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1

Title: Genicular artEry embolizatioN in patiEnts with oSteoarthrItiS of the Knee (GENESIS) Using Permanent Microspheres: Interim Analysis

Summary:
GAE is a safe, minimally invasive treatment for mild to moderate knee OA. In the GENESIS pilot study, VAS scores dropped from 60 to 36 at 3 months and 45 at 12 months. KOOS scores improved across all domains, especially pain and quality of life. MRI showed reduced synovitis with no osteonecrosis. Complications were minimal, with 75% patient satisfaction.

Abstract:
Purpose: Planned interim analysis of GENESIS; a prospective pilot study investigating the role of genicular artery embolization (GAE) in patients with mild to moderate osteoarthritis of the knee using permanent microspheres.
Methods: Thirty-eight patients, median age = 60 (45-83), attended for GAE using 100-300 μm permanent microspheres. All patients had mild to moderate knee OA, resistant to conservative treatments over 6 months. Knee MRI was performed at baseline, and 12 months, enabling semi-quantitative analysis using Whole-Organ Magnetic Resonance Imaging Score (WORMS). Knee Injury and Osteoarthritis Outcome Score (KOOS) and visual analogue scale (VAS) (0-100 mm) were completed at baseline, 6 weeks, 3 months (n = 32), and 1-year (n = 16). Adverse events were recorded prospectively.
Results: Technical success of accessing and embolizing the target genicular arteries was 84%. Six patients were not embolized: four due to a presumed risk of non-target embolization, and two due to a lack of hyperaemic target. Mean VAS improved from 60 (SD = 20, 95% CI 53-66) at baseline to 36 (SD = 24, 95% CI 28-44) at 3 months ($p < 0.001$) and 45 (SD = 30, 95% CI 30-60) at 1-year ($p < 0.05$). All KOOS subscales showed a significant improvement at 6-weeks, 3-months, and 1-year follow-up, except function in daily living, which reached borderline significance ($p = 0.06$) at 1-year. Four patients experienced mild self-limiting skin discoloration over the embolized territory. One patient experienced a small self-limiting groin haematoma. WORMS scores at 1-year follow-up showed significant improvement in synovitis ($p < 0.05$). There were no cases of osteonecrosis.
Conclusion: GAE using permanent microspheres in patients with mild to moderate knee OA is safe, with potential efficacy at early follow-up.

Reference:

Little MW, Gibson M, Briggs J, Speirs A, Yoong P, Ariyanayagam T, Davies N, Tayton E, Tavares S, MacGill S, McLaren C, Harrison R. Genicular artEry embolizatioN in patiEnts with

oSteoarthrItiS of the Knee (GENESIS) Using Permanent Microspheres: Interim Analysis. Cardiovasc Intervent Radiol. 2021 Jun;44(6):931-940. doi: 10.1007/s00270-020-02764-3. Epub 2021 Jan 20. Erratum in: Cardiovasc Intervent Radiol. 2021 Jul;44(7):1153. doi: 10.1007/s00270-021-02849-7. PMID: 33474601; PMCID: PMC8172391.
https://pubmed.ncbi.nlm.nih.gov/33474601/

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2

Title: Transcatheter arterial embolization as a treatment for medial knee pain in patients with mild to moderate osteoarthritis

Summary:
Okuno (2014) introduced GAE as a novel treatment for moderate knee OA. In 14 patients with pain unresponsive to conservative therapy, GAE achieved 100% technical success and rapid, sustained pain relief (WOMAC pain scores dropped from 12.2 to 1.7 by 4 months). Improvements persisted at 1-year follow-up with no major complications, supporting GAE as a safe, minimally invasive option.

Abstract:
Purpose: Osteoarthritis is a common cause of pain and disability. Mild to moderate knee osteoarthritis that is resistant to nonsurgical options and not severe enough to warrant joint replacement represents a challenge in its management. On the basis of the hypothesis that neovessels and accompanying nerves are possible sources of pain, previous work demonstrated that transcatheter arterial embolization for chronic painful conditions resulted in excellent pain relief. We hypothesized that transcatheter arterial embolization can relieve pain associated with knee osteoarthritis.
Methods: Transcatheter arterial embolization for mild to moderate knee osteoarthritis using imipenem/cilastatin sodium or 75 μm calibrated Embozene microspheres as an embolic agent has been performed in 11 and three patients, respectively. We assessed adverse events and changes in Western Ontario and McMaster University Osteoarthritis Index (WOMAC) scores.
Results: Abnormal neovessels were identified within soft tissue surrounding knee joint in all cases by arteriography. No major adverse events were related to the procedures. Transcatheter arterial embolization rapidly improved WOMAC pain scores from 12.2 ± 1.9 to 3.3 ± 2.1 at 1 month after the procedure, with further improvement at 4 months (1.7 ± 2.2) and WOMAC total scores from 47.3 ± 5.8 to 11.6 ± 5.4 at 1 month, and to 6.3 ± 6.0 at 4 months. These improvements were maintained in most cases at the final follow-up examination at a mean of 12 ± 5 months (range 4-19 months).
Conclusion: Transcatheter arterial embolization for mild to moderate knee osteoarthritis was feasible, rapidly relieved resistant pain, and restored knee function.

