Chondromalacia patella: current options and new cell therapies

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ANNOTATION. Chondromalacia patella (CP), also known as runner's knee, typically occurs in young patients and is characterized by anterior knee pain (AKP) that is associated with visible changes in the patellar cartilage. Initial pathological changes include softening of the cartilage, swelling and edema. CN is caused by several factors, including trauma, increased cartilage vulnerability, patellar and femoral instability, anatomical changes in bone, abnormal patellar kinematics, and occupational hazards. CN may be reversible or may progress with the development of patellofemoral osteoarthritis. Wasting of the quadriceps muscle, patellofemoral crunch, and effusion are obvious clinical signs. In addition, X-ray examinations are also necessary for diagnosis. Magnetic resonance imaging (MRI) is a noninvasive diagnostic modality that promises to have the unique ability to potentially identify cartilage lesions. Treatments for cartilage lesions in the PF joint have traditionally been proposed, but none have become the gold standard for either alleviating symptoms and function or preventing OA degeneration. Recently, researchers have focused on cartilage-targeted therapies. Various efforts, including cell therapy and tissue regeneration of cartilage, represent a promising regimen, especially using mesenchymal stem cells (MSCs). Intra-articular injections of MSCs from various sources are considered safe and useful for the treatment of CN, with improved clinical parameters, less invasiveness , symptomatic relief, and reduced inflammation. The mechanism of MSC administration remains the subject of further clinical research and is extremely promising for the treatment of PCC. This brief review examines the etiology, MRI diagnosis, and treatment of CN, especially treatment with cell therapy.

Key words: chondromalacia patella, MRI, cell therapy, chondrocyte implantation , mesenchymal stem cells.

Introduction. The knee joint is a three-component structure consisting of the patellofemoral (PF) joint and the medial and lateral tibiofemoral (TIF) joints. Anterior knee pain (AKP) is usually associated with TF disorders , while PF is rarely a concern. PF impairments typically cause PCH and yielding, which are usually aggravated by squatting, running, climbing stairs, and other activities. Among the most common PF disorders leading to PPK are chondromalacia patellar (CP), lateral patellar compression syndrome (LPCS), and osteoarthritis (OA). CN, also known as runner's knee, is a common cause of PPK among young people, especially young women who enjoy sports, and is characterized by AKP, which is associated with visible changes in the patellar cartilage. It is sometimes also referred to as a catch-all phrase to describe the pain of PF with or without documented cartilaginous abnormality. The thickness and integrity of the covered hyaline cartilage determines the health of the patella.

Normally, the hyaline cartilage of the patella is bluish-white, smooth, shiny and elastic. The initial pathological change in CN is that the cartilage becomes dull or even slightly yellowish-white, becoming soft, swollen and edematous in the early stage. Characteristically, the lesion is usually located in the middle of the medial surface of the patella. , or simply distal to this point, and is about half an inch or more in diameter, followed by fibrillation, fissure, fragmentation, or erosion of the cartilage at an advanced stage. In 1906 Budinger et al . first reported pathological changes in the patellar cartilage, and then Kelly et al . considered this pathological phenomenon as CMP. The original definition of KMP is softening of the cartilage layer of the patella, or the phenomenon in which the cartilage layer of the patella is no longer as tight as it used to be in a healthy state. " Chondromalacia " comes from Greek words. Chrondros means cartilage and malakia means softening. Ralph Edward Outerbridge et al. It was believed that the process of pathological changes in CN can be classified into four degrees: in degree 1, cartilage damage manifested itself in the form of softening and swelling, edema; at 2nd degree there are fragments and cracks in an area up to half an inch in diameter; grade 3 is the same as grade 2 but involves an area greater than one-half inch in diameter; and at grade 4, cartilage exposure, cartilage erosion down to the subchondral bone, and proliferation are observed. Regarding the Asian population, Ye et al . It was believed that grade 1–2 is an early stage of CMP, and grade 3–4 is a characteristic of an advanced stage. Meanwhile, they suggested that patellar cartilage has the ability to repair itself in the early stage of CP (stage 1–2); however, cartilage damage in advanced CMP (stage 3–4) has progressed to patellofemoral osteoarthritis (PFJ), and patellar cartilage has no real ability to repair itself. Similarly, another report also believed that CN may be reversible or may progress to OPFS. Chondrocyte replication suggests the ability to heal in early cases after treatment that changes the load affecting the cartilage. Therefore, interventions at an early stage may be more promising, whereas the early stage should be determined first. Identification of CN appears to play an important role in the early and perhaps even preclinical stages of APFS.

