The Academic
International Journal of Multidisciplinary Research

An Online Peer Reviewed / Refereed Journal
Volume 3 | Issue 3 | March 2025
ISSN: 2583-973X (Online)
Website: www.theacademic.in

Review of an Observational Study to Assess Quality of life in Osteoarthritis Patients Receiving Genicular Artery Embolization Treatment

Mehra Vidhi Mukesh Bhai, Patel Atmiykumar Shashikant , Ms. Dhatri Patel

Department of Master in Pharmacy Practices, Students of Shivam Pharmaceutical Studies and Research Centre, Anand, Gujara

E-mail: vidhimehra061@gmail.com, E-mail: atmiypatel2610@gmail.com, E-Mail :megdhara@gmail.com

ARTICLE DETAILS

Research Paper

Accepted: 24-03-2025

Published: 15-04-2025

Keywords:

Genicular artery embolization (GAE) , Knee osteoarthritis (OA), Chronic pain, Inflammation, Minimally invasive treatment ,Alternative to surgery

ABSTRACT

Genicular artery embolization (GAE) is a novel, minimally invasive treatment for knee osteoarthritis (OA), offering a safe and effective solution for chronic pain and inflammation. By selectively blocking blood flow to the affected joint, GAE reduces inflammation and alleviates pain, enhancing mobility, function, and overall well-being. This innovative approach provides a viable alternative to surgery, potentially delaying or eliminating the need for joint replacement. With its promising results and minimal risk of complications, GAE is emerging as a valuable treatment option for patients with knee OA. Genicular artery embolization (GAE) is a groundbreaking treatment for knee osteoarthritis, offering a safe, effective, and minimally invasive solution for chronic pain and inflammation. By targeting the root cause, GAE enhances mobility, function, and overall well-being, providing a viable alternative to surgery. This innovative approach may also reduce the need for medication, physical therapy, and other conservative therapies, potentially delaying or eliminating the need for joint replacement surgery and significantly improving quality of life. Genicular artery embolization (GAE) is a groundbreaking treatment for

knee osteoarthritis, offering a safe and effective solution for chronic pain and inflammation. By targeting the root cause, GAE enhances mobility, function, and overall well-being, providing a viable alternative to surgery. This innovative approach may also reduce the need for medication and other therapies, potentially delaying or eliminating the need for joint replacement surgery

DOI : https://doi.org/10.5281/zenodo.15223099

1.1 INTRODUCTION

OSTEOARTHRITIS

Cartilage loss is a hallmark of osteoarthritis (OA), a chronic, degenerative joint disease that affects the flexible tissue that cushions the ends of bones in joints. Joint stiffness, swelling, and discomfort are caused by bones rubbing against each other as cartilage breaks down. Older adults are more susceptible to OA due to older age, genetic predisposition, previous joint injuries, and repetitive stress on their joints. Osteoarthritis (OA) commonly affects weight-bearing joints such as the spine, hips, and knees. Maintaining joint function and relieving symptoms depend on proper treatment and therapy, which can significantly affect daily activities and quality of life as the disease progresses. The goal of a knee replacement is to restore function and relieve pain with knee arthroplasty surgery, commonly called a knee replacement.

GENICULAR ARTERY EMBOLIZATION

For patients suffering from osteoarthritis or other knee joint diseases, genicular artery embolization (GAE) is a minimally invasive technique used to treat persistent knee pain. Withthis method, the genicular arteries—small blood vessels that supply the knee joint—are specifically targeted to have their blood supply blocked. GAE contributes to the reduction of pain, swelling, and inflammation by limiting blood flow to the inflammatory regions. When conventional therapies, like drugs, physical therapy, and injections, have not produced enough alleviation, the surgery is usually taken into consideration. As an alternative to more intrusive surgical procedures, GAE offers a quicker recovery period and lower risks for treating knee pain and enhancing function. Hemarthrosis is a disease that causes bleeding into the interior ofa joint. It may happen as a result of trauma.

Genicular Artery Embolization (GAE)Procedure:

-Type: Minimally invasive

Description: Involves inserting a catheter through a small incision in the groin or wristto access the genicular arteries that supply the knee joint. Small particles are injected to block blood flow to specific areas, reducing inflammation and pain.

- Duration: About 30 minutes to 1 hour.

