Review paper

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Joints and needles: summary of radiosynoviorthesis

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Abstract

Radiosynoviorthesis is a minimally invasive treatment for inflammatory joint disorders. It is an alternative to surgical synovectomy and is used when systemic treatment and intraarticular glucocorticosteroid injections have failed. This literature review summarizes the effectiveness of this method in various inflammatory joint disorders. A systematic literature search was performed in the PubMed, Embase, Web of Science and DOAJ databases. Depending on the type of inflammation and level of joint destruction, the effectiveness of therapy is 50–80%, up to even 90–100% in hemarthrosis. The present study demonstrates that the therapy is safe, with almost no side-effects. It provides long-term cost-effectiveness for patients due to its ambulatory characteristics, does not require rehabilitation, and leads to reduced use of other therapies. Moreover, it may be used as an independent type of therapy as well as a part of complex treatment. Given its benefits, the method should be considered by specialists of various fields.

Key words: rheumatoid arthritis, hemophilia, radiosynoviorthesis, RSO.

Introduction

Radiosynoviorthesis (RSO) is a non-invasive method for treatment of synovitis through intraarticular injection of a radiopharmaceutical. Despite long-term use, it is still a rare alternative to surgical methods and an adjunct to ineffective drug treatment [1, 2]. Radioisotope particles in the structure of colloidal solutions are phagocytosed by macrophages of the inflamed synovial membrane. The radiopharmaceuticals used nowadays are β-emitters, such as yttrium, erbium, and rhenium. By emitting β radiation, they cause necrosis of synoviocytes and consequently fibrosis of the synovial membrane. The most important factor is the choice of radiopharmaceutical, which is based on the size of the joint and the necessary penetration and energy. Those with the smallest range are used mainly for treating small joints and those with the largest range for treating larger joints [3]. Erbium-169 (^{169}Er; maximum β energy: 0.3 MeV, max range: 1 mm) is used to treat small joints: metacarpophalangeal, metatarsophalangeal, and interphalangeal. Rhenium-186 (^{186}Re; maximum β energy: 0.98 MeV, max range: 3,7 mm) is used to treat medium-sized joints such as the ankle, shoulder, elbow, and shoulder joint. Yttrium-90 (^{90}Y; maximum β energy: 2.26 MeV, max range: 11 mm) is used to treat large joints such as the knee joint. The size of the colloid particles is chosen to be sufficiently large that the radiopharmaceutical does not enter the lymphatic vessels, and sufficiently small that the synoviocytes can phagocytose it. This allows the drug to be confined to the synovial membrane.

Radiosynoviorthesis is used most often for the treatment of chronic synovitis with recurrent joint effusions in patients with rheumatoid arthritis (RA), hemophilic arthritis, osteoarthritis (OA) with effusion, and juvenile idiopathic arthritis (JIA).

In comparison to surgical treatment, RSO is a significantly less invasive method and can be performed on an outpatient basis. It does not need access to an operating room or, even more importantly, anesthesia. It requires no rehabilitation after the procedure, and only 1 to 3 days of immobilization of the joint are needed – after that, the patient can use the joint freely. Another advantage over surgical treatment is the possibility to perform RSO in multiple joins in one session. It is worth mentioning that the method is repeatable, and if at least a partial improvement is observed after the performed treatment, a second administration of the radiopharmaceutical should be considered.

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There is a paucity of publications about RSO with arthroscopic synovectomy. In one of them, Ramazan et al. [4] studied combined subtotal arthroscopic synovectomy with RSO in 14 patients with chronic nonspecific synovitis. The mean follow-up period was 30.3 ±3.7 months. Arthroscopic synovectomy alone was found to have a higher recurrence rate. This suggests that combining RSO with surgical treatment may be preferable treatment to acquire a long-term effect.

There are limited contraindications for RSO. As in all nuclear medicine procedures, they include pregnancy and breastfeeding. A special contraindication for RSO is an active infection of the area of the joint to which the radiopharmaceutical is to be applied. Additionally, for the knee, a ruptured Baker's cyst is a contraindication for RSO. Relative contraindications include widespread joint instability with bone destruction (Steinbrocker period III and IV in RA) or fractures, significant cartilage loss in the joint, and lack of response to 2 previous RSO. It is worth adding that despite the concerns of both patients and medical personnel about the potential increase in the risk of malignancy following treatment, an analysis of 2,412 adult patients showed no increased risk of cancer [5].