Etiology of CMP

Although the etiology of CMP is complex, several factors such as trauma (eg, direct to the patella), increased cartilage vulnerability (congenital, post-artellotomy /plaster rehabilitation period, etc.), patellofemoral instability (luxation, subluxation, etc.), variations in bony anatomy (congenital flattened lateral femoral condyle, osteochondral ridge, etc.), abnormal patellar kinematics (high patella, valgus knees, excessive lateral positioning of the tibial tubercle, etc. kneeling and squatting, etc.), are involved in the etiology HN. Among the causes of CN, subluxation is probably the most common and most often missed because there is obvious patellar dislocation.

In recent decades, researchers have discovered several new discoveries. In a study of 301 patients with knee pain, researchers examined the relationship between PFJ morphology and CN using MRI. To assess patellar severity, the researchers measured groove angle, trochlear depth, and patellar angle, and assessed patellar tilt using lateral patellar tilt angle. The results showed that the lateral patellar inclination angle and

trochlear depth in patients with CMP were significantly reduced, and the groove angle was significantly higher, and there was no correlation between the patellar angle and CMP. Another MRI study of 200 patients with knee pain also found that patients with CN had lower lateral patellar tilt angle, shallower trochlear depth, and higher groove angle. It also suggested that the ratio of trochlear groove angle to trochlear depth could be used as a marker in the early development of CN. In addition to lateral patellar inclination and trochlear depth, tibial inclination and patellar height are also important factors associated with the likelihood of CN.

Another important factor associated with CN is the thickness of the subcutaneous fat in the knees. In Hong's study Kuan K et al . evaluated the association between obesity and CN, they found that the thickness of the subcutaneous fat in the knees of 33 patients with CN identified by MRI was significantly higher than that of the normal group, and there was also a significant correlation between the thickness of the subcutaneous fat in the knees and the degree of CN . In addition, female patients had thicker knee subcutaneous fat and more severe KMP than male patients. This correlation was also confirmed in the study mentioned above. It can be concluded that increased subcutaneous fat thickness is associated with the occurrence of CMP along with a high groove angle, low trochlear depth and low patellar inclination angle.

Diagnostics

It has been argued that physical signs of PCC, such as effusion, quadriceps wasting, and retropatellar crepitus, are more helpful in diagnosing CN. However, none of these signs are considered specific for CMP. A reliable diagnosis of CN requires the exclusion of conditions that may also lead to the symptoms of CP syndrome, such as patellar malalignment, excessive lateral pressure on the patella, osteochondral injury, meniscus tear , Hoffa syndrome , and synovial plica, as there is great variability in the treatment of these conditions. , especially when choosing surgical treatment. The lower sensitivity and specificity of radiography is a limitation for diagnosing early stages of CMP; Radiographs have not proven helpful in diagnosing CN until advanced stages, such as extensive cartilage loss, loss of joint space, and associated sclerosis and cystic changes in the subchondral bone. Arthrography in combination with radiographs can reveal contrast uptake in the area of chondromalacia , but again the sensitivity is low. Arthroscopy can provide a reliable diagnosis because it allows a clear view of the PFJ; however, there is no correlation between the severity of CMP and the clinical symptoms of PSP syndrome. Therefore, these symptoms should not be used as an indication for knee arthroscopy. Moreover, arthrography , as an invasive diagnostic method, as well as as a modality, is usually used only for advanced stages of disorders. Magnetic resonance imaging (MRI), which is a non-invasive diagnostic modality, has the unique ability to potentially detect cartilage damage as well as internal abnormalities in the cartilage prior to macroscopic morphological loss of cartilage.