Anesthesia: Local or mildsedation.

Objectives:

- Reduce inflammation and pain in the knee joint.

Improve function and mobility with less invasive intervention compared tosurgery.

Recovery: Hospital Stay: Often outpatient; patients may go home the same day. Rehabilitation: Minimal; light activity is typically resumed quickly.

Infection at the catheter insertion site Recovery times few weeks Bruising or discomfort at the site Potential incomplete pain relief Rarely, risk of non-target

DEFINITION: Genicular artery embolization (GAE), also referred to as embolization of the knee, is a unique minimally invasive treatment that reduces blood supply to the synovium, thetissue lining the knee, to provide patients with osteoarthritis (OA) with both immediate and long-term pain relief. An interventional radiologist (IR), a professional physician who uses X-rays and other imaging modalities to examine inside the body and cure problems without surgery, performs the procedure.

1.2 EPIDEMIOLOGY:

Firstly, Background and Indications - Purpose: GAE is intended to alleviate knee discomfort, particularly in instances of osteoarthritis (OA) or persistent knee ailments.

Engine: The genicular arteries, which provide blood to the knee joint, are blocked during the treatment to lessen discomfort and inflammation. GAE is mostly utilized for older persons

Patient Demographics - Age because knee osteoarthritis is more common in this age group. **Osteoarthritis Prevalence**: Approximately 10-15% of those over 60 have osteoarthritis. **Number Three**: Utilization Trends - **Growing Popularity:** GAE is gaining traction as a less intrusive substitute

learn about its advantages. The literature indicates that general anesthesia

Indications:

GAE is primarily indicated for patients with knee osteoarthritis, particularly those with intractablepain who are not candidates for, or have failed, more conventional treatments (e.g., physical therapy, pharmacotherapy, or knee replacement).

It may also be used for patients with post-traumatic knee pain or other conditions that cause chronic knee pain involving the joint.

Prevalence and Incidence:

Knee osteoarthritis is one of the most common musculoskeletal conditions, with an estimated global prevalence of approximately 10% in men and 18% in women over the age of 60 years. AsOA is a major contributor to knee pain, many of these patients may be candidates for GAE.

The incidence of GAE itself is less well-established, but it is growing due to increasing recognition of its potential efficacy as a treatment for knee pain and the rising demand for non- surgical interventions.

Patient Demographics:

Most patients undergoing GAE are older adults, often those in their 50s to 80s, reflecting the higher rates of knee OA in this age group.

Gender: Knee OA, and by extension the need for GAE, tends to be more common in women, particularly after menopause, though men also receive the procedure.

Success and Efficacy Rates:

Studies report varying success rates for GAE, but many suggest it is an effective option for reducing knee pain and improving function, especially for patients with moderate to severe osteoarthritis.

The success of GAE is typically measured in terms of pain relief and improved quality of life, with some studies indicating up to 70-80% of patients experiencing significant improvements.

Complications and Safety:

While GAE is considered minimally invasive, risks still exist, including infection, hematoma, or potential damage to surrounding tissues, though complications are generally rare.

Long-term safety data is still evolving, and GAE's efficacy compared to other interventional options (like knee arthroplasty) requires further study.

Trends and Advancements:

The growing emphasis on non-surgical treatments for knee OA and the need for personalized carehas led to a rise in the use of GAE.

Advancements in imaging technology and embolic agents have contributed to improved precision and

(GAE) has the potential to alleviate pain and enhance knee function in individuals with osteoarthritis (OA). Long-term effects and comparative efficacy with alternative treatments are still being investigated, though.

Success Rates: Although outcomes can differ, numerous studies suggest notable pain alleviation and enhanced quality of life .

Difficulties and Hazard

Adverse Events: Serious problems are uncommon, but possible risks include bleeding, infection, and non-target embolization. A thorough pre-procedure imaging and careful patient selection are essential to reducing risks and improving the outcome of the treatment

Future Directions - Research: Research is concentrated on technique optimization, long-term outcome evaluation, and comparing GAE with alternative treatment approaches. **Advances in Technology**: Advancements in imaging and embolization materials could potentially improve the accuracy of

1.3 ETIOLOGY:

Osteoarthritis: The pathophysiology of osteoarthritis (OA) entails the knee joint experiencing inflammation and cartilage degradation, resulting in pain and decreased function. Difficulties Using Conventional Treatments: Keep in mind that conventional therapies frequently fall short of treating the inflammation completely, calling for the use of alternative strategies like GAE.