On the other hand, the increased risk of RSO should be taken into account depending on the degree of joint degeneration. Kisielinski et al. [6] evaluated 79 cases with OA of diverse joints, 12 cases of arthroplasty and 2 cases of chronic shoulder impingement with joint effusion. Among OA patients, 63.3% had a Kellgren-Lawrence score of 4. Twenty-two of 93 patients showed complications after RSO, osteonecrosis was observed in 19 and infection in 5 patients. This shows that RSO may not be as safe in patients with advanced OA as it is declared to be generally, and treatment should be considered in terms of potential profit and risks in patients with high grades of cartilage damage.

The procedure is safe only with local injection of radiopharmaceutical but still showed some side effects. The most common side effect is a short-term increase in inflammation of the treated joint. Another complication is inflammation of the surrounding lymph nodes, which is counteracted by immobilizing the joint for 1–3 days.

Material and methods

A systematic literature search was performed in the PubMed, Embase and Web of Science and DOAJ databases applying the key words "RSO", "radiosynoviorthesis", "rhenium", "yttrium", "erbium", as well as their combinations, e.g. "rhenium RSO". Database searches were performed between June and August 2024. Meta-analyses, systematic reviews, interventional studies, clinical studies and therapy studies on RSO, published between 1997 and 2024, were included. Studies which were observational, published in languages other than English or Polish, included no follow-up or involving fewer than 15 people were excluded. All findings were independently obtained by the authors and discussed to ensure that only relevant studies were included. A summary of the search strategy and results is shown in Figure 1.

Radiosynoviorthesis in rheumatoid arthritis

The most common indication for RSO is RA, which ranks 8th among all diseases in terms of the burden on the health care system in Poland, and its incidence is steadily increasing [2, 5, 7–10]. The range of treatment options is wide and includes the use of disease-modifying drugs, analgesics, surgical synovectomy, rehabilitation and glucocorticosteroids (GCs) therapy [11, 12]. The overall response rate of RSO in RA varies between 35 and 100% depending on the stage of disease.

A retrospective study, involving 577 RSO performed in 137 patients, evaluated the response on a subjective 4-point scale – excellent, good, moderate, and poor – in patients grouped according to the joint treated [13]. The study recruited patients whose 6-month systemic therapy did not reduce the severity of the condition. The overall efficacy of RSO was estimated at 75% of all treated joints. An excellent or good response to treatment, meaning a complete or significant reduction in symptoms, was observed in 57% of treated knee joints,

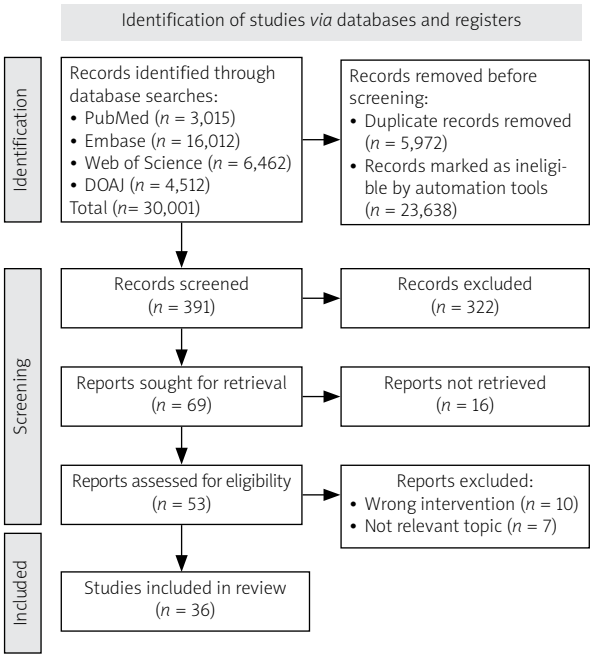

Fig. 1. PRISMA flow chart of literature screening.

63% of shoulder joints, 60% of wrists, 54% of thumb base joints, 55% of metacarpophalangeal joints, 54% of proximal interphalangeal joints, 53% of distal interphalangeal joints, and 54% of metatarsophalangeal joints. The incidence of side effects, i.e., transient increases in inflammation, was estimated at 7%. It is worth noting that the study used a 3-month follow-up, which is an important limitation of the reported data. According to data reported in the European Association of Nuclear Medicine (EANM) guideline for RSO, efficacy decreases with longer patient follow-up, and some of the side effects can occur even after 3 months [14].