It would be beneficial if MRI could confirm the diagnosis of CN, which is a more comfortable procedure as well as a lower risk of complications than diagnostic arthroscopy for the patient. MRI has gradually replaced arthroscopy as a non-invasive

and reliable method for detecting CMP. An earlier study comparing arthroscopy and 1.0-T MRI found that MRI had a higher rate of detecting more severe CMP. The study used Shahriaree's four-level rating system to measure the severity of cartilage damage. Of the 56 patients with anterior knee pain, 25 patients were diagnosed as CMR-positive by arthroscopy, among which 17 patients were diagnosed as CMR grades II and III , and the diagnostic accuracy of CMR-positive patients was 68%. Meanwhile, 20 patients were diagnosed with CN by MRI, of which 18 patients were diagnosed as grade II and III , with a diagnostic accuracy of 90% in positive patients. In addition, none of the 36 negative patients who did not have CMP identified by MRI were identified at arthroscopy as having positive CMP more severe than grade II ; however, among the 31 patients with a negative result identified by arthroscopy, 2 patients were diagnosed with stage III CN by MRI. However, the severity of CN is difficult to correlate with clinical symptoms such as ICH syndrome, and it is unclear whether MRI can help accurately diagnose CN in patients with ICH. It is therefore not surprising that the reported accuracy of MRI for cartilage lesions in CMP varies widely in the literature. Previous studies have shown that sensitivity ranged from 26 to 100%, specificity from 50 to 94%, and diagnostic accuracy from 77 to 90 % . These studies varied widely in terms of imaging techniques, patient samples, and classification systems used, which likely explains the different results.

Along with the development of medical iconography, MRI can display images with higher resolution and clarity in a faster and more accurate manner. Specifically, in a recent study using a 3.0 T magnetic resonance imaging system, researchers developed a more detailed classification system based on the classification system for arthroscopic cartilage injuries developed by the International Society for Cartilage Research. Under Class 1, it was further divided into 1A, 1B and 1C. Under each of grades 2, 3 and 4 there were four sub-classes of grades A , B , C and D. Additionally, any grade 4 lesion with subchondral fibrocystic bone changes is classified as grade 5. A more detailed classification of patellar cartilage injuries will make it possible to more accurately diagnose CMP and more accurately predict the prognosis and clinical outcomes of patients.

Treatment.

CN may be reversible or may progress to OPFS. Unfortunately, it is known that cartilage does not have the ability to repair itself in progressive OA. Thus, early diagnosis and interventional treatment of CMP are more important and effective for the treatment of this disorder.

Conservative treatment

As we all know, conservative intervention appears to be the initial treatment for all patients with PCA, including mainly activity restriction or rest and, if necessary, nonsteroidal anti-inflammatory drugs. Additionally, before surgery was considered, patients were always instructed and encouraged to perform exercises under the supervision of a physical therapist to strengthen the quadriceps muscle, decrease the Q angle , and crepitus. The simplest effective procedure to avoid quadriceps dysfunction

and fibrosis is medial realignment of the distal patellar tendon with lateral release and medial grooved quadriceps extension. Bakhtiari et al. and Petersen et al . showed that strengthening the quadriceps muscle through various exercises markedly alleviated PCI in patients with early CN.

Surgery

When CN progresses to the terminal stages and conservative treatment fails, surgical treatment such as patellar cartilage excision, shaving, drilling, or surgery to realign the proximal soft tissue and distal patellar bone may be an effective alternative; however, choosing the best procedure is difficult as each measurement has its relative indications and limitations, especially with regard to the extent of patellar cartilage damage and the age of the patients. Patellectomy includes partial patellectomy and total patellectomy , but should only be performed if the patient has excellent quadriceps function preoperatively and is motivated to exercise after surgery. Total patellectomy is a radical treatment for CN, which causes more damage to the surrounding ligaments and quadriceps femoris muscle, and changes in the lever effect of the extensor muscle, instability of the extensor tendon, acute rupture of the patellar tendon and other complications may occur at a later time compared to partial resection. patella Thus, in the treatment of CMP, partial patellectomy was usually used . Tibial tuberosity surgery, mainly consisting of tibial tuberosity osteotomy, tibial tuberosity anteversion and tibial tuberosity elevation, by restoring the biomechanical force line of the patellofemoral joint can improve joint function, but will promote PFJ degeneration to a certain extent. Harrington et al. reported that the McKeever patellar resurfacing prosthesis showed positive long-term effects in the treatment of severe CN, which is commonly used as a salvage procedure for advanced APFS. However, due to the presence of many complications, such as patellar tendon injury, secondary patellar fracture, ischemic necrosis, PFJ instability, and prosthesis loosening, this method was gradually neglected. Arthroscopy can smooth out fibrillated and damaged areas of articular cartilage, which is usually used in stages II , III and IV CMP. However, treatment with arthroscopy is indicated in <10% of patients; in addition, the initial treatment of CMP requires a period of rehabilitation, and furthermore, as a reliable diagnostic method, if the examination does not reveal an arthroscopically treatable injury, it may seem like an expensive diagnostic method that unnecessarily consumes our limited healthcare resources. Meanwhile, arthroscopy causes short-term functional disability, pain and stress and carries risks associated with anesthesia and surgery.