Inflammation and Pain - Inflammatory Factor: Describe how inflammation aggravates knee pain and reduces knee function.

Impact of Blood Flow: Explain how enhanced blood flow to inflammatory regions can exacerbate symptoms and necessitate specialized treatments like GAE.

GAE Mechanism - Embolization Process: Describe how GAE reduces inflammation and pain by obstructing the genicular arteries, which feed blood to the knee joint. **Impact on Pain and Function**: Talk about how less blood supply to inflammatory areas promotes better function and pain alleviation.

Clinical Justification Unmet Needs: Highlight the limitations of existing treatments, such as medications and physical therapy, and how GAE might fill these gaps.

Evidence and Rationale: Present emerging clinical evidence supporting the efficacy and safety of GAE, reinforcing its role as a viable treatment option.

1.4 SIGN AND SYMPTOMS OF OSTEOARTHRITIS

Pain and Discomfort: Temporary pain or discomfort in the knee area is common, often due tothe procedure itself or the reaction to the embolization.

Swelling: Swelling around the knee might develop, which can vary in intensity. Bruising: Bruising at the site of the catheter insertion or around theknee.

Infection: As with any procedure involving an incision, there's a risk of infection at the catheterinsertion site.

Fever: Mild fever can occur as a reaction to the procedure**.**

1.5 Age

Age is a one of the strongest risk factors for OA of all joints. The increase in the prevalence and incidence of OA with age probably is a consequence of cumulative exposure to various risk factors and biologic changes that occur with aging that may make a joint less able to copewith adversity, such as cartilage thinning, weak muscle strength, poor proprioception, and oxidative damage.

1.6 Gender and hormones

Women not only are more likely to have OA than men, they also have more severe OA (The definite increase in OA in women around the time of menopause has led investigations hypothesize that hormonal factors may play a role in the development of OA. However, resultson effect of estrogen, either endogenous or exogenous, on OA from observational studies have been conflicting. In a randomized clinical trial (the Heart and Estrogen/Progestin ReplacementStudy) in a group of older postmenopausal women with heart disease, no significant differencewas found in the prevalence of knee pain or its associated disability between those taking estrogen plus progestin therapy or those taking placebo

Data from the Women's Health Initiative showed that, women on estrogen replacementtherapy were

15% less likely to require total knee or hip arthroplasty than those not takingsuch therapy (hazard ratio 0.86; 95% Confidence Interval, 0.70-1.00), but that estrogencombined with progestin therapy was not associated with the risk of joint replacement

2.6Race/ethnicity

The prevalence of OA and patterns of joints affected by OA vary among racial and ethnic groups. Both hip and hand OA were much less frequent among Chinese in the Beijing Osteoarthritis Study than in whites in the Framingham Study but Chinese women in the BeijingOsteoarthritis Study had significantly higher prevalence of both radiographic and symptomaticknee OA than white women in Framingham Study . Results from the Johnston County Osteoarthritis Project have shown that the prevalence of hip OA in African American women (23%) was similar to that in white women (22%), and prevalence was addition, African Americans were also more likely to have more severe and tri-compartmental osteophytes than their White counterparts. Whether some of these racial/ethnic differences arerelated to differences in anatomic femoral and acetabular features, shown to be important in radiographic hip OA in whites is worthy of further study.

2.7.1 Obesity Repetitive use of joints at work is associated with an increased risk of OA. Studies have foundthat farmers have a high prevalence of hip OA. The prevalence of Heberden's nodes was muchhigher in the cotton mill workers, whereas spinal OA was no more common in these workers than in controls. Workers whose jobs required repeated pincer grip had more OA at distal interphalangeal joints than did workers whose job required power grip.kneeling and squatting were much higher among subjects who were overweight or whose job also involved with lifting.

2.7.2 Physical activity/sports

Studies examining the relationship between sports activities and subsequent OA have produced conflicting results. There is some evidence that elite long-distance runners are at high risk for the development of knee and hip OA and elite soccer players are at higher risk of getting kneeOA when compared with non-soccer players. Surprisingly, the general level of physical activityitself may also increase the risk of OA.

For instance, physical activity among elderly subjects in the Framingham Study was generally characterized by leisure time walking and gardening. However, person who engaged in relatively high levels of such activity had a threefold greater risk of developing radiographic knee OA than sedentary persons over 8 years of follow-up Similar findings also were reportedin another study in which women who had a high lifetime level of physical activity had a highprevalence of hip OA. In contrast, others

have shown that, in the absence of acute injury,

recreational (moderate) long distance running and jogging did not appear to increase the risk of OA

2.7.3 Mechanical factors

The relationship between muscle strength and OA is complex, may vary by joint site, and is notentirely understood. Muscle weakness and atrophy commonly associated with knee OA had been thought to be the product of disuse resulting from pain-avoidance. One study reported that women who had asymptomatic radiographic knee OA but had no muscle atrophy showed quadriceps muscle weakness suggesting that this might be a risk factor for the development ofsymptomatic knee OA Baker and colleagues confirmed that persons who had both asymptomatic patellofemoral and tibiofemoral radiographic knee OA had weaker quadriceps strength than those who did not have OA. In a follow-up study quadriceps muscle weakness notonly resulted from painful knee OA, but also increased the risk of knee structural damage. Otherstudies however, showed that greater quadriceps muscle strength in the setting of malalignmentand laxity may actually be associated with an increased risk of knee OA progression. Using the data from the Genetics of Generalized Osteoarthritis Study, Dominick and colleaguesfound an inverse cross-sectional association between grip strength and OA of the carpometacarpal joint and development of OA in those joints.

risk factors include:

Allergic Reactions: Some patients may have allergies to contrast agents used during theprocedure **Infection**: There is a small risk of infection at the puncture site or within the joint. **Bleeding**: There could be bleeding at the site where the catheter is inserted or within the joint. **Pain or Discomfort**: Some patients experience increased pain or discomfort in the knee following the procedure.

Allergic Reaction to Embolic Agents: Although rare, there may be reactions to the materialsused to block the arteries.

Pathophysiology

After an injury the duration of time determines whether inflammation appears as acute or chronic. General inflammation symptoms include local fluid accumulation and granulocytic cell presence which lead to systemic manifestations such as heat in the body and elevated white blood counts as well as protein breakdown and elevated serum C-reactive protein markers. The entry of monocytic cells defines chronic inflammation while this condition appears less noticeable to the human eye. The condition of acute inflammation can disappear entirely or evolve into chronic inflammation but chronic inflammation

also has the capability of starting independently..

Angiogenesis

The synovial joint combines a stable configuration with flexible movements because of its design. Vascular cells within the synovial membrane feed the cartilage which lacks blood vessels. The increasing quantity and penetration of new blood vessels occurs through these factors which enables inflammatory cell entry into the area. The mechanism of angiogenesis continues inflammation in osteoarthritis despite being unable to start it. 6 27 Multiple processes lead to the development of angiogenesis which helps different pathological conditions such as chronic inflammation and tumor metastasis form. The synovial tissue supports the release of angiogenic factors VEGF and Ang-1 and NGF and bFGF from inflammatory cells. Local endothelial cells produce proteolytic enzymes after the factors trigger their production thus degrading basement membranes while dissolving the surrounding extracellular matrix. The breakdown process allows endothelial cells to grow and move toward each other which creates a sprout that eventually becomes capillary loops. The loops undergo basement membrane production which finishes the development of capillaries. The synovial membrane's inflammatory areas contain pro-inflammatory cytokines at elevated concentrations than normal areas of the synovial membrane.

2.8 Pharmacological Action for Genicular Artery Embolization (GAE) 13

1. Preoperative Medication: Analgesics and Sedative Sedatives: Such as midazolam, may be used to alleviate anxiety and ensure patientcomfort during the procedure

Analgesics: Non-opioid analgesics may be administered to manage baseline painbefore the procedure

Intraoperative Medication:

Contrast Agents:

- Contrast Media: Injected to visualize the genicular arteries during angiography.

Common agents include iodine-based contrast media

- Embolic Agents:

Embolic Materials: Include particles, coils, or other agents used to occlude the targetarteries. These agents act locally to reduce blood flow and inflammation

2. Postoperative Medication: Analgesics:

Pain Management: Postoperative pain is managed with analgesics. NSAIDs or opioids may be used depending on the severity of pain

- **Anti-inflammatory Drugs:**

- **NSAIDs or Corticosteroids:** May be used to manage inflammation followingthe procedure, although corticosteroids are less commonly used due to potential sideeffects

3. Additional Considerations:

Anticoagulants: Depending on the patient's risk factors, anticoagulants may be used toprevent clot formation post-embolization

2.9 Expected Outcome and Complications [23]

Expected Outcome

The results of GAE for the treatment of refractory knee pain secondary to osteoarthritis are usually evaluated with the use of validated self-administered scales either general, such as VAS, or specificfor hip and knee osteoarthritis as in the case of WOMAC. While the former exclusively evaluates pain, WOMAC also takes into consideration articular functionality and stiffness. Some authors decided to use the Knee Injury and Osteoarthritis Outcome Score Page 27 of 63 - Integrity Submission Patients experienced meaningful reductions in VAS and WOMAC scores during the first month and these improved results proved to be sustained until the third month according to published primary case series. Different research studies revealed that pain and joint symptoms slightly increased after the first month yet this may be caused by patient-specific characteristics. Patients with severe osteoarthritis developed symptom relapses according to Lee et al. but subjects with mild to moderate osteoarthritis saw their benefits last until month twelve according to the research due to advanced disease status. The clinical outcomes of intra-articular corticosteroid injections differed substantially based on patient Kellgren-Lawrence (KL) grades according to Choi and colleagues showing that KL grade 3 or higher indicated an increased chance of poor response due to osteoarthritis severity. 45 6 Padia et al discovered different patients who had reached the 1-month time point 60% demonstrated at least a 50% decrease in VAS and WOMAC scores while at the 1-year follow-up these percentages rose to 68%. The major variation between studies exists in embolization methods since Padia's team implemented non results when their research involved participants with KL grade 4 osteoarthritis among a study cohort reaching 40% success rate. Among -absorbable materials but Lee et al. along with Choi et al. employed temporary

embolic materials that included IM/CS along with IM/CS and gelatin sponge mixture. The clinical study by Sapoval and colleagues implemented the resorbable embolic agent known as ethiodized oil-based Lipiodol Ultra-Fluid (Guerbet, Paris, France) for patients with KL grade 3 and 4 injuries. Three months into the research the team revealed that patients experienced a decline of fifty percent in VAS scoring before conclusion of the study period but additional years of results verification are required to confirm this data effectively.

2.10 BENEFITS:

Pain Relief: GAE can significantly reduce knee pain, often improving the patient'squality of life. **Reduced Inflammation**: By targeting the blood vessels that supply the knee joint,GAE can decrease inflammation and swelling.

Minimally Invasive: The procedure is less invasive compared to surgical options,with a generally shorter recovery time.

Preservation of Joint Function: GAE can help preserve knee function andpotentially delay the need for joint replacement surgery.

Outpatient Procedure: It is typically performed on an outpatient basis, meaningpatients can often return home the same day

2.11 PHYSIOTHERAPY: for genicular artery embolization

Genicular artery embolization (GAE) is a minimally invasive procedure used primarily for treating knee pain, especially due to osteoarthritis. It involves injecting small particles into thegenicular arteries to reduce pain and inflammation.

Post-procedure, physiotherapy can play a critical role in enhancing recovery and improvingfunction. Key aspects of physiotherapy for patients who have undergone GAE might include:**Pain Management**: Techniques such as ice therapy, heat application, and gentle stretches tomanage pain and discomfort. **Range of Motion Exercises**: To help maintain or improve the knee's range of motion andprevent stiffness.

Strengthening Exercises: Focusing on strengthening the muscles around the knee to support and stabilize the joint.

Gait Training: To ensure proper walking mechanics and reduce stress on the knee joint. **Education**: Providing guidance on activity modifications and proper body mechanics to avoidexacerbating the condition.