As mentioned, the effectiveness of RSO depends on the severity of symptoms and the duration of the condition. A meta-analysis by Kresnik et al. [15], which included 2,190 treated joints, examined the relationship between the effectiveness of RSO and the etiopathogenesis of the disease and the degree of joint destruction before treatment. Overall, the mean efficacy in RA patients was 66.7 ±15.4%. The authors noted that the effectiveness of the treatment depends on the stage of the disease at which RSO is used. The highest efficacy was described in the early period of RA (periods I and II according to Steinbrocker), with 64–72.8% at 1-year follow-up, while it dropped to 52.4% in the later stage of disease (stages III and IV according to Steinbrocker). The results of the above study indicate the desirability of early incorporation of RSO, both because of its higher efficacy and longer response time than the frequently used intraarticular GCs therapy.

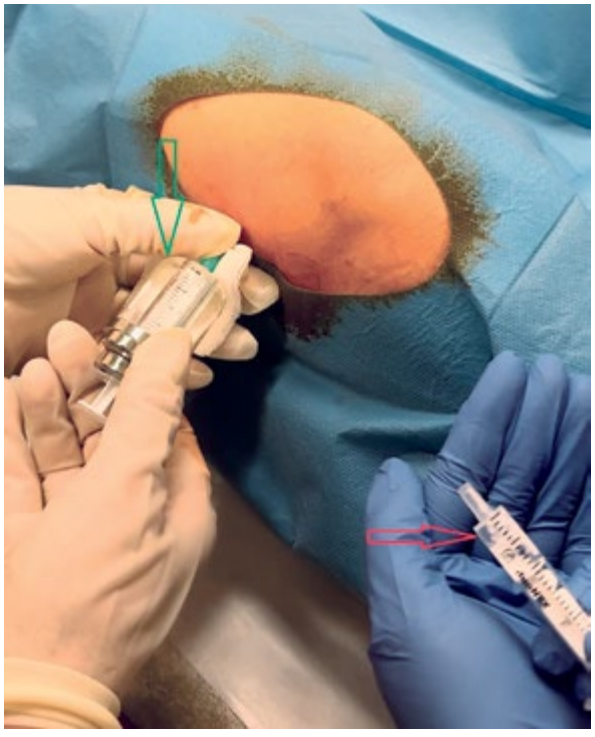

Fig. 2. Radiosynoviorthesis of the knee joint, covered in sterile sheet. Green arrow – syringe with yttrium-90 citrate with plexiglass shielding device. Red arrow – syringe with betamethasone.

These methods were directly compared in a randomized, multicenter study in systemically treated patients in whom one or more joints were characterized by swelling or soreness despite treatment [16]. Patients divided into 2 groups (wrist and other joints) were randomized to receive either GCs or ^{186}Re injection. There were no statistically significant differences in response at 3, 6, and 12 months after treatment; however, at 18 and 24 months, efficacy was significantly higher in the RSO-treated group. Improvement increased over time and included all measured criteria (soreness and swelling). No serious side effects were observed. This study further proves that RSO could and should be considered in every patient with joint inflammation and provides better effects than GCs injection over time.

While in direct comparison RSO seems better than GCs injection, it is worth noting that combining both methods provides excellent results. Göbel et al. [17] studied long-term efficiency of RSO with ^{186}Re combined with triamcinolone hexacetonide. The researchers divided the patients into 3 groups: treated only with ^{186}Re (group 1) vs. treated with ^{186}Re + triamcinolone (group 2) vs. treated only with triamcinolone (group 3). All measured parameters (pain, reduction of synovitis, increased range of motion) improved in all groups in short-term follow-up. However, at 12 months the patients treated with ^{186}Re, in combination or in monotherapy, still benefited from the treatment. Also, the study proved the superiority of RSO in combination with intraarticular GCs injection, which is now the gold standard (Figs. 2 and 3). This is one of the few studies in which the follow-up period exceeded 1 year and, as stated in the article, RSO (preferably combined with GCs) should be considered as an alternative to surgery. However, 71 out of 150 treated joints were excluded due to a change in disease-modifying drugs or recurrent synovitis, which may be a mild drawback.

