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Coverage Policy

Articular Cartilage Repair
Each of the following procedures* is considered experimental, investigational or unproven for treatment of articular cartilage defects in locations other than the distal femur of the knee and of cartilaginous defects involving joints other than the knee (e.g., ankle, elbow, shoulder):

- autologous chondrocyte implantation (e.g., Carticel®, MACI® [Vericel Corporation, Cambridge, MA])
- osteochondral allograft transplantation
- osteochondral autograft transplantation

*Note: Please reference the Cigna Medical Policy - Musculoskeletal “CMM 312 Knee Surgery: Arthroscopic and Open Procedures” for medical necessity criteria for defects within the knee.

Healing Response Technique
Healing response microfracture technique for treatment of intra-articular ligament injury is considered experimental, investigational or unproven.

Ankle Subchondroplasty
Ankle subchondroplasty for the treatment of a subchondral bone defect is considered experimental investigational or unproven.

Miscellaneous Knee Procedures
Each of the following knee procedures is considered experimental, investigational, or unproven:

- minimally invasive knee replacement
- focal resurfacing of a single knee joint defect (e.g., HemiCAP™, UniCAP™)

Overview
This Coverage Policy addresses miscellaneous musculoskeletal procedures, including but not limited to articular cartilage repair (other than the knee joint), minimally invasive knee replacement procedures, healing response microfracture technique, focal resurfacing of a knee joint and ankle subchondroplasty procedures.

General Background
Articular Cartilage Repair
Autologous chondrocyte implantation (ACI), also referred to as autologous chondrocyte transplantation (ACT), utilizes a patient’s own cells in an effort to repair damage to articular cartilage with the goal of improving joint function and reducing pain. The procedure involves the collection and culture of articular cartilage cells (i.e., chondrocytes) that are then implanted into the cartilage defect with the intent that the cultured cells will contribute to the regeneration and repair of the articular surface.

Normal articular cartilage is a complex tissue composed of matrix, chondrocytes and water. The chondrocytes are responsible for synthesizing the matrix, which is composed primarily of collagen fibers, hyaluronate, and sulfated proteoglycans. Cartilage has a poor intrinsic ability to heal itself. When a full-thickness cartilage injury occurs, the articular surface does not usually regenerate on its own. Pain, effusion, and mechanical symptoms are associated with cartilaginous defects.

According to the American Academy of Orthopaedic Surgeons (AAOS), two procedures commonly used to restore articular cartilage include autologous chondrocyte implantation and osteochondral autograft/allograft transplantation (AAOS, 2009).

Autologous Chondrocyte Repair
Autologous chondrocyte implantation (ACI), a type of tissue engineering, is proposed as surgical treatment for individuals with deep cartilage defects in the knee and involves replacing the defective cartilage with cultured chondrocytes that will produce articular cartilage similar in composition and properties to the original tissue. Based on the available evidence, guidelines, and FDA indications for use, ACI should be limited to use as a second-line treatment for carefully selected symptomatic individuals with defects of the femoral condyle caused by acute or repetitive trauma who have had an inadequate response to prior arthroscopic or other surgical repair.

U.S. Food and Drug Administration (FDA): Until recently, Carticel® (Vericel Corporation, Cambridge, MA) was the only technology that received FDA approval for the culturing of chondrocytes. In December 2016, MACI® (autologous cultured chondrocytes on porcine collagen membrane) (Vericel Corporation, Cambridge, MA) received approval from the U.S. Food and Drug Administration as an autologous cellularized scaffold indicated for repair of single or multiple symptomatic, full-thickness cartilage defects of the knee with or without bone involvement in adults. The safety and effectiveness of MACI Implant in joints other than the knee and in individuals over age 55 has not been established.

