Teriparatide. JBMM 2015;33:553-559


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