Autologous transplantation chondrocytes

All measures mentioned above are not aimed at the damaged cartilage, but at relieving symptoms, maintaining function and minimizing disability, rather than at regenerating articular cartilage, given that CN is characterized by softness, swelling and swelling of the cartilage in the early stage, followed by fibrillation, fissure , fragmentation or erosion of advanced cartilage, none of these have emerged as primary treatments.

In the last two decades, much research into the treatment of OA has focused on the cell therapy level. Cell transplantation is a new therapeutic method for the treatment of OA, consisting mainly of the use of autologous chondrocytes and corresponding cartilage tissue. Like OA, the authors of this review agree that CMP is a mesenchymal disease, meaning that positive therapeutic effects at the cellular level in OA will also be beneficial for CMP. Emerging cell therapies, including autologous transplantation chondrocytes and MSC injections are becoming new treatment options for patients with CN.

In 1994 Brittberg et al . first reported the implantation of autologous chondrocytes (ACI). They performed ACI on 23 patients with full-thickness knee cartilage defects. Two years after implantation, 14 of 16 patients with femoral condyle implantation achieved satisfactory results. However, out of 7 patellar implantations, only 2 had good or excellent results. In fact, there have been many reports on the treatment of cartilage damage by implantation of autologous chondrocytes . In October 2009, ChondroCelect , an autologous chondrocyte product from TiGenix (which was acquired by Takeda in 2018), was approved for marketing in October 2009. Early research conducted by Simon Macmull et al . performed implantation of autologous chondrocytes , which showed positive clinical results in 48 patients with CN, they found that subjective pain scores and objective function scores improved significantly over a mean follow-up period of 40.3 months. In their study, patients' own chondrocyte cells were cultured in vitro for 4–6 weeks and then implanted back. Of the 48 patients, 25 received the ACI method , and 23 received the matrix-assisted chondrocyte implantation (MACI) method. In the ACI method , cultured cells were infiltrated directly under a collagen I / III membrane previously sutured to the cartilage defect. In the MACI method , cultured cells were pre-seeded onto a type I / III collagen membrane with a density of 1×10 6 / cm 2 . then glued to the defect cartilage fibrin glue Finally, it was confirmed that cartilage lesions in patients with CN responded well to chondrocyte implantation , moreover, the MACI method had a better treatment outcome than the ACI method , in addition, the MACI procedure was technically simpler and less time consuming. In December 2016, Vericel 's MACI for the treatment of knee cartilage injuries was also approved by the FDA , and was the first FDA -approved cell therapy product using a porcine collagen membrane scaffold. Research into how implanted chondrocytes interact with cartilage tissue in vivo , there was little evidence, but it appears that exogenous chondrocytes form new hyaluronic cartilage through proliferation, migration, and secretion of extracellular matrix for repair. Although autologous chondrocytes as the main cell type in cartilage can be a safe and effective method, chondrocyte implantation has the inherent disadvantages of limited availability, dedifferentiation and loss of function during culture, such as dedifferentiation chondrocytes in in vitro , which can lead to fibrocartilage. than hyaline cartilage. Moreover, an additional surgical procedure can lead to further damage and degeneration of the cartilage. Therefore, the use of MSCs for the treatment of CMP has attracted much more attention from scientific researchers.

MSC injections

In recent years, autologous mesenchymal stem cells (MSCs) have become the most important source of adult stem cells in basic research and clinical applications. MSCs have significant advantages in regenerative medicine due to self-availability , pluripotent differentiation, paracrine nutritional effect, immune immunity, non-tumorigenicity and safety. The human body has abundant sources of MSCs, mainly in the bone marrow. MSCs also exist in non-bone marrow parenchymal tissues, including peripheral blood, adipose tissue, wisdom teeth, primary teeth, synovial fluid, hair follicles, and in neonatal cord blood and umbilical cord.

Chondrogenic differentiation is one of the minimal prerequisites for defining MSCs and is the basis for tissue engineering procedures to generate articular cartilage. Differentiation of MSCs towards osteochondral lineages is determined by the mediation of Indian signaling pathways hedgehog (Ihh) and Wnt / β - catenin , which osteoblastic precursors differentiate into chondrocytes in the absence of β - catenin . Prerequisite for chondrogenic differentiation in vitro is a superfamily TGF - β . The extracellular TGF - β superfamily promotes early and intermediate phases of chondrogenesis through binding of TGF - β type II receptor followed by phosphorylation of TGF - β type I receptor, which activates Smad 2/3 and 4 signaling pathways , thereby activating Sox 9 expression. The transcription factor Sox 9 initiates early chondrogenesis by inducing the expression of collagen type II , alpha 1 (COL 2 A 1) and other Col downstream genes I , Col II , Coll IX and ACAN . The TGF - β superfamily has also been reported to promote early chondrogenesis through induction of Runx 2 (Runt -related transcription factor 2) and enhance the production of type II collagen and aggrecan , which are the major cartilaginous extracellular matrix.

It is known that MSCs stimulate the proliferation of chondrocytes and the synthesis of extracellular matrix, and also have anti-inflammatory and immunomodulatory effects. Previous studies have reported that MSCs modulate inflammation and provide an environment for tissue regeneration, either by directly secreting bioactive materials or by controlling the production of cytokines and growth factors by endogenous cells. MSCs promoted the repair of damaged articular cartilage through homing, engraftment, and cartilage matrix formation in OA models. The differentiation of delivered MSCs into chondrocytes appears to be induced by the local environment of the homing site. Barry et al. and Kaplan et al. believe that the potential mechanisms of MSCs for the treatment of cartilage lesions are considered in two ways. One is direct differentiation into chondrocytes , and the other is paracrine effects through the secretion of bioactive materials.

The first case of CMP treatment with MSCs was reported from a Korean research group. The researchers isolated the patient's own stromal vascular fraction containing adipose-derived MSCs and injected it into the retropatellar joints of three patients, mixing it with platelet-rich plasma and hyaluronic acid. After 3 months of treatment, pain in 3 patients was reduced by 80–90%, and MRI showed that the damaged patellar cartilage tissue was almost completely restored compared to that before treatment. However, it should be noted that patients in this study received multiple injections of platelet-rich

plasma and hyaluronic acid or dexamethasone at very low doses 3 , 7 , 14 and 28 numbers .days after the initial injection of adipose tissue-derived mesenchymal stem cell mixtures. Additionally, the lack of a control group also makes it difficult to conclude that the possible treatment mechanism was solely due to adipose-derived mesenchymal stem cells, but is more likely due to a complex factor, as the researchers themselves suggested. Similar to OA, reviewers agree that CN is a mesenchymal disease, a condition in which the activity, phenotype, or mobilization of the MSC population is altered, resulting in a lack of repair and increased cartilage degeneration. In OA, MSCs are exhausted, have reduced proliferative capacity and reduced differentiation ability. Therefore, it would be beneficial if sufficient numbers of healthy and functional MSCs were provided to enhance self-healing or inhibit the progression of cartilage loss.

The positive role of MSCs in the treatment of knee joint cartilage damage and knee OA is beyond doubt. Moreover, in January 2012, South Korea approved MEDIPOST 's CARTISTEM ® , a mesenchymal stem cell derived from umbilical cord blood, for the treatment of knee cartilage defects in OA patients caused by degeneration or repetitive trauma. Regarding the mechanism of MSC-induced cartilage repair, more and more evidence tends to support the secretory role of MSCs rather than their differentiation ability to directly differentiate into chondrocytes . Plumikers et al cocultured human adipose tissue MSCs or bone marrow MSCs with bovine chondrocytes in vitro or implanted them into NMRI nude mice with a cartilage cut along the spinal centerline and found that human MSCs could promote chondrogenesis . , and the new cartilage tissue came only from bovine chondrocytes . Results from another Phase I clinical trial conducted by Tommy S de Windt et al . showed that regenerated knee cartilage tissue was derived from receptor cells themselves after implantation of allogeneic bone marrow MSCs, they demonstrated that stem cell-induced paracrine mechanisms may play an important role in the observed chondrogenesis and successful tissue regeneration. It is therefore clear that the cartilage repair mechanism of MSCs is more likely due to their trophic effects and induction of chondrocyte regeneration .