Literature Review: Although there is sufficient evidence to support improved clinical outcomes using ACI for a subset of individuals with articular cartilage defects of the knee joint, evidence in the medical literature is insufficient to support the use of ACI for articular cartilage lesions of other joints, including but not limited to the tibia/patella, ankle, hip or shoulder. Additionally, published evidence does not support clinical utility for the treatment of generalized osteoarthritis (Brown, et al., 2005; Washington State Department of Labor and

**Use Outside of the US:** MACI has been available for use in Europe and Australia.

**Osteochondral Autograft**

Osteochondral autologous transplant involves the placement of viable hyaline cartilage grafts obtained from the individual into a cartilage defect. The grafts are harvested from a nonweight-bearing region of the joint during an open or arthroscopic procedure and then transplanted into a cartilage defect to restore the articular surface of the bone. Osteochondral autologous transfers are performed mainly to treat small and medium-size focal chondral and osteochondral defects of the weight-bearing surfaces of the knee joint (i.e., distal femur) but have also been used in the ankle, patella, elbow and tibia. The most common donor sites, whether the recipient site is in the knee or another joint, are the medial and lateral trochlea and the intercondylar notch.

The advantages of using autograft include graft availability, the absence of possible disease transmission risk, and that the procedure is a single-stage procedure. Disadvantages reported include donor site morbidity and limited available graft volume. In addition, tissue may have to be harvested from two different donor sites in order to provide enough material for a large defect without compromising the donor site.

There are two forms of osteochondral autografting addressed in the medical literature: mosaicplasty and the osteochondral autograft transplantation system (OATS®) procedure.

The mosaicplasty procedure consists of harvesting cylindrical bone-cartilage grafts and transplanting them into focal chondral or osteochondral defects in the knee. A recipient tunnel is created and sized with a drill bit slightly larger than the length of the graft. The harvested graft is placed in the tunnel by a press-fit method. All subsequent grafts are inserted in a similar pattern. Donor sites are routinely left open and fill with cancellous bone and fibrocartilage within 4–8 weeks. Authors claim that mosaicplasty reduces the possibility of donor-site morbidity and produces a more even surface (Scapinelli, et al., 2002).

The OATS procedure is similar to mosaicplasty, involving the use of a larger, single plug that fills an entire defect. It is often performed to graft chondral defects that are also associated with anterior cruciate ligament (ACL) tears. Increased donor-site morbidity has been reported by some authors with the use of larger, single plugs.

**Patella:** Osteoarthritis conditions may affect the patella. Osteoarthritis dissecans may occur on the medial or lateral facet and the central ridge or the medial or lateral aspect of the trochlea. Treatments for osteoarthritis of the patella typically include patellectomy, realignment procedures, arthroplasty, and resurfacing methods, all of which have varying degrees of success. When mechanical symptoms persist with pain and swelling despite conservative treatment or microfracture, some authors recommend autologous osteochondral transplant. Nevertheless, patella cartilage is thicker than cartilage in other areas of the knee, and the differences between the donor cartilage and patella cartilage may lead to suboptimal clinical outcomes (Nho, et al., 2008).

There are few studies that specifically report on autologous osteochondral transplantation of the patella and much of the evidence is in the form of case reports or case series lacking control groups and statistical evaluation (Nho, et al., 2008; Visona, et al., 2010; Astur, et al., 2014; Astur, et al., 2017). The reported clinical outcomes have not been as encouraging compared to those of the femoral condyles although some studies do support improvement in knee function scores following surgery. One group of authors reported that the results of patellar and trochlear osteochondral plug transfers had 79% good to excellent results compared to 92% good to excellent results in a femoral condyle group (Hangody and Fules, 2003). Another group of authors compared autologous chondrocyte implantation to mosaicplasty for treatment of femoral chondyle lesions or patellar lesions. They reported that patients who underwent patellar mosaicplasty had fair to poor arthroscopic appearance in addition to 60% good to excellent results. This group of authors indicated the primary reason for failure may have been due to differences in articular cartilage thickness and concluded that the procedure was contraindicated for chondral lesions of the patella (Bentley, et al., 2003). Evidence in the published scientific literature evaluating patella osteochondral autografts is limited, the reported clinical outcomes are mixed, sample
populations are small and patient selection criteria have not been clearly defined. At present, there is insufficient data to support the clinical efficacy of osteochondral autograft transplant for the patella.