Radiosynoviorthesis, by acting locally, and reducing inflammation, may also improve some systemic parameters. Zwolak et al. [18] studied the effect of the applied treatment with the levels of hyaluronic acid, osteoprotegerin, and inflammatory markers in the blood, serum amyloid A, and radiological assessment of the skeleton (Steinbrocker scale). As mentioned above, RSO does not have a significant effect on the degree of bone destruction of the joint. However, the authors observed a statistically significant improvement in the parameters of the blood test. This forces a broader perspective on

the seemingly local treatment of the condition. It is also worth noting that RSO should be considered an important part of combined therapy of synovitis [19]. While the results of this study give grounds for optimism, only a few parameters were evaluated in the heterogenous group. As the authors of the study stated, further research is necessary.

Radiosynoviorthesis in hemophilic arthritis

Radiosynoviorthesis is the treatment of choice for hemophilic arthritis [20]. Hemophilia is a genetic disorder associated with deficiency or improper synthesis of coagulation factors VIII and/or IX. Diagnosis is based on the evaluation of hemostatic parameters, especially activated partial thromboplastin time. The condition is associated with impaired blood coagulation and complications of this process, including multiple joint hemorrhages, which can permanently and irreversibly damage the joints. In the literature, 70–90% of patients benefit from RSO in terms of bleeding frequency, the intensity of pain, joint function, and thickness of the synovium. It is worth noting that most patients with hemophilia are diagnosed in early age, and while most systemic drugs are effective, their side-effects tend to worsen over time.

Kachooei et al. [21] evaluated 43 studies, which sampled over 20 knees each, on the use of RSO in hemophilic arthritis. In 66–91% of cases, reductions in short-term and middle-term bleeding frequency were observed, while hemarthrosis-free status was reported in 29–84% of cases in the short term. Considering the pain, studies showed that up to an 81% decrease in the Visual Analogue Scale (VAS) score for pain was observed in 6 months. After repeating RSO, significant improvement in pain levels was observed in 59–78%.

Spanish researchers [22] analyzed studies from Cochrane Library and PubMed relating to total knee arthroplasty (TKA) in people with hemophilia. Although the success rate of TKA is usually high, the complication rate can be as high as 31.5%. The most important complications were infection and postoperative bleeding (due to popliteal artery injury), but also hemarthrosis and bleeding in the form of hematoma. The risk of prosthetic re-infection after revision knee arthroplasty is about 10%. This suggests that whenever treatment with RSO is possible, it should be chosen instead of surgical treatment.

The largest published study on hemophilic arthritis was a summary of 500 RSOs performed over 38 years [23]. Essential improvements in the reduction of bleeding episodes (mean 64.1%), pain reduction (mean 69.4%), and clinical WFH score (World Federation of Hemophilia Physical Examination Score, also called the Gilbert score) were observed. The radiographic WFH score showed no differences between patients before and after surgery. Importantly, only 28 joints (6.3% of the total) required arthroscopic synovectomy or a joint alloprosthesis.

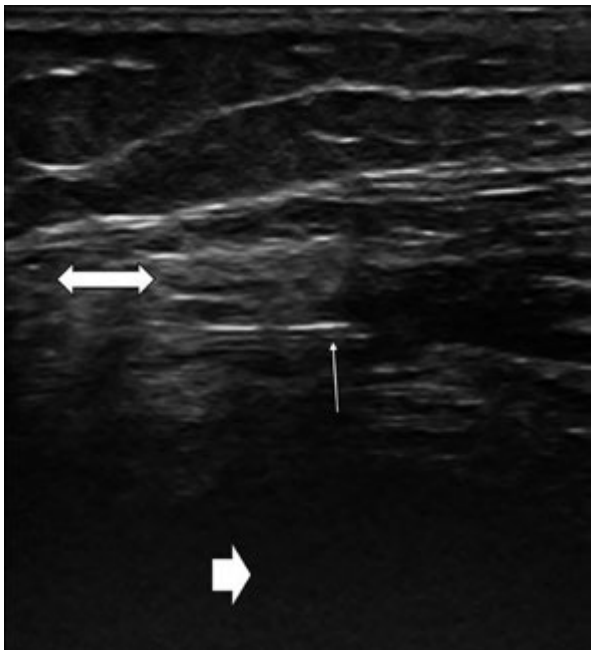

Fig. 3. Image presents ultrasound confirmation of needle position during radiosynoviorthesis of the knee joint. Double-sided arrow – synovium; slim arrow – end of needle; short right-sided arrow – femur.