Recent animal reports have shown the beneficial effects of MSCs in improving clinical symptoms and facilitating cartilage repair in OA. Another study found that intra-articular injection of human embryonic stem cell-induced mesenchymal stem cells (ESC -MSCs) significantly slowed cartilage destruction in a DMM mouse model O.A. Further research in vitro showed that intra-articular injection of hESC-MSC-derived exosomes successfully alleviated cartilage destruction by increasing the synthesis of type II collagen and decreasing the expression of ADAMTS -5, which had a beneficial therapeutic effect on OA. In Wang et al . they demonstrated that intra-articular injection of autologous human adipose tissue-derived mesenchymal stem cells (ha MSCs) promote articular cartilage regeneration in a rabbit OA model.

A large body of preclinical data has demonstrated the safety and effectiveness of intra-articular injections of MSCs for the treatment of knee OA. In another Wang report et al . They performed intra-articular injection of ha MSCs with different doses to treat knee OA, and three injections were given during the procedure and the patients were

followed for 96 weeks. . They demonstrated that intra-articular injections of vaMSCs did not cause side effects or increase cartilage volume in knee OA, and vaMSCs supported long-term improvements in symptomatic relief, function, and quality of life, which may be a promising new treatment for the knee. osteoarthritis. Exactly the same Chris Hyunchul et al . also found the absence of adverse events when autologous adipose tissue-derived MSCs (AD -MSCs) were administered intra-articularly at various doses for the treatment of knee OA. Meanwhile, they confirmed that the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score improved after the injection in the high-dose group over 6 months. In addition, arthroscopy and MRI confirmed that the size of the cartilage defect decreased while the cartilage volume increased in the high dose group, furthermore, histology confirmed the regeneration of thick hyaline-like cartilage. Their results showed that intra-articular injection of a high dose (1.0 × 10 8) AD -MSCs in the knee joint with osteoarthritis improved function and relieved pain in the knee joint without causing side effects, and also slowed down cartilage degeneration due to the regeneration of hyaline-like articular cartilage. Evidence from Jaskarndip Chahal et al . study showed that autologous mesenchymal bone marrow stromal cells (BM -MSCs) were safe and resulted in significant improvements in patient-reported outcomes (PROMs). In their study, patients with advanced knee OA received a single intra-articular injection of 1, 10 , or 50 million BM -MSCs for 12 months. 50 million doses resulted in clinically meaningful improvements in most PROMs , and there were significant overall improvements in pain, symptoms, quality of life, and WOMAC Osteoarthritis Outcome Scale severity compared with baseline. Moreover, the levels of pro-inflammatory monocytes/macrophages and interleukin 12 were reduced in synovial fluid after administration of MSCs at doses of 50 and 10 million. Most importantly, despite the lack of a direct protective effect of MSCs on cartilage regeneration using MRI, they showed that BM-MSCs, accompanied by increased levels of anti-inflammatory and anti-fibrotic gene and protein markers, which likely improved clinical efficacy in terms of PROMs at 12 months. They concluded that BM -MSCs reduce synovial inflammation in OA.]. In Mohsen's study Emadedin et al . investigated the safety of treatment of BM-MSCs transplanted into patients with OA of the knee, ankle or hip joints. In their study, they showed that all subjects experienced no serious side effects such as pulmonary embolism, death, or systemic complications. Very minor local side effects such as rash and erythema were observed in a limited number of patients. The results showed that MSC injections into various joints affected by OA were safe and therapeutically beneficial. These results provided strong evidence that clinical outcomes such as pain and function improved after intra-articular application of MSCs. However, randomized controlled trials have reported conflicting results regarding clinical outcomes. One study reported that there was no significant change in the MSC group from baseline to final follow-up and that there were no differences between groups in terms of WORMS score . In the Wakitani study et al . they showed that clinical improvement did not differ significantly between groups, but cartilage repair was better in the MSC group than in the cell-free control group.

Conclusion

CN is a common disease of the PFJ. As a non-invasive diagnostic method, MRI plays an indispensable role in assessing the severity of CMP. For patients, conservative intervention is clearly a better choice than surgery, but the question of whether it can help patellar cartilage repair itself makes it difficult to guarantee long-term effectiveness. However, it has been difficult to definitively conclude on the effectiveness of MSCs on clinical outcomes and cartilage repair in cartilage injuries. Fortunately, a large number of reports have shown that MSCs have beneficial effects on cartilage regeneration and improve clinical outcomes.

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