**Ankle:** Older patients and those with severe arthritis or large lesions of the ankle generally undergo ankle fusion or replacement as standard treatment. Ankle replacement has not been successful in many patients, and ankle fusion, while associated with pain relief, may result in functional limitations. Osteochondral autografting has been proposed as an alternative method of treatment for individuals with lesions of the ankle. Although patient selection criteria are not clearly defined, osteochondral autograft of the talus has been recommended for individuals with advanced disease, continued pain and decreased function despite prior conservative management and/or prior arthroscopic procedures, and who are not considered candidates for ankle arthrodesis. Proponents additionally recommend absence of ankle arthritis, infection, bipolar lesions and/or diffuse osteonecrosis of the talar dome.

Preliminary clinical trials demonstrated encouraging results for patients who underwent osteochondral autograft transplant for treatment of symptomatic osteochondral defects of the talus (Hangody, et al., 2001; Mendicino, et al., 2001; Al Shaihk, et al., 2002). Despite these early results, it has been noted in the medical literature that there are some challenges with this method of treatment. Reported concerns include the differences in the characteristics between knee and ankle cartilage, associated donor site morbidity, and complications which may arise from medial and lateral osteotomies (Easley and Scranton, 2003).

Evidence evaluating use in ankles is limited to retrospective and prospective case series and few randomized controlled trials, nonrandomized controlled trials involving small patient populations and published reviews (Kolker, et al., 2004; Giannini, et al., 2005; Kruez, et al., 2005; Balzer and Arnold, 2005; Scranton, et al., 2006; Gobbi, et al., 2006; Reddi, et al., 2006; Saxena and Elkin, 2007; Zengerink, et al., 2010; Berlet, et al., 2011; Imhoff, et al., 2011; Emre, et al., 2012; Paul, et al, 2012; Hayes, 2014; Yoon, et al., 2014; Giorgiannos, Bisbinas, 2014). The evidence base is not as robust when compared to that evaluating the knee, although reported clinical outcomes extend short-to intermediate-term; on average two to eight years post-operatively. In general, the clinical outcomes have been mixed regarding improvement in postoperative pain and function, with some authors reporting high failure rates and the need for further surgery. In 2004 Kolker et al. reported their concern as to the overall efficacy of the procedure when used in the treatment of full-thickness, advanced, osteochondral defects of the talar dome. Open bone grafting did not predictably improve symptoms and yielded poor results in the patient population studied. Authors have acknowledged further well-designed studies with larger sample size are needed to assess improved long-term outcomes (Balzer and Arnold, 2005; Scranton, et al., 2006). More recent literature continues to support clinical outcomes that are mixed (Zengerink, et al., 2010; Yoon et al., 2014).

**Elbow:** There is insufficient evidence in the peer-reviewed, published scientific literature evaluating the use of osteochondral autograft transplantation to treat lesions of the elbow. Many of the trials consist of small patient populations, lack control or comparative groups and evaluate short-term outcomes (Shimada, et al., 2005; Tsuda, et al., 2005; Yamamoto, et al., 2006; Iwasaki, et al., 2006; Ansah, et al., 2007; Oveson, et al., 2011; Shimada, et al., 2012). Mid to long-term outcomes have been reported (Vogt, et al, 2011), however the sample population of this trial were small and the study was not designed to be comparative. The results of some studies demonstrate improved pain scores in addition to radiograph confirmation of graft incorporation (Shimada, et al., 2005; Iwasaki, et al., 2006; Ansah, et al., 2007; Iwasaki, et al., 2009, Shimada, et al, 2012). Few studies reported that radiographs showed no signs of degenerative changes or osteoarthritis at follow-up (Ansah, et al., 2007). De Graaf et al. (2011) conducted a systematic review of articles (case series) evaluating osteochondral autograft for treatment for osteochondritis dissecans of the elbow and reported the quality of the evidence was methodologically poor. The outcomes reported regarding pain, return to sports and elbow function were satisfactory however the authors noted further long-term clinical trials supporting efficacy are needed. Bexkens et al. (2017) conducted a systematic review of the literature (n=11 studies, 190 subjects) to evaluate donor site morbidity after OATS for capitellar osteochondritis dissecans. Grafts were harvested from either the femoral condyle or the costal-osteoochondral junction. The authors concluded donor site morbidity occurred in a considerable group of subjects, in 7.8% after harvesting from the femoral condyle and 1.6% after harvesting from the costal-osteoochondral junction. Larger clinical trials evaluating long-term outcomes compared to conventional methods of treatment are needed to support widespread use of this procedure.
Shoulder: Focal osteochondral lesions of the shoulder are less common than those of the knee or ankle. Although evidence is limited, authors have reported on osteochondral autologous transplant as a method of treatment for full-thickness osteochondral lesions of the shoulder. Evidence consists primarily of case reports and small case series evaluating outcomes that, on average, extend two to four years (Schiebel, et al., 2004; Park, et al., 2006). One group of authors (Kircher, et al., 2009) reported results at a mean follow-up of 8.75 years for a group of seven individuals; (short-term results for this same group were previously reported by Schiebel, et al., 2004). The authors noted that there was no deterioration and no complications. Arthritis of the shoulder developed in all patients although findings were not matched by functional restriction, pain or loss of patient satisfaction. The authors acknowledged further studies are needed evaluating long term outcomes and comparing results of other bone-stimulation techniques. At present, there is insufficient data to support the efficacy of osteochondral autograft transplant for the shoulder.

