Osteochondral Lesions of the Talus: From Birth to Near Death

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I. Terminology
   A. Multiple terms used to describe similar problem, including:
      1. transchondral fracture
      2. osteochondral fracture
      3. osteochondritis dissecans
      4. talar dome fracture
      5. flake fracture
   B. Best term probably is Osteochondral Lesion of Talus (OLT)

II. Incidence
   A. OLT comprise 4% of all O.D.
   B. Average age of patients – between 20 and 30 years, with males slightly predominant
   C. Medial dome lesions more common than lateral
   D. Bilateral lesions about 10%. Recent study by Hermanson & Ferkel found the incidence to be 10% in a group of 526 patients with OLT

III. Location and Characteristics of Lesion
   A. Medial lesions are deeper, larger, cup-shaped and are usually non-displaced
   B. Medial dome of talus in mid or posterior third. Medial talar dome/middle row (Raikin zone 4) most common (53% of 428 lesions)
   C. Lateral dome of talus in mid or anterior portion. These are located in lateral/middle second most common (26%)
   D. Lateral lesions are usually shallow and wafer-shaped and often displaced and elevated by levering effect of distal tibia
   E. Lateral lesions occur more in “shear”, while medial lesions occur more with “compression”
   F. There are exceptions to the above rules
IV. Staging

A. Berndt & Harty classified OLT as to their appearance on x-ray into four stages:
   1. small compression fracture without displacement (intact)
   2. partially detached osteochondral fragment
   3. completely detached fragment remaining in its bed
   4. completely displaced fragment of loose body

B. Ferkel, Cheng & Sgaglione developed a CT scan staging 1-4. This correlates better with treatment & outcome (Table 1)

C. MRI staging has been done by Anderson and others

D. Arthroscopic staging
   1. Pritsch et al. classified lesions by arthroscopic appearance of overlying cartilage into 3 grades:
      a. intact, firm shiny articular cartilage
      b. intact but soft cartilage
      c. frayed cartilage
   2. Lesion can progress from Grade I to III during course of treatment
   3. Correlation poor between x-ray appearance and arthroscopic findings
      a. Scope appearance is more important determinant of treatment
   4. Arthroscopic classification of Ferkel & Chen is probably best way to stage lesion (Table 2)
      a. Ferkel, Cheng & Applegate found correlation between CT, MRI and new arthroscopic classification

V. Radiologic Features

A. Three views of ankle done on all patients. Weight bearing views and special views are occasionally helpful. Stress x-rays done when appropriate

B. Tomography in two planes can be helpful but is presently rarely used

C. CT in coronal and axial planes with sagittal reconstructions is one of the best ways to study lesion and most helpful for preop planning. Adding contrast and air can help determine if the lesion is loose. I prefer a bilateral study to check the asymptomatic side.

D. Bone scans helpful in Stage I lesions

E. MRI helpful in diagnosing OLT, and in future may provide information on vascularity of lesion, treatment and subsequent healing. Gadolinium injection can help determine if lesion is loose

VI. Surgical Indications

A. Staging determined by CT and/or MRI scan and arthroscopic evaluation

B. Stage 1 & 2, and Stage 3 in children – fail 8-12 weeks of casting and conservative treatment

C. All Stage 3 and 4 lesions in adults

VII. Arthroscopic Technique (Ferkel)

A. Use thigh and ankle holder in supine position with ankle distractor

B. 2.7-mm 30- and 70-degree arthroscopes with interchangeable cannulae

C. Use anteromedial, anterolateral and posterolateral portals to visualize and treat the lesion. Use 2.9 and 3.5 shavers and burrs for debridement of the lesion. Small curettes (3.5-, 4.5-mm with different angulations) critical for removal of lesion. Small joint graspers are needed for loose body removal
D. Treatment of chronic OLT
1. unroof or remove separated or loose fragment
2. curettage and/or drill OLT bed using standard, transmalleolar or transtalar approaches with 0.045-mm or 0.062-mm K-wires and drill guide
3. alternatively, microfracture can be done with or without drilling; abrasion arthroplasty does not appear to be as useful

E. Anteromedial lesion (rare) drilled or microfractured through anteromedial portal, visualize through anterolateral portal

F. Posteromedial lesion best approached by visualization through posterolateral portal and drilling transmalleolarly or transtalarly with the drill guide. Microfracture also is used through either anteromedial or posterolateral portal. In larger lesion, use a combination of drilling and microfracture. Shaver and curettes through anteromedial portal

G. Anterolateral lesions drilled and/or microfractured through anterolateral portal and visualized through anteromedial portal. Occasionally drill through tibia using drill guide. Microfracture also used as noted above.