Tayfun Küpesiz et al. [24] analyzed a group of 18 severe hemophilia patients with a total of 32 RSO procedures. In 83.3% of patients, the amount of hemarthrosis decreased after RSO and no further treatment was needed. The average follow-up time was 8.8 ±4.9 years. In patients requiring re-treatment, the procedure was performed after an average of 20.8 ±14.8 months. The study did not observe uncontrolled bleeding, leakage of radioisotope from the joint, or local inflammation after injection.

In the efficacy evaluation for hemophilic arthritis, the greatest improvements after a single radiosynovectomy procedure were observed in the amount of bleeding and joint soreness as assessed by the VAS. It is worth noting that the thickness of the synovial membrane for this condition decreased by an average of 30% [21]. After the second RSO, improvements in soreness, amount of hemarthrosis, and thickness of the synovial membrane were 62.1%, 58%, and 30.8%, respectively, and after the third radiosynovectomy were 61.2%, 77.7%, and 48%, respectively. Only 7.6% of cases required surgery despite radiopharmaceutical treatment. Important reminder:

hemophilic patients are diagnosed in the early age, and while surgical treatment is effective, it should be the last resort.

Radiosynoviorthesis appeared to be a safe treatment method in pediatric patients. Tena-Sanabria et al. [25] treated 60 joints (29 knees, 21 ankles, 10 elbows) of 27 patients with mostly severe hemophilia. Some of them also received FEIBA (mainly non-activated factors II, IX and X, as well as activated factor VII), and 1 patient received activated recombinant factor VII (FVIIrA). In the follow-up, which lasted until patients were 16 years and 11 months old (median 9.5 months), only 3 patients presented bleeding after RSO. The remaining patients had no new hemarthrosis during the follow-up period. Also, 66% of those who developed inhibition of factor VII presented a high response with previous administration of FVIIrA, which suggests that presence of an inhibitor does not affect the effectiveness of RSO. Similar results were obtained by Kamarulzaman et al. [26], who treated a total of 68 hemophilic arthropathy pediatric patients, with marked improvement (up to 100%) in elbow joints.

Rodriguez-Merchan et al. [21] compared synovial membrane thickness on palpation on a 4-grade scale in over 500 procedures performed in a 38-year period. At 6 months after RSO compared to 6 months before RSO, the improvement was 43.8%, the amount of bleeding decreased by 67.8%, and on imaging, synovial membrane thickness decreased by 26.7%.

In a prospective study, synovial membrane thickness as measured by magnetic resonance imaging and skeletal status as measured by X-ray were assessed at preoperative evaluation and at 1, 3, 6 and 12 months after RSO. Significant improvements in VAS pain, synovial membrane thickness, FISH (Functional Independence Scale in Hemophilia), and Gilbert's questionnaire score were observed, while no significant differences were observed in Pettersson and Denver scores. Side effects such as transient pain and swelling affected 20% of patients, and no significant complications occurred after radiopharmaceutical administration [24]. Both aforementioned studies prove that RSO effectiveness can be measured in objective imaging tests in short-term follow-up.

In summary, RSO is reported to be a safe method in hemophilic arthritis, as it indicates local complications only rarely when performed in specialist centers. There were also no reports of cancer in long follow-up studies after RSO.

Radiosynoviorthesis in osteoarthritis with effusion

Another indication for RSO treatment is OA with effusion, where overall the improvement rate ranges from 40 to 89%.

Szentesi et al. [27] observed the effectiveness of the RSO treatment over 10 years in patients with knee OA (follow-up at 1 year, 5 years, and each subsequent year up to 10 years after the procedure). The procedures were performed in patients with joint destruction in grades 1–3 according to Kellgren-Lawrence (KL) with soreness and swelling of the knee joint despite treatment with GCs injections for 4–6 months. Excellent/good improvement in soreness and joint mobility was observed in 82.5% of patients one year after RSO, and in 73.7% and 50% 8 and 10 years after treatment, respectively. In patients with KL grade III joint destruction, the improvement was 45.9% after 1 year and 41.2% after 8 years.

Chatzopoulos et al. [28] observed a group of 97 patients with OA unresponsive to systemic treatment for 6 and 12 months after RSO. Improvement of ≥ 50% on the VAS was reported by 71.1% of patients after 6 months and 72.5% after 12 months. In addition, night pain relief, improvement in knee joint mobility, resolution of joint effusion, and reduction of Baker's cyst were observed. The likelihood of improvement was inversely proportional to the radiological severity of the joint destruction. The results of both aforementioned studies indicate the desirability of early incorporation of RSO, because of both its high efficacy and the long response.

Radiosynovectomy in juvenile idiopathic arthritis

Radiosynovectomy can also be used successfully in JIA. Gazda et al. [29] evaluated the efficacy of the method using the VAS and Colorado pain scales, as well as swelling, effusion, and mobility limitation. Each of the parameters improved significantly at 6 weeks after the procedure and worsened at 6 months. The overall success rate after 6 months was 85.6%, while remission lasted an average of 560 days. Given the typical severe course of JIA, RSO is worth considering in adolescent patients. Another study that evaluated the effectiveness of the treatment studied 24 joints in 20 children [30]. Diagnosis of JIA was established based on the International League Against Rheumatism classification. Twenty knee joints, 3 ankle joints, and 1 wrist joint were treated. There was a good clinical effect in 13 children and significant improvement in the ultrasound examination of 16 joints. In one child, ulceration in the area of the ankle joint was observed, which spontaneously healed within 3 weeks. Given the typical severe course of JIA, RSO is worth considering in adolescent patients.

Future perspective

Effective RSO depends primarily on the choice of the appropriate radionuclide. β particle-emitting radionuclides

and Auger electron-emitting radionuclides are well suited for RSO because of their ability to deliver localized cytotoxic ionizing radiation. β radiation emitting colloids, such as ^{90}Y, ^{188}Re, and ^{169}Er, have been commercially available for many years. They are safe, well-studied, and have been successfully used for many years. Their limited accessibility and high cost are the main limitations. Therefore, there is a growing need for radioisotopes that do not require nuclear reactors for production and can be obtained using long-lived generators.

One of the tested isotopes is ^{177}Lu, widely used in nuclear medicine (maximum energy 0.48 MeV with a maximum penetration of 1.7 mm). Turkish researchers studied the development of ^{177}Lu-labeled tin colloid and *in vivo* characterization in an animal study [31]. The investigation achieved colloid-sized particles < 5 μm with labeling efficiency and radiochemical purity of > 95% and 97.3%, respectively. The colloid was stable *in vitro* in both phosphate-buffered saline and synovial fluid at room temperature. SPECT/CT images showed retention of injected activity in the joint cavity of the rabbit's knee, up to 48 hours after administration, with the support of further clinical studies for clinical use in the future.

Another β-emitter, phosphorus-32 (^{32}P), is an interesting radiopharmaceutical thanks to its long half-decay time (about 14 days and 7 hours), and maximum tissue penetration of 7.9 mm, which makes it suitable for the treatment of large, inflamed joints, such as the knee. The relatively long half-life makes it easy to transport and distribute. The main drawbacks are: high β-energy radiation, which may lead to an increase in injuries of both articular cartilage and the growth plate, and no detectable γ photon (required for arthroscintigraphy, sometimes performed after RSO). Liepe et al. [32] compared the efficacy of RSO performed in a group of 99 RA patients with radiolabeled colloids available commercially: ^{90}Y (66 patients) and ^{188}Re (16 patients) and new ^{32}P (15 patients) vs. GCs injection (46 patients). Pain relief assessed by VAS achieved with the 3 radiocolloid formulations did not differ significantly ($p > 0.1$) between them. Pain relief at 12 months was more durable in RSO compared to GC injection ($p < 0.05$), which shows that ^{32}P may be at least as effective as the other radionuclides available. In another clinical experiment involving 36 men with hemophilia, RSO of the knee using ^{32}P colloid was carried out in 26 hemophilic patients. Ten hemophilic patients received rifampicin antibiotic therapy [33]. The treatment improved joint mobility and reduced the frequency of use of anti-hemophilic agents in 80% after RSO. The medial remission rate for hemophilic patients treated with ^{32}P was significantly higher than in patients who received rifampicin, $p < 0.025$ (remission rates of 1.5 vs. 1.1 on the scale made by the authors). That shows that this method has high potential as an alternative therapy to widely used anti-hemophilic factors.