Osteochondral Allograft
The use of allograft cartilage has the advantage of providing osteochondral segments that are able to survive transplant, having the ability to heal to recipient-site tissue, and no associated donor site morbidity. Small grafts have been used for damaged regions of articular cartilage in young, physically active patients.

Allograft size is not well delineated in the medical literature. Osteochondral allografts can be either dowel grafts (i.e., cylindrical) or shell grafts (i.e., noncylindrical). Dowel grafts are inserted by press fit and are similar to the OATS procedure. Shell grafts are not limited by size or shape, are formed to match the size or contour of the defect and require supplemental fixation. Sizing of allografts can be difficult although some authors recommend using allografts for defects greater than 2.5 cm (Caldwell and Shelton, 2005). Furthermore, while surgeons generally restrict the use of autografts to lesions less than 2 cm, dowel grafts may be applicable to lesions up to 35 mm. Some surgeons have used allografts to treat lesions that are 1 cm², although many experts suggest lesion size of 2–3 cm² or greater (Alford and Cole, 2005).

To ensure cellular viability, osteochondral allografts are generally implanted fresh (Brautigan, et al., 2003). The osteochondral allograft procedure typically involves an arthrotomy incision rather than arthroscopic, with the transplantation of a piece of articular cartilage and attached chondrocytes from a cadaver donor to the damaged region of the articular surface of the joint. Cryopreservation often damages the cartilage matrix and kills the chondrocytes. Chondrofix® (Zimmer Biomet, Warsaw, IN) is an osteochondral allograft composed of decellularized hyaline cartilage and cancellous bone. Chondrofix is a donated human tissue graft regulated by the FDA which undergoes proprietary processing to remove lipids and decontaminate the tissue, preserving hyaline cartilage (Gomoll, 2016; Farr, et al., 2016). The allograft material can be used off-the-shelf, can be stored up to 24 months at less than 40 degrees C, and is not to be frozen. Purportedly Chondrofix offers structural and osteoconductivity benefits similar to an OATS procedure, removes associated donor site morbidity and eliminates wait time for a fresh allograft (Degen, et al., 2016). Evidence in the peer-reviewed published scientific literature evaluating decellularized cartilage for treatment of osteochondral cartilage defects is limited. Farr et al. (2016) reported the results of a retrospective case series (n=32) evaluating the use of decellularized allograft for treatment of osteochondral cartilage defects. The authors reported failure in 72% of the subjects (n=23) within two years of implantation. Failure was defined as structural damage to the allograft plug using MRI or arthroscopic evaluation demonstrating evidence of subchondral collapse or loss of > 50% of the articular cartilage cap of a plug. Whether or not implantation of decellularized cartilage promotes cell remodeling and repair has not been firmly established in the published scientific literature.

Evidence in the published scientific literature evaluating allograft transplant primarily addresses defects of the knee and ankle, is limited and evaluates short- to intermediate-term outcomes. Authors have reported that treatment of talus lesions in particular, is technically challenging but may allow patient’s avoidance of other end-stage procedures, similar to indications for osteochondral autografts. Allograft of the talus however is generally reserved for larger extensive lesions and/or when autograft is not available. Evidence regarding defects of other joints (e.g., elbow, shoulder) is also limited and does not allow strong conclusions regarding the efficacy of the procedure.