H. When articular cartilage is intact and lesion cystic, transtalar bone grafting can be done using the drill guide, but in our experience, these lesions are rare.

VIII. Large Cystic OLT
A. Introduction
1. in the past, large unstable cystic OLT have been treated with excision, drilling and/or microfracture through an arthroscopic approach
2. results are variable in these large lesions when treated as described above
3. better results with debridement, drilling or microfracture and bone grafting

B. Technique for bone grafting
1. ankle arthroscopy done as described
2. arthroscopic bone grafting equipment
3. patient should be paralyzed for maximum distraction
4. lesion is excised and all loose articular cartilage and cystic membrane is removed down to healthy bleeding bone
5. edges of the cystic lesion should be cut at 90° to promote blood pooling
6. incision over distal tibia with exposure of the distal tibia and elliptical bone graft taken from the medial side of the distal tibia metaphyseal region
7. morselizing of bone graft so it can be inserted through a 3- or 5-mm cannula arthroscopically
8. insertion of the bone graft into the cannula and placement of the cannula into the cystic lesion
9. using an obturator, the bone graft is advanced in the cystic lesion and continuously impacted with a Freer Elevator through the anterolateral portal while the bone graft is inserted through the anteromedial portal (on a medial lesion); visualization is done through the posterolateral portal and the bone graft is slowly compacted
10. insertion of fibrin glue (optional)
11. tourniquet and distraction are released while pressure is held on the bone graft with two Freer Elevators. After 2 minutes, the bone graft site has had enough bleeding to form an adhesive clot to hold the graft in place
12. posterior splint for 2 weeks, then removable splint for gentle dorsi and plantar flexion exercising 4 times a day
13. patient is non-weight bearing 6-8 weeks, depending on the size of the lesion
IX. Postoperative Arthroscopic Surgical Treatment
   A. Posterior splint and compression dressing applied at surgery
   B. Remove splint in 1 week for arthroscopic procedures that involve excision and/or drilling and microfracture; then start ROM and strengthening with removable splint non-weight bearing
   C. Drilling with or without curettage
      1. non-weight bearing 2-4 weeks if lesion <1.0 cm$^2$ in diameter
      2. non-weight bearing 6-8 weeks if lesion >1.0 cm$^2$
   D. Curettage and debridement alone weight bearing in 1 week
   E. Follow-up CT scan or MRI in 6 months to assess healing

X. Arthroscopic Results
   A. Kumai, Takakura (1999)
      1. 17 patients/18 ankles, f/u 2 to 9.5 years
      2. all patients drilled, with immediate weight bearing, no cast
      3. results good in 13, fair in 5
      4. best results for patients under 30 years of age and non-cystic lesion
   B. Kelberine, Frank (1999)
      1. 48 patients with different treatments
      2. acute did best, with 16 G/E out of 18
      3. chronic 20 G/E out of 30
   C. Erggelet (2000)
      1. 42 patients over 5 years
      2. 22 percutaneous drilling and 13 bone grafting
      3. hindfoot score improved in most patients
   D. Tol et al. (2000)
      1. meta analysis of electronic databases of all cases 1966-1998
      2. excision alone, 38% G/E
      3. excision and curettage, 78% G/E
      4. excision and drilling, 85% G/E
      5. nonoperative, 45% G/E
   E. Hinterman (2001)
      1. 36 cases
      2. results better in most grades I and II, especially laterally
      3. results unsatisfactory in grade II and III medial lesions
      4. recommend stage 1 conservative and stage IV surgery
      5. grade II to III conservative with medial and surgery with lateral
   F. van Dijk (2002)
      1. 38 patients
      2. curettage and drilling
      3. follow-up 56 months
      4. primary – 86% G/E; revision – 75% G/E
   G. Ferkel (2008)
      1. 50 cases treated arthroscopically
      2. 65-75% G/E
      3. f/u 71 months
H. Guo et al. (2010)

1. 48 patients with OLT
2. all had debridement and 36 had microfracture
3. 5 lost to follow-up.
4. average follow-up 24 months
5. 82% G/E; AOFAS 70-90
6. strong correlation found between the size of the lesion and successful outcome

I. Kennedy et al. (2011) used bone marrow aspirate concentrate (BMAC) as a biological adjunct for the treatment of OLT

XI. Future
A. Long term solution to treating full thickness cartilage defects involve cartilage growth enhancement instead of drilling or abrasion
B. Techniques of cartilage growth enhancement
   1. osteochondral autograft
   2. osteochondral allograft
   3. autologous chondrocyte implantation
   4. scaffolds with autologous chondrocytes
   5. particulated juvenile articular cartilage allograft
   6. others

XII. Osteochondral Autograft Transplantation (OATS)
A. Robs Peter to pay Paul
B. Uses osteochondral graft plugs from the sulcus terminalis of knee, anterior talar head, or medial or lateral non-articulating portions of the talus for graft sources
C. Advantage of single setting procedure
D. Size limitations for autograft transplantations – usually between 8 and 20 mm
E. Question of long-term problems with femoral plug holes and subsequent pain
F. Anteromedial talar lesions
   1. Arthroscopy and debridement
   2. Arthrotomy establish lesion size
   3. Core out or drill out lesion to at least 10 mm deep
   4. Compact the base and measure depth
   5. Harvest donor graft from the knee or ankle
   6. Insert donor graft into the defect
G. Posterolateral lesions
   1. Arthroscopy and debridement
   2. Arthrotomy and release the anterior talofibular and calcaneofibular ligaments
   3. Sublux talus anteriorly
   4. Insert graft as above
H. Posteromedial talar lesions
   1. Arthroscopy and debridement
   2. Medial malleolar osteotomy, including pre-drilling the medial malleolus for later screw insertion
   3. Same as above
I. Allograft OATS – core grafting or en bloc
   1. Steps as above
2. Try to match the exact location and morphology on the allograft to the insertion site

J. Retrograde OATS tibial plateau or tibial plafond
   1. Arthroscopically define the size of the lesion
   2. Use angle drill guide to retrograde drill at 70-degrees into the plateau or plafond lesion
   3. Harvest graft and insert with special instrumentation, as described by Scranton

K. Results – OATS
   1. Sammarco (2002) did 12 patients and harvested graft from medial or lateral facet of talus for OATS
      a. AOFAS scores 64 to 91
   2. Scranton et al. (2005) did 50 OATS cases with 2 to 6 year follow-up
      a. 64% had failed one or more surgeries prior to grafting
      b. 90% good/excellent
      c. 15 required either screw removal or second-look for scar debridement
      d. 2 failed required ankle arthrodesis

L. Results – Allograft OATS
   1. Gross (2001) did 9 patients; 6 patients remain in situ with mean survival 11 years. 3 cases required fusion;
   2. Gortz et al. (2010) reported on 12 ankles in 11 patients with fresh osteochondral allografts for OLT; all involved partial unipolar grafts of the talar dome implanted through an anterior approach without osteotomy
      a. Mean follow-up 38 months
      b. Mean OMAS improved from 28 to 71
      c. 30% excellent; 20% good; 30% fair; 20% poor
   3. El-Rashidy et al. (2011) reported on 42 patients using fresh osteochondral allograft for OLT
      a. Mean follow-up 38 months
      b. Mean AOFAS 52 to 79
      c. Graft failure in 4 patients

XIII. Autologous Chondrocyte Implantation
   A. Definition – implantation of in vitro cultured autologous chondrocytes using a periosteal tissue cover or membrane after expansion of isolated chondrocytes
   B. Cartilage Repair Registry (Genzyme Tissue Repair, vol. 6:3-00)
      1. Prospective multicenter data from 636 surgeons, 47 patients at 4 year follow-up
      2. Mean total defect size = 4.6cm²
      3. Average age 38 years (15-55)
      4. 81% of condyle group improved on Modified Cincinnati Score
      5. 78% had at least one associated procedure
      6. Overall debridement 4.3%, AF 1.9%, hypertrophy 1.3%, 3.2% failure

XIV. Indications for ACI in the Ankle
   A. Indications
      1. Patients aged 15 to 55
      2. Focal defect
      3. Unipolar (only talus affected)
      4. Contained
5. Edge loading
6. Failed previous surgery
7. Large lesions with extensive subchondral cystic changes

B. Relative Indications
   1. Multifocal unipolar lesions
   2. Uncontained lesions

XV. ACI – Generations
   A. Generation 1 – Carticel suspended under a periosteal flap
   B. Generation 2 – Carticel inserted under a tissue patch or onto a carrier scaffold
   C. Generation 3 – Carrier-free, immature cartilage tissue