2.12 SIDE EFFECTS:

Skin discoloration: This can occur in 10–65% of patients Pain: This can include pain at the injection site or knee painSwelling: This can occur at the injection site

Bruising: This can occur at the insertion siteNumbing: This can be temporary Other, more rare side effects include:

Hematoma at the puncture site

Plantar paresthesia, which can feel like tingling Bone infarction, which is damage to bone tissue Postembolization syndrome, which can cause fever, nausea, and other symptoms for a shorttime, infection , bleeding, damage to the arteries

2.13 COST 34 35

Genicular artery embolization (GAE) is a minimally invasive procedure that can cost ₹1.70 lakh. The cost of GAE can vary depending on multiple factors, including pre-operative assessments, surgery charges, anesthesia, hospitalization, post-operative care, and follow-up appointments. Insurance may cover GAE, but the out-of-pocket expense will depend on the specific insurance plan. It's recommended to check with your insurance provider to determine the extent of coverage and any out-of-pocket

3. MATERAIL AND METHODS

3.1 MATERAIL AND METHODS FOR GENICULAR ARTRY EMBOLISZATION

Materials and Methods

- **Aim :** To evaluate the impact of Genicular Artery Embolization (GAE) on quality of life in osteoarthritis patients. This study aims to assess the efficacy, safety, and clinical outcomes of GAE treatment. The findings will provide valuable insights into the potential benefits and limitations of GAE in managing osteoarthritis

- **Primary Objective**

- **To determine the quality of life in patients with osteoarthritis after post GAE Treatment**

- **Secondary Objectives:**

- **To determine the satisfactions level after GAE**

- **An observational study to assess quality of life in osteoarthritis patients receiving genicular artery embolization treatment at Bankers vascular hospital Ahmedabad-380015**

- **STUDY DESIGN-** Prospective observational survey based study

- **PERIOD OF STUDY-** 3 months.

- **STUDY LOCATION-**This study will be conduct at Bankers vascular hospital Ahmedabad-380015

- In this study, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scale will be used to assess the severity of symptoms and functional limitations, while a 16-question quality of life assessment will also be employed to evaluate the impact of the treatment on patients' overall well-being.

- https://docs.google.com/forms/d/1dQkAqW1YEe5cXJCSamJgwsEBaOifS6Y13Ue2POhjM1Y/previe w

- **SAMPLE SIZE-**40 above

- **Inclusion criteria**

- Provided informed consent

- Age of 40 to 80 yr

- Ineligibility for or refusal of surgery (like knee replacement)
- Moderate to severe knee pain
- Ability to provide informed consent. Willingness to participate in follow-up assessments.
- Ability to read and understand the study in the chosen language (e.g. English, Gujarati**,** Hindi).
- On pain medications (NSAIDs, opioids).
- **Exclusion criteria**
- Recent or active cigarette use
- Drug interactions (e.g., anticoagulants, antiplatelets).
- Recent medication changes (within 30 days).
- Non-compliance with medication regimen
- treatment options and cost-effectiveness.
- **METHODOLOGY**

- Ethical Approval & Consent: Obtain approval from the hospital and Ethics Committee, and ensure informed consent from participants.
- Participant Selection: Recruit eligible participants post-surgery.
- Data Collection: Use a questionnaire to know about effectiveness, quality of life, costs, and medication side effects.
- Medical History: Record relevant medical conditions (e.g., high blood pressure, diabetes, etc.).

- Data Analysis: satisfaction, quality of life, and financial impact.
- Recommendations: Provide suggestion to improve treatment effectiveness and cost- efficiency.
- conclusions will be drawn, and recommendations will be made for improving treatment options and cost-effectiveness.

- **conclusions**

The following is a somewhat enlarged paraphrase: Genicular artery embolisation (GAE) is a novel minimally invasive treatment for osteoarthritis (OA) of the knee that has shown remarkable safety and effectiveness in lowering inflammation and chronic pain. GAE offers long-lasting relief from inflammation by addressing its root cause, enhancing function, mobility, and general quality of life. This novel technique has great promise for patients with severe knee pain, delaying surgical intervention by acting as a feasible alternative to surgery or a bridge and possibly lowering the need for painkillers and other conservative therapy, even though more research is necessary.

REFERENCE:

1. Talaie R, Torkian P, Clayton A, Wallace S, Cheung H, Chalian M, Golzarian J. Emerging targets for the treatment of osteoarthritis: new investigational methods to identify neo-vessels as possible targets for embolization. Diagnostics 2022;12(6):1403.