Ankle: Evidence in the published medical literature evaluating allografts as a method of treatment for osteochondral lesions of the ankle is inconsistent. Data from well-designed controlled clinical trials that compare osteochondral allografting of the ankle with accepted standards of care (i.e., ankle fusion, ankle arthroplasty) are
lacking. Many of the studies are retrospective or prospective case series involving small patient populations and lack controls (Gross, et al., 2001; Kim, et al., 2002; Tontz, et al., 2003; Rodriguez, et al., 2003; Meehan, et al., 2005; Jeng, et al., 2008; Valderrabano, et al., 2009; Hahn, et al, 2010; Gortz, et al., 2010; Adams, et al., 2011; Haene, et al., 2011, Galli, et al., 2014). Some authors have reported clinical outcomes extending as long as 12 years, (Gross, et al., 2001; Kim, et al., 2002) but in general follow-up extends on average to two years. Some studies have demonstrated a trend toward short-term improvement in pain and function, however high failure rates have also been reported (Kim, et al., 2008; Jeng, et al., 2008; Haene, et al., 2011, Haene, et al, 2012; Bugbee, et al. 2013). Few studies reporting long term clinical outcomes are available.

Clinical failure and reported reoperation rates are high. One group of authors (Valderrabano et al., 2009) reported the results of a case series (n=21) and acknowledged long-term clinical outcomes were moderate. At a mean of 72 months, 12 patients were available for follow-up—radiologically recurrent lesions were noted in 10 of 10 cases and in all 12 there was some degree of cartilage degeneration and discontinuity of the subchondral bone. Short-term subjective outcomes were reported as good to excellent. In 2013 Bugbee et al. published the results of a case series with mean follow-up of 5.3 years. Patients with intact grafts showed improvement in ankle pain and function in addition to high levels of satisfaction with the procedure at average follow-up of 5.3 years. However, 36 of 82 ankles (42%) required further surgical procedures after allograft transplantation. A total of 25 (29%) were defined as clinical failures; 10 underwent revision of the graft, seven underwent arthrodesis and two underwent amputation due to persistent pain. Radiographs categorized 29 (46%) as failures (>50% joint space narrowing) at 3.5 years mean follow-up. At five years and 10 years, survivorship of the graft was 76% and 44% respectively. The authors acknowledged their reoperation and revision rates were higher than those reported for ankle arthrodesis or arthroplasty (Bugbee, et al, 2013). VanTienderen et al. (2017) published the results of a systematic review evaluating functional outcomes, complications and reoperation rates following osteochondral allograft of the talus. Five studies were included involving 91 lesions. At a mean followup of 45 months AOFAS scores improved, Pain VAS scores improved, and 25% of subjects required at least one reoperation. Reasons for reoperation included development of moderate to severe osteoarthritis, pain due to hardware, extensive graft collapse, and delayed or nonunion at osteotomy site. Twelve of the cases were considered failures.

In general, reported complications associated with allograft transplant of osteochondral ankle lesions include graft fracture, graft fragmentation, poor graft fit, graft subluxation, and non-union. Patients with unsuccessful outcomes after allografting have required ankle fusion or ankle arthroplasty (Gross, et al., 2001; Jeng, et al., 2008). As a result of these and other limitations of the medical literature, accurate conclusions cannot be made regarding the efficacy of osteochondral allografting for articular disorders of the ankle.

Patella: There are few studies evaluating osteochondral resurfacing of the patella (AAOS, 2001; Jamali, et al., 2005; Spak and Teitge, 2006; Gracitelli, et al., 2015). Much of the evidence consists of case series without controls and small sample populations; as such results cannot be generalized to larger groups of patients. While some of the results have been successful with authors reporting good to excellent scores for pain relief, function and range of motion, overall the evidence is insufficient to draw reliable conclusions regarding efficacy. In one study the authors reported additional surgery was performed in 12 of the 14 knees; the most common reason being symptomatic hardware (Spak and Teitge, 2006).