XVI. Surgical Technique – ACI Generation 1
   A. Medial or lateral malleolar osteotomy performed under fluoroscopic control
   B. Defect preparation includes removing all damaged cartilage from subchondral bone and
debraiding defect on the calcified cartilage layer without penetrating bone
   C. Harvest periosteum from distal tibia along the medial malleolus or from just distal to the pes
   anserinus and the proximal anterior tibia
   D. Mark non-cambium layer of periosteum
   E. Periosteum fixation
      1. Place periosteum in the defect with the cambium layer down, suture with 5.0 or 6.0
         Vicryl suture and seal with fibrin glue
   F. BioGide membrane
      1. Absorbable porcine bilayer collagen I/III membrane used by dentists in the United
         States for a number of years
      2. Recently has been used in knee and ankle ACI in place of periosteum, but this indication
         is not FDA approved
      3. Has a rough and smooth layer
      4. Made by the same company as Chondro-gide and very similar
   G. Aspirate cell vial contents and resuspend cells
   H. Implant via catheter through opening in the periosteum
   I. Close hole in the periosteum and use fibrin glue; then reattach osteotomy
   J. Wound closure
      1. Re-insert pre-drilled guide pins and insert appropriate length screws in the medial
         malleolus
      2. Insert lag screws in fibula, then appropriate size plate and screws
      3. The patient goes into short leg cast in neutral position

XVII. Postoperative Care for OATS and ACI
   A. Four phases
   B. Immobilization 2-3 weeks, until wounds are healed
   C. Then start partial weight bearing with removable CAM walker and TED stocking
   D. At 6 weeks, go to full weight bearing and start physical therapy
      1. Progress through Phase 1, 2, 3 and 4 with specific protocol

XVIII. Results of ACI – First Generation (ACI-P)
   A. Baums et al. (2006)
1. 12 patients
2. Mean follow-up 63 months
3. Hannover score increased from 40 to 86 points
4. AOFAS increased 45 points
5. Patients involved in competitive sports were able to return to their full activity level

B. Ferkel (2010)
1. 32 patients done; the first 11 patients have been reviewed and published in AJSM
2. Current study: Follow-up on 29 of 32 (91%)
3. Average age: 34 (18-54)
4. Average follow-up: 70 months (24-129)
5. 9 “sandwich” procedures done, with bone grafting of large cystic underlying defect and use of two periosteal grafts back to back
6. 2nd look arthroscopy on 90% of patients (26/29)
7. Results: Excellent: 8; Good: 15; Fair: 5; Poor: 1
8. Entire paper presented at AAOS 2011

XIX. ACI Periosteal Problems
A. First Generation ACI complications include:
   1. Periosteal hypertrophy
   2. Delamination
   3. Graft failure
B. USFDA estimated 3.8 complication rate in knees
   1. 18% graft hypertrophy
C. Type I/III bilayer porcine collagen membranes available in United States to be used in place of periosteum
   1. Gomoll et al. compared subsequent surgeries with periosteum versus collagen membrane
   2. Results similar except hypertrophy related surgery: 52% with periosteum and 3.4% with collagen membrane

XX. Second Generation ACI
A. A variety of scaffolds being used in Europe, implanted either through a small arthrotomy or arthroscopically.
   1. Used as a patch and cells inserted underneath
   2. Cells seeded onto the scaffold membrane
B. Collagen-covered autologous chondrocyte implantation (CACI or ACI-C)
   1. Absorbable porcine bilayer collagen I/III membrane
   2. Chondro-Gide membrane with one compact and one porous surface
   3. Gooding found no difference in results between periosteum and membrane cover in knees with CACI
C. Hyalograft C
   1. Benzyl ester of Hyaluronic acid
   2. Bioabsorbs in 3 months
   3. Marcacci et al. presented 175 patients with grafts in the knee with 46 month mean follow-up. Results were 93% improvement at ICRS 2006
   4. Giannini et al. (2008) – 46 patients in ankle
      a. Mean age 32; follow-up 3 years
b. Preop 57; postop 90 mean AOFAS score
c. Biopsies collagen type II

D. Membrane/matrix autologous chondrocyte implantation (MACI)
   1. Highly purified type I/III collagen membrane
   2. Guillen and Abelow presented first 50 cases (42 knees; 8 ankles)
   3. 8 ankles (ages 22-46)
   4. Large full thickness cartilage lesions of the talus (2-6 cm)
   5. 5/6 good & excellent results with follow-up 4 months-2 1/2 years
   6. Giza et al. did MACI on 10 patients; AOFAS 61 to 73

XXI. Third generation ACI
A. Use carrier-free, immature cartilage tissue
B. Lack of carrier scaffold
C. Avoids carrier integration, degradation and biocompatibility complications
D. Jubel et al. used an alginate matrix to produce cell-rich chondrocyte disc in MFC of 48 sheep
E. Chondral defects treated with De Novo cartilage transplantation showed qualitatively better micro and macroscopic regeneration than those with periosteal flaps alone
   1. Farr and Yao reported earlier results in the knee
   2. Adams et al. reported particulated juvenile articular cartilage allograft transplant for OLT with early good results
F. DeNovo particulated juvenile cartilage results
   1. Coetzee, Giza, Schon et al. reported on 24 ankles, average age 35
   2. 14 failed at least one prior bone marrow stimulation procedure with average lesion size 125 mm² and average depth 7 mm
   3. AOFAS score 85 with 18 (78%) ankles showing G-E scores
   4. 92% G-E in lesions 10-15 mm