Samarium-153 (^{153}Sm), a well-known radiopharmaceutical commonly used to treat bone metastases [34], was also investigated regarding its use in radiosynovectomy. As mentioned above, ^{153}Sm is a β-emitter with a maximum energy of 0.81 MeV and penetration up to 2.5 mm. Samarium-153 in patients with radiologically significant arthropathy has better long-lasting efficacy (over 12 months) than the compared ^{90}Y. The prospective pilot study, which included 19 patients treated with ^{153}Sm and 21 treated with ^{90}Y, with follow-up for 1 year after treatment, demonstrated the effectiveness of ^{153}Sm application. In 6 months follow-up ^{153}Sm showed a reduction of hemarthrosis comparable to ^{90}Y (50% vs. 66.7%). It is worth noting that after 12 months, the reduction in hemarthrosis after using ^{153}Sm was significantly higher than in RSO with ^{90}Y (87.5% vs. 50%).

Rhenium-188 is an attractive radioisotope due to the possibility of obtaining it from a ^{188}W/^{188}Re generator, allowing independent use without reliance on outside production, together with the long, 69.7-day half-life of ^{188}W. Rhenium-188 is a high-energetic β emitter (maximum energy 2.11 MeV), which provides sufficient energy to penetrate and target tissues, with a maximum penetration of 11 mm and a short half-life of 16.9 hours. Ahmadi et al. [35] considered labeling of chitosan with ^{188}Re with a radiochemical purity of 97%. Dissection of laboratory rats subjected to intra-articular injection of the radiopharmaceutical showed high biodistribution and no leakage into surrounding organs. Taking these results into consideration, ^{188}Re-chitosan may in the future be a new radiopharmaceutical used in RSO. However, the high cost of the ^{188}W/^{188}Re generator obstructs its wide-scale utility in clinical practice.

Not only β emitters are in the testing phase. Auger electron-emitting radionuclides such as ^{117m}Sn (Tin-117m) seem promising [36]. This radioisotope has been tested only in an animal study – in dogs with elbow OA. Analysis of joint fluid showed a significant reduction in the percentage of monocytes after 6 months. However, there was no difference in OA progression.

Summary and authors' thoughts

To summarize, RSO is a safe, effective, and minimally invasive treatment method for synovitis and can provide astounding results, especially in hemophilic arthritis and RA. The effectiveness of the method even reaches 100% in some cases. Widening access to the treatment, its cost-effectiveness, and more and more new pharmaceuticals may lead to this type of treatment becoming more common. It is worth noting that the age of patients is not a limitation.

The main drawback of the reviewed studies was the large variety of follow-up, study design and patient population. The underuse of RSO contributes to a lack of high-quality studies and clinical data. We found no studies on comparison of RSO and novel disease-modifying drugs in RA. There is a negligible amount of research on long-term efficacy of RSO.

There is still a lack of studies that compare RSO with surgical synovectomy, which has much more short-term drawbacks such as procedure time, access to the operating room, staff needed to perform the procedure and consequently higher cost. Radiosynoviorthesis, being well tolerated, can also be a more attractive method for patients, as physiotherapy is not needed, and they can be independent immediately after the treatment.

On the other hand, comparing RSO to GCs injection, which appears to have similar brief effects, in a period of over a year the efficacy of RSO is significantly higher. That suggests that RSO may be performed as a first-line treatment rather than local steroid treatment.

We believe, however, given the promising results, that the method, with its low cost, safety and almost no side-effects, will be taken into consideration by a wider number of clinicians. The studies included above and their results should prompt a proper examination of the method in randomized studies with a longer follow-up. It also should be compared in long-term cost-effectiveness. The future perspective suggests that even more substances may be used soon, which will provide easy access to the treatment.

Another point to consider is using RSO as a single method as well as part of complex treatment, e.g. with joints for which systemic therapy does not work. Studies described above show promising results for improving the quality of life of patients and with a high probability of at least reducing the number of drugs they use – such as anticoagulants in hemarthrosis.

Radiosynoviorthesis seems to be a valuable component of combined therapy with surgical synovectomy. Despite the small group of patients, which was a major drawback of the study, improvement in all examined aspects was significant. As there is a lack of research in combined treatments in specific synovitis, it may be the subject of further studies with longer follow-up.

Conclusions

Radiosynoviorthesis is a safe, effective and minimally invasive treatment for synovitis. This method can be a single form of treatment or part of a complex treatment, e.g. for joints where systemic treatment does not work. The main drawback of the studies reviewed was the wide variety of observations, study design and patient population.

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Data availability: The data that support the findings of this study are available on request from the corresponding author (M.K.).

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