2. Wylde V, Dieppe P, Hewlett S, Learmonth ID. Total knee replacement: is it really an effective procedure for all? The Knee 2007;14(6):417-23.

3. Morfini M, Agnelli Giacchiello J, Baldacci E, Carulli C, Castaman G, Giuffrida AC, et al. Managing relevant clinical conditions of hemophilia A/B patients.

4. Ciaffi J, Papalexis N, Vanni E, Miceli M, Faldini C, Scotti L, et al. Minimally invasive interventional procedures for osteoarthritis and inflammatory arthritis: A systematic review and meta-analysis. Seminars in Arthritis and Rheumatism 2024.

5. Marecek G. AAOS Comprehensive Orthopaedic Review 4. Lippincott Williams & Wilkins; 2024.

6. Heller DB, Beggin AE, Lam AH, Kohi MP, Heller MB. Geniculate artery embolization: role in knee hemarthrosis and osteoarthritis. Radiographics 2022;42(1):289-301.

7. Michael JW, Schlüter-Brust KU, Eysel P. The epidemiology, etiology, diagnosis, and treatment of osteoarthritis of the knee. Deutsches Arzteblatt International 2010;107(9):152.

8. Femia M, Valenti Pittino C, Fumarola EM, Tramarin M, Papa M, Giurazza F, et al. Genicular artery embolization: A new tool for the management of refractory osteoarthritis-related knee pain. Journal of Personalized Medicine 2024;14(7):686.

9. Gu YT, Chen J, Meng ZL, Ge WY, Bian YY, Cheng SW, et al. Research progress on osteoarthritis treatment mechanisms. Biomedicine & Pharmacotherapy 2017;93:1246-52.

10. Rahmati M, Mobasheri A, Mozafari M. Inflammatory mediators in osteoarthritis: A critical review of the state-of-the-art, current prospects, and future challenges. Bone 2016;85:81-90.

11. Epelboym Y, Mandell JC, Collins JE, Burch E, Shiang T, Killoran T, et al. Genicular artery embolization as a treatment for osteoarthritis related knee pain: a systematic review and meta-analysis. Cardiovasc Intervent Radiol 2023;46(6):760-9.

12. Padia SA, Genshaft S, Blumstein G, Plotnik A, Kim GH, Gilbert SJ, et al. Genicular artery embolization for the treatment of symptomatic knee osteoarthritis. JBJS Open Access 2021;6(4):e21.

13. Nevitt MC, Cummings SR, Lane NE, et al. Association of estrogen replacement therapy with the risk of osteoarthritis of the hip in elderly white women. Arch Intern Med 1996;156(18):2073-80.

14. Lane NE, Lin P, Christiansen L, et al. Association of mild acetabular dysplasia with an increased risk of incident hip osteoarthritis in elderly white women: the study of osteoporotic fractures. Arthritis Rheum 2000;43(2):400-4.

15. Dolan AL, Hart DJ, Doyle DV, Grahame R, Spector TD. The relationship of joint hypermobility, bone mineral density, and osteoarthritis in the general population: the Chingford Study. J Rheumatol 2003;30(4):799-803.

16. Neogi T, Booth SL, Zhang YQ, et al. Low vitamin K status is associated with osteoarthritis in the hand and knee. Arthritis Rheum 2006;54(4):1255-61.

17. Messier SP, Loeser RF, Miller GD, et al. Exercise and dietary weight loss in overweight and obese older adults with knee osteoarthritis: the Arthritis, Diet, and Activity Promotion Trial. Arthritis Rheum 2004;50(5):1501-10.

18. Lohmander LS, Ostenberg A, Englund M, Roos H. High prevalence of knee osteoarthritis, pain, and functional limitations in female soccer players twelve years after anterior cruciate ligament injury. Arthritis Rheum 2004;50(10):3145- 52.

19. Hadler NM, Gillings DB, Imbus HR, et al. Hand structure and function in an industrial setting. Arthritis Rheum 1978;21(2):210-20.

20. Spector TD, Harris PA, Hart DJ, et al. Risk of osteoarthritis associated with long-term weightbearing sports: a radiologic survey of the hips and knees in female ex-athletes and population controls. Arthritis Rheum 1996;39(6):988-95.

21. Slemenda C, Brandt KD, Heilman DK, et al. Quadriceps weakness and osteoarthritis of the knee. Ann Intern Med 1997;127(2):97-104.

22. Femia M, Valenti Pittino C, Fumarola EM, Tramarin M, Papa M, Giurazza F, et al. Genicular artery embolization: A new tool for the management of refractory osteoarthritis-related knee pain. Journal of Personalized Medicine 2024;14(7):686.

23. Sun C, Chen Y, Gao Z, Wu L, Lu R, Zhao C, et al. Genicular artery embolization for the treatment of knee pain secondary to mild to severe knee osteoarthritis: One year clinical outcomes. European Journal of Radiology 2024;175:111443.

24. Uman LS. Systematic reviews and meta-analyses. Journal of the Canadian Academy of Child and Adolescent Psychiatry 2011;20(1):57.

25. Doucet J, Kiri L, O'Connell K, Kehoe S, Lewandowski RJ, Liu DM, et al. Advances in degradable embolic microspheres: a state of the art review. Journal of Functional Biomaterials 2018;9(1):14.

26. O'Grady AM, Little MW. Genicular Artery Embolization Data Review. Techniques in Vascular and Interventional Radiology 2023;26(1):100880.

27. Salaffi F, Leardini G, Canesi B, Mannoni A, Fioravanti A, Caporali RO, et al. Reliability and validity of the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index in Italian patients with osteoarthritis of the knee. Osteoarthritis and Cartilage 2003;11(8):551-60.

28. Taslakian B, Miller LE, Mabud TS, Macaulay W, Samuels J, Attur M, et al. Genicular artery embolization for treatment of knee osteoarthritis pain: Systematic review and meta-analysis. Osteoarthritis and Cartilage Open 2023;5(2):100342.

29. Badar W, Anitescu M, Ross B, Wallace S, Uy-Palmer R, Ahmed O. Quantifying Change in Perfusion after Genicular Artery Embolization with Parametric Analysis of Intraprocedural Digital Subtraction Angiograms. Journal of Vascular and Interventional Radiology 2023;34(12):2190-6.

29. Badar W, Anitescu M, Ross B, Wallace S, Uy-Palmer R, Ahmed O. Quantifying Change in Perfusion after Genicular Artery Embolization with Parametric Analysis of Intraprocedural Digital Subtraction Angiograms. Journal of Vascular and Interventional Radiology 2023;34(12):2190-6.

30. Amano T, Tamari K, Tanaka S, Uchida S, Ito H, Morikawa S, et al. Factors for assessing the effectiveness of early rehabilitation after minimally invasive total knee arthroplasty: a prospective cohort study. PLoS One 2016;11(7):e0159172.

31. Poursalehian M, Bhia I, Firoozabadi MA, Mortazavi SM. Genicular Artery Embolization for Knee Osteoarthritis: A Comprehensive Review. JBJS Reviews 2023;11(9):e23.

32. Epelboym Y, Mandell JC, Collins JE, Burch E, Shiang T, Killoran T, et al. Genicular artery embolization as a treatment for osteoarthritis related knee pain: a systematic review and meta-analysis. Cardiovasc Intervent Radiol 2023;46(6):760-9.

33. Kwak DH, Zane K, Yu Q, Fustok J, Ahmed O, Patel M. Genicular Artery Embolization for the Treatment of Knee Osteoarthritis Pain. Contemporary Diagnostic Radiology 2024;47(16):1-8.

34. 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. Journal of Vascular and Interventional Radiology 2024.

35. McAlindon TE, Bannuru RR, Sullivan MC, Arden NK, Berenbaum F, Bierma- Zeinstra SM, et al. Response to Letter to the Editor entitled "Comments on 'OARSI guidelines for the non-surgical management of knee osteoarthritis'". Osteoarthritis Cartilage 2014;22(6):890-1.

36. National Institute for Health and Care Excellence (NICE). Osteoarthritis: care and management. NICE Clinical Guideline [CG177]. 2014.

37. Sterbis E, Casadaban L. Genicular artery embolization technique. Techniques in Vascular and Interventional Radiology 2023;26(1):100878.

38. Bagla S, Piechowiak R, Hartman T, Orlando J, Del Gaizo D, Isaacson A. Genicular artery embolization for the treatment of knee pain secondary to osteoarthritis. Journal of Vascular and Interventional Radiology 2020.