XXII. Recommended reading on current and future innovations on ACI and treatment of osteochondral lesions of the talus
A. Safran, Kim and Zaffagnini in JAAOS, 2008
B. Mitchell, Giza, Sullivan in JAAOS, 2009
C. Getgood, Brooks, Fortier, Rushton in JBJS (Br) 2009
D. Gikas, Bayliss, Bentley, Briggs in JBJS (Br) 2009
E. O’Loughlin, Heyworth, Kennedy in AJSM 2009
F. Ferkel, Scranton, Stone in Instructional Course Lectures 2010
G. McGahan, Pinney in FAI 2010
H. Easley, Latt, Santangelo et al in JAAOS 2010
I. Harris, Siston, Pan, Flanigan in JBJS 2010
L. Coetzee, Giza, Schon, et al. in Foot Ankle Int 2013.
M. Murawski, Kennedy in JBJS 2013.
N. Moran, Pascual-Garrido, Chubinskaya et al. in JBJS (Am) 2014.

XXIII. Summary
A. Zengerink et al. has nicely summarized when to use which treatment for OLT (see Table 3)
B. Is there a critical defect size for poor outcome?
1. Choi et al (2009) found initial defect size is important prognostic factor for OLT and can serve as a basis for preop surgical decisions
2. OLT defect of $150 \, \text{mm}^2$ or greater as calculated from MRI has a high correlation of having a poor clinical outcome

XXIV. Is there a critical defect size for poor outcome?

A. Chuckpaiwong et al. (2008) did debridement and microfracture on 105 patients with mean follow-up of 32 months.
   1. Lesions smaller than 15 mm, no failures
   2. Lesions greater than 15 mm, one patient successful
   3. Factors affecting negative outcome: increasing age, higher BMI, trauma history and presence of osteophytes

B. Guo et al. (2010) treated 43 patients arthroscopically with mean age of 32 years
   1. AOFAS 70 to 90; 81% good/excellent
   2. Strong correlation with size of lesion (<10 mm) and successful outcome

C. Choi et al (2009) found initial defect size is important prognostic factor for OLT and can serve as a basis for preop surgical decisions
   1. OLT defect of $150 \, \text{mm}^2$ or greater as calculated from MRI has a high correlation of having a poor clinical outcome
   2. OLT defect of <150 mm$^2$ has a high correlation of a good clinical outcome

XXV. Summary

A. Zengerink et al. has nicely summarized when to use which treatment for OLT (see Table 3)

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<thead>
<tr>
<th>Table 1. CT Classification$^{17}$</th>
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<tr>
<td>Stage 1: Cystic lesion within dome of talus, intact rim on all views</td>
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<tr>
<td>Stage IIA: Cystic lesion with communication to talus dome surface</td>
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<tr>
<td>Stage IIB: Open articular surface lesion with overlying displaced fragment</td>
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<td>Stage III: Undisplaced lesion with lucency</td>
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<td>Stage IV: Displaced fragment</td>
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<tr>
<th>Table 2. Surgical Grade Based on Articular Cartilage$^{17}$</th>
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<tr>
<td>Grade A: Smooth, intact but soft or ballottable</td>
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<tr>
<td>Grade B: Rough surface</td>
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<td>Grade C: Fibrillations/fissures</td>
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<td>Grade D: Flap present or bone exposed</td>
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<td>Grade E: Loose, undisplaced fragment</td>
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<td>Grade F: Displaced fragment</td>
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<tr>
<th>Table 3. Guideline for Treatment of Osteochondral Talar Lesions$^{24}$</th>
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<tr>
<td>Lesion</td>
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<tr>
<td>Type 1: asymptomatic lesions, low-symptomatic lesions</td>
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<td>Type 2: symptomatic lesions $\leq 10$ mm</td>
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<td>Type 3: symptomatic lesions $11-14$ mm</td>
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Type 4: symptomatic lesions > 15 mm  
Consider fixation, graft or ACI

Type 5: large talar cystic lesions  
Consider retrograde drilling + bone transplant, or ACI with sandwich procedure

Type 6: secondary lesions  
Consider osteochondral transplant

For types 4 through 6, debridement and bone marrow stimulation can always be considered a treatment option.


References


Recommended Reading