Atypical Femoral Fractures (AFFs): Controversies in diagnosis and Management in 2016

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Learning Objectives

1. Understand the pathophysiology and prognosis of AFFs
2. Identify multimodality imaging appearances of AFFs
3. Review controversies in surgical and medical management of AFFs
4. Understand the AFF Alert Program and how to incorporate into practice
Atypical Femoral Fractures

- Bisphosphonates (BPs) – antiresorptive drugs used to ↓ risk of osteoporotic fracture
- AFFs – result from low-energy or no trauma
- Associated with BPs but also reported with other drugs (denosumab)

J Clin Invest. 2002;110(9): 1239-1241
Atypical Femoral Fractures

- High prevalence of BP use in AFFs but...
- Absolute risk of AFF with BP use is low (2000 users for 1 AFF)
- AFFs – 1.1% of femoral fractures
- Uncommon complication of BPs
- Benefit of BP use outweighs risk of AFF
ASBMR Case Definition of AFFs
(Revised 2014)

Major Features (4 of 5):
1. Minimal or no trauma
2. Fracture line originates at lateral cortex and is substantially transverse in orientation although may become oblique as it progresses medially across the femur

ASBMR Case Definition of AFFs
(Revised 2014)

Major Features (4 of 5):
3. Complete fractures extend through both cortices and may be associated with a medial spike:
incomplete fractures involve only lateral cortex
ASBMR Case Definition of AFFs
(Revised 2014)

Major Features (4 of 5):
4. Noncomminuted or minimally comminuted
5. Localised periosteal or endosteal thickening of the lateral cortex is present at the fracture site ("beaking" or "flaring")
ASBMR Case Definition of AFFs
(Revised 2014)

Minor Features:
1. Generalized increase in cortical thickness of the femoral diaphysis
2. Unilateral or bilateral prodromal symptoms such as dull or aching pain in the groin or thigh
ASBMR Case Definition of AFFs
(Revised 2014)

Minor Features:

3. Bilateral incomplete or complete femoral diaphysis fractures
ASBMR Case Definition of AFFs (Revised 2014)

• Bilateral fractures in up to 60% of patients
• Most bilateral AFFs occur within 5 cm of each other

ASBMR Case Definition of AFFs
(Revised 2014)

Minor Features:

4. Delayed fracture healing
ASBMR Case Definition of AFFs
(Revised 2014)

Specifically excluded:
- #s of the femoral neck, intertrochanteric
- pathologic fractures
- periprosthetic fractures
Imaging Modalities

- CT
Imaging Modalities

- MRI
Imaging Modalities

- Bone Scan
Imaging Modalities

- Bone Scan
Imaging Modalities

- Bone Density
Imaging Modalities

- Ultrasound
AFF – Management

• Stop BP
• Image contralateral femur
• Image unexplained hip or thigh pain
• Hardware fixation for complete and some incomplete AFFs
Hardware Fixation

• DHS Fixation
Hardware Fixation

• IM nail
Hardware Fixation

• Blade Plate
Hardware Failure

- Occur in up to 15% of AFFs with hardware instrumentation
- Less common with IM nailing

Summary

• Defined case definition for diagnosing AFFs
• Typical imaging features on imaging modalities
• Hardware fixation: watch for delayed healing and failure
Pharmacologic Therapies Acting on Osteoclasts

Activated Osteoclast

Osteoblasts

Bone Resorption

Prefusion Osteoclast

Bone Formation

BPs = bisphosphonates

AFF Swedish Cohort Study

- Schilcher et. al. – NEJM May 2011
- Xrays of all subtrochanteric/shaft fx in 2008 reviewed – 12,777 hip fx F> 55
- 1351 F femoral shaft fx – 1234 xrays seen
- 59 AFF seen – 13/59 never used BPs
- Rx, hospitalization data – National registry
- Not on BP – AFF 0.09/10,000 person years
- On BP – 5.5/10,000 person years
- NNH 1/2000 person years of use
- Risk higher with longer duration of use
Locations

- Femoral shaft
- Ulnar – Moon 2013, Ang 2013
- Pelvis – Patel 2013

AFF

• More common in Asians – Marcano 2014
• X sectional US study – 54 pts with AFF
• 17% Asians – BFF, 3% BNF p=0.004
• Systematic review and meta-analysis
• 11 studies Gedmintas 2013 – RR 1.62 with at least 5 yrs of BP use
AFF