Professional Societies/Organizations: In 2013 the American Orthopaedic Foot and Ankle Society (AOFAS, 2013) published a position statement supporting osteochondral transplantation for the treatment of osteochondral lesions of the talus when the individual has failed non-operative management, particularly for large diameter lesions (>15 mm in diameter) and cystic lesions (i.e., cyst in subchondral bone).

The Washington State Health Care Authority technology assessment program published a technology assessment evaluating Osteochondral Allograft/Autograft Transplantation (2011). Regarding the evidence for the effectiveness of autograft OAT/mosaicplasty in the knee and ankle, there were substantial differences in patient populations, comparators, and outcome measures across all studies and given the high potential for bias, it was noted no firm conclusions could be drawn.

The American College of Rheumatology (ACR) Recommendations for the Medical Management of Osteoarthritis of the Hip and Knee (ACR, 2000) has noted that significant advances such as autologous chondrocyte
transplantation, cartilage repair using mesenchymal stem cells, and autologous osteochondral plugs are being investigated; however, they do not recommend those procedures for the treatment of patients with osteoarthritis. There has been no update to the recommendations since the initial publication in 2000.

**Use Outside of the US:** No relevant statements.

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**Healing Response (Microfracture) Technique**

The Healing Response (Microfracture) Technique is a treatment method employed for treatment of intra-articular ligament injuries that theoretically promotes vascularization by stimulating blood clot and subsequent scar formation. The technique has been utilized to assist in healing of tissues, for example with anterior cruciate ligament reconstruction. As part of an arthroscopic procedure small microfracture holes are made in the bone where the ligament originates. The blood clot that forms theoretically captures the injured portion of the ligament and as it heals attaches it back to the bone.

**U.S. Food and Drug Administration (FDA):** Healing Response Technique is a procedure and as such is not regulated by the US FDA.

**Literature review:** There is insufficient evidence in the medical literature at this time, in particular with ACL/PCL reconstruction using allograft tissue or meniscal transplant, to support any improvement in health outcomes with the use of this adjunctive treatment.

**Use Outside of the US:** No relevant statements.

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**Ankle Subchondroplasty**

Subchondral bone refers to the epiphyseal bone directly below the articular cartilage. In general, treatment of a subchondral bone defect, such as a bone marrow lesion or edema, includes analgesics, unloader bracing, reduction in weight bearing, activity modification, and appropriate nutrition including additional calcium and vitamin D, if appropriate. Subchondroplasty is a procedure currently under investigation for treatment of nonhealing subchondral bone defects. Under fluoroscopic guidance a bone void filler is injected into the region of the bone marrow lesion defect with the goal of improving the structural integrity of the damaged bone, until it is replaced by bone. There is a paucity of evidence in the peer reviewed scientific literature evaluating subchondroplasty of the ankle. As a result, evidence based conclusions regarding safety, efficacy, and the impact on net health outcomes has yet to be determined.

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**Customized Knee Replacement Procedures**

**Customized Knee Replacement, Patient-Specific Instrumentation, Gender Specific Prostheses**

Custom made knee replacement procedures may include customized prostheses (e.g., Custom Fit Knee™ Replacement [OtisMed Corp., Almeda, CA]), patient-specific template components, patient-specific instrumentation (designed from patient imaging data), preoperative imaging with associated magnetic resonance or computerized tomography scans, and/or intraoperative navigation systems, all of which are currently under investigation. In general, during knee replacement surgery a portion of the knee is resected using instrumentation guided by templates or cutting devices. Prosthetic devices are then used to replace the joint components. Some knee implants are claimed to be “gender-specific” and are implants that are designed to fit more accurately than a conventional knee implant (e.g., narrower in design), and theoretically may improve clinical outcomes, particularly for a female. Similar to conventional knee implants these devices are available as other off-the-shelf designs. Patient-specific templates and/or instrumentation systems may be utilized as an alternative to standard equipment for both total and partial knee replacement to aid in more properly designing and aligning the implants. These devices are used to assist with marking an area before cutting the bone and then positioning of the knee components. When customized techniques and devices are used a few weeks prior to surgery preoperative images are obtained using computed tomography or magnetic resonance imaging for the...
development of a knee model which is then used to develop specially sized prosthetic components, implants and instruments based on an individual's anatomy. In addition, intraoperative navigation systems (e.g., MAKOplasty® [MAKO Surgical Corporation®, Fort Lauderdale, FL]) that employ preoperative imaging and 3-dimensional views during surgery to improve alignment are under development.