Reference:
Okuno Y, Korchi AM, Shinjo T, Kato S. Transcatheter arterial embolization as a treatment for medial knee pain in patients with mild to moderate osteoarthritis. Cardiovasc Intervent Radiol. 2015 Apr;38(2):336-43. doi: 10.1007/s00270-014-0944-8. Epub 2014 Jul 4. PMID: 24993956. https://pubmed.ncbi.nlm.nih.gov/24993956/

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3

Title: Genicular Artery embolisation in Patients with Osteoarthritis of the Knee (GENESIS) Using Permanent Microspheres: Long-Term Results

Summary:
GAE is a safe, minimally invasive treatment for mild-to-moderate knee osteoarthritis. In the GENESIS trial, GAE demonstrated:

- Sustained pain relief at 2 years (VAS ↓ from 58.6 to 37.7)
- Significant improvement in function and quality of life (KOOS, WOMAC)
- MRI-confirmed reduction in synovitis with no osteonecrosis
- High patient satisfaction and no compromise to future surgical options

Abstract:
Purpose: To report the 2-year follow-up of patients with mild-to-moderate knee osteoarthritis (OA) treated with genicular artery embolisation (GAE) as part of the GENESIS study.
Materials and methods: Forty-six patients, median age = 60 (45-83) underwent GAE using permanent microspheres (100-300 μm). Technical success was defined as embolisation of the targeted genicular arteries. Knee Injury and Osteoarthritis Outcome Score (KOOS) and Visual Analogue Scale (VAS) (0-100 mm) were recorded at baseline, 6 weeks, 3 months, 1, 2 years. Contrast-enhanced MRI knee scans were acquired at baseline and 1 year, and evaluated with the Whole-Organ Magnetic Resonance Imaging Score (WORMS). Functional MRI brain imaging and psychometric assessments were undertaken to investigate correlation between neuropsychological phenotypes and clinical outcome. Adverse events were recorded prospectively.
Results: Technical success was achieved in forty patients (87%). Mean VAS improved from 58.63 (SD = 20.57, 95% CI 52.7-65.5) at baselines to 37.7 at 2-years (SD = 26.3, 95% CI 27.0-47.5). Whole and subgroup KOOS were significantly improved at each timepoint with associated reductions in analgesia usage. WORMS analysis demonstrated significant reduction in synovitis ($p < 0.05$) with no cases of osteonecrosis. Self-limiting skin discolouration occurred in four patients. A self-limiting groin haematoma and single case of deep-vein thrombosis due to immobilisation were also recorded. Nine patients subsequently underwent knee arthroplasty with no additional operational complexities identified. Neuropsychometric assessment

elucidated a correlation between baseline catastrophising and greater reduction in pain post GAE.
Conclusion: GAE is a safe intervention for mild-moderate knee osteoarthritis, with sustained efficacy at 2 years. These results are promising and justify ongoing controlled trials.

Reference:
Little MW, O'Grady A, Briggs J, Gibson M, Speirs A, Al-Rekabi A, Yoong P, Ariyanayagam T, Davies N, Tayton E, Tavares S, MacGill S, McLaren C, Harrison R. Genicular Artery embolisation in Patients with Osteoarthritis of the Knee (GENESIS) Using Permanent Microspheres: Long-Term Results. Cardiovasc Intervent Radiol. 2024 Dec;47(12):1750-1762. doi: 10.1007/s00270-024-03752-7. Epub 2024 May 31. Erratum in: Cardiovasc Intervent Radiol. 2024 Oct;47(10):1432. doi: 10.1007/s00270-024-03868-w. PMID: 38819473; PMCID: PMC11621196.
https://pubmed.ncbi.nlm.nih.gov/38819473/

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4

Title: Genicular Artery Embolization for Treatment of Symptomatic Knee Osteoarthritis: 2-Year Outcomes from a Prospective IDE Trial

Summary:
In a long-term follow-up study, 47% of patients who underwent GAE for moderate to severe knee osteoarthritis experienced sustained symptom relief at 2 years, highlighting GAE as a durable, minimally invasive option for selected patients.

Abstract:
Purpose: To report the 24-month outcomes and subgroup analysis evaluating the safety and effectiveness of the genicular artery embolization (GAE) for the treatment of symptomatic knee osteoarthritis (OA).
Materials and methods: Forty participants with symptomatic moderate-to-severe knee OA from a single-center, single-arm, prospective investigational device exemption trial of GAE were included in this study. Abnormal genicular artery neovascularity was identified at the subject's focal knee pain with digital subtraction angiography and cone-beam computed tomography (CT). Embolization was performed with 100-μm microspheres. The primary end point was treatment effectiveness as measured by sustained improvement in OA symptoms at 24 months, quantified using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Treatment success was defined as ≥50% decrease in WOMAC relative to baseline. Clinical

outcomes were assessed with mean age of 66.0 years (SD ± 8.1) and body mass index of 30.1 kg/m2 (SD ± 6.2).
Results: Of the 40 patients, 2 (5.0%) were lost to follow-up. Overall, 18 of 38 (47.4%) patients demonstrated ≥50% reduction in WOMAC at 24 months. In the subset of patients with initial clinical success at 12 months, 18 of 25 (72.0%) reported sustained clinical success at 24 months. Seven of 25 (28.0%) patients had symptom recurrence between 12 and 24 months and were determined to be clinical failures. All treatment-related adverse events occurred within 12 months after GAE, without additional events after 12 months.
Conclusions: GAE is effective in achieving sustained symptom relief related to moderate-to-severe knee OA for up to 24 months with an acceptable safety profile.

Reference:
Cusumano LR, Sparks HD, Masterson KE, Genshaft SJ, Plotnik AN, Padia SA. Genicular Artery Embolization for Treatment of Symptomatic Knee Osteoarthritis: 2-Year Outcomes from a Prospective IDE Trial. J Vasc Interv Radiol. 2024 Dec;35(12):1768-1775. doi: 10.1016/j.jvir.2024.08.028. Epub 2024 Sep 23. PMID: 39322180.
https://pubmed.ncbi.nlm.nih.gov/39322180/
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5

Title: Genicular Artery Embolization for the Treatment of Symptomatic Knee Osteoarthritis

Summary:
In a large real-world study (n=333), GAE significantly reduced knee pain (NRS: 7→3) and improved KOOS scores, including quality of life (KOOS-QoL: 19→42) at 12 months.
No serious adverse events were reported across 444 procedures, supporting GAE as a safe, well-tolerated, outpatient treatment for symptomatic knee osteoarthritis.

Reference:
Fleckenstein FN, Maleitzke T, Auer TA, Bolle P, Gebauer B, Winkler T, Collettini F. *Genicular artery embolization for the treatment of symptomatic knee osteoarthritis*. Radiology. 2025;316(1).
https://doi.org/10.1148/radiol.243648

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6

Title: Short-Term Effects of Genicular Artery Embolization on Symptoms and Bone Marrow Abnormalities in Patients with Refractory Knee Osteoarthritis

Summary:
This study demonstrates that GAE reduces the bone marrow edema, improves pain and physical function in patients with knee OA.

Abstract:

Purpose: To evaluate the short-term outcomes of genicular artery embolization (GAE) for knee osteoarthritis (OA) with and without bone marrow lesion (BML) and/or subchondral insufficiency fracture of the knee (SIFK).

Materials and Methods: This single-institution prospective observational pilot study analyzed 24 knees in 22 patients with mild to moderate knee OA, including 8 knees without BML, 13 knees with BML, and 3 knees with both BML and SIFK. The area and volume of BMLs on magnetic resonance images were measured before and after GAE. Baseline and postoperative pain and physical function were assessed using the visual analog scale (VAS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Results: GAE significantly reduced the BML area and volume 3 months after embolization in the knees with BML (both $P < .0005$). GAE significantly decreased the VAS scores at 3 and 6 months after embolization in patients without BML (both $P = .04$) and those with BML (both $P = .01$). GAE also lowered the WOMAC scores 3 months after embolization in patients without and with BML ($P = .02$ and $P = .0002$, respectively). However, GAE did not significantly alter the BML area and volume (both $P = .25$), VAS scores ($P = 1.00$), and WOMAC scores ($P = .08$) in patients with BML and SIFK at 3 months after GAE.

Conclusions: This observational pilot study suggested that GAE effectively reduces the BML area and volume and improves pain and physical function in patients with knee OA accompanied by BML but is inefficacious in those with both BML and SIFK.

Reference:

Wang B, Tai T-W, Liang K-W, et al. Short-term effects of genicular artery embolization on symptoms and bone marrow abnormalities in patients with refractory knee osteoarthritis. J Vasc Interv Radiol. 2023;34(7):1126-1134.e2. doi:10.1016/j.jvir.2023.02.028
https://www.sciencedirect.com/science/article/pii/S1051044323002026