• Benefit >> risk in OPS: NNT << NNH
• Pts complain of groin/thigh pain – bone scan, MRI evaluate, review indications Rx
• Evidence of association with long term BP use, not causal
• BBx – suppression of turnover in some cases, other cases inc resorption, impaired mineralization only 1/19 – Khan 2014
• Need to know true incidence and risk factors
AFF and Denosumab

- 2 AFF seen in FREEDOM
- 1 xcross over arm – 6 doses of exposure
- 1 long term arm – 14 doses of exposure
Pathogenesis

- Decreased bone turnover
- Accumulation of microdamage
- Accumulation of advanced glycation end products alter collagen strength
- Crack propagation
Pathogenesis

- Loss of toughness (ability to absorb energy)
- Stress fx – high tensional stress – lateral cortex of femoral shaft
- Fatigue fx – seen athletes, heal slowly with cortical thickening
- Stop Rx: rapid dec risk of AFF 70%/yr
Baseline Follow-up

Female, age 65
Duration of therapy: 637 days (approx 21 mos)
BMD Change:
⇒ Lumbar Spine: +7.4% (group mean = 9.7 ± 7.4%)
⇒ Total Hip: +5.2% (group mean = 2.6 ± 4.9%)

Data on File, Eli Lilly & Co.
Biopsy from patient in Fracture Prevention Trial
Reporting of AFF

- Chart Audit: Lian et. al. CARJ 2016
  - January 2005 to March 2013
  - Retrospective audit of all subtrochanteric hip fx discharged from Vancouver General Hospital - review chart & xrays
  - 3084 pts discharged Dx of hip fx
  - 204 coded – subtrochanteric fxs
  - 178 of these – xray evidence of other fx usually intertrochanteric
  - 11 pts did not have available radiographs
  - 193 patients with xrays reviewed
  - 24/193 (12.4%) fulfilled the published criteria for AFF
Reporting of AFF

• Radiologists Dx AFF in only 1 of the 24 pts with characteristic radiographic signs of AFF

• 19 of 24 patients there was an adequate image of part of the contralateral femur

• 12 of 19 (63%) had a contralateral focus of PENB situated 2.5 cm from the index lesion site when measured from the upper aspect of the greater trochanter
Bilateral and Multifocal

- 3 of 19 patients multiple foci of PENB on lateral aspect of contralateral femur
- Suggest material properties of bone altered
- AFFs assoc. with bisphosphonates in 75% of pts.
- Mechanism of injury more complex than simple low-energy trauma
AFF ALERT Program

- Include findings of an AFF in the concluding comments of the report
- Highlight the association of AFF with use of bisphosphonate or denosumab
- Recommend x-rays of entire contralateral femur
- Complete AFFs are often preceded radiographically by an incomplete AFF
AFF ALERT Program

• Incomplete AFF characterized by periosteal thickening and a lucent line, known as “beaking”, or endosteal thickening of the lateral cortex

• Report these findings as a potential incomplete AFF and mention association with bisphosphonates
AFF ALERT Program

- Instruct technologist to always complete bilateral total femur x-rays if the indication is to exclude AFF
- If images are normal in the presence of thigh or groin pain, further evaluation with repeat imaging in 6 months is advised, as well as exclusion of other causes of thigh or groin pain
AFF Management

• **STOP** BP or denosumab Rx
• Limit weight bearing
• Teriparatide, an anabolic agent associated with enhanced fracture healing in case reports
• Intramedullary nailing is necessary for complete AFFs
• Prophylactic nailing of incomplete femoral fractures may be advisable depending on the extent of the incomplete fracture
Summary

• AFF alert program will enable radiologists to play a key role in improving identification of AFFs and enhancing quality of patient care

• Appropriate coding of AFF will enable more accurate assessment of incidence, associated healthcare costs and impact on Canadian healthcare system
Conclusion

• Early identification of AFF is crucial for appropriate withdrawal of BP and Dmab
• Radiographic findings need to be highlighted in report to referring MD- alert referring MD
• Integration of anabolic therapy with antiresorptive therapy may reduce long term complications of AR Rx
• Further research will enable us to develop strategies for improved management
The End

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