**U.S. Food and Drug Administration (FDA):** Various instrumentation systems and software systems for developing patient specific templates/instrumentation are currently available. These devices are regulated by the U.S. Food and Drug Administration (FDA) through the 510(k) marketing process. Devices that have received FDA approval include but are not limited to the following: TruMatch Solutions (DePuy Orthopaedics, Inc.), Visionaire Patient matched Cutting Blocks (Smith and Nephew, Inc) and Stryker Patient Specific Cutting Guide (Stryker Corporation). In addition, various customized and/or gender specific knee implants have been approved by the FDA through the 510(k) process.

**Literature Review:** Evidence in the peer reviewed published literature evaluating gender specific type implants, customized knee replacement procedures and patient specific instrumentation (PSI) is conflicting. A number of studies support there is improvement in outcomes such as better mechanical alignment and range of motion in the short to intermediate term (Zeller, et al., 2017; Schwarzkopf, et al., 2015; Ivie, et al., 2014; Ng, et al., 2012; Noble, et al., 2012; Spencer, et al., 2009). However, authors have also reported there is minimal to no relevant difference in alignment and clinical outcomes resulting from customized knee procedures (Boonen, et al., 2017; Thienpont, et al., 2017; Kwon, et al., 2017; Predescu, et al., 2017; Van Leeuwen, et al., 2017; Huijibregts, et al., 2016; Cheng, et al., 2014; Abdel, et al., 2014; Kerens, et al., 2014). At present, the clinical benefit of any one implant over another compared to conventional knee replacement has yet to be proven (Mannan, et al., 201; Thienpont, et al., 2017; Huijibregts, et al., 2016; Nam, et al., 2016a; Nam, et al., 2016b; Lee, et al., 2016; Voleti, et al., 2014; Chotanaphuti, et al., 2014). Although there is a growing body of evidence to suggest PSI and/or customized knee replacement may be considered an alternative to conventional knee replacement, the evidence is insufficient to support superiority of these technologies at this time.

Hayes published a search and summary report in August evaluating the iTotal customized total knee replacement and concluded there is insufficient published evidence to assess safety and/or impact to health outcomes of patient management (Hayes, 2017). In 2016 Hayes, Inc. published a Medical Technology Directory Report evaluating patient specific instrumentation for knee replacement. According to the report, when compared with conventional instrumentation there was no superior benefit regarding alignment and/or function when using patient specific instrumentation (Hayes, 2016b). Furthermore, it was noted by Hayes the published evidence suggests that any small reduction in surgical time or length of stay is insufficient, (on average), to confer a benefit and failed to address whether patient specific instrumentation results in lower reoperation rates. Hayes reported it is reasonable to assume that revision rates would not be reduced if neither alignment nor functional outcomes showed superiority over conventional instrumentation. In another technology report published by Hayes (2012, reviewed 2014) it was reported there is insufficient evidence to assess the safety and/or impact on health outcomes or patient management of customized total knee arthroplasty. Due to insufficient published scientific evidence available at this time the overall benefit of customized knee prostheses, patient-specific templates/instrumentation systems and/or imaging/navigation systems has yet to be determined.

The American Academy of Orthopaedics (AAOS) published the evidence based guideline “Surgical Management of Osteoarthritis of the Knee” (AAOS, 2015). Within this guideline the authors report strong evidence supports not using patient specific instrumentation compared to conventional instrumentation of total knee arthroplasty (TKA) because there is no difference in pain and functional outcomes. In addition, moderate evidence supports not using patient specific instrumentation for TKA because there is no difference in transfusions or complications. Strong evidence is defined as evidence from two or more “high” strength studies with consistent findings, and moderate evidence is defined as evidence from two or more moderate strength studies with consistent findings or from a single high quality study. Guideline recommendations for gender specific knee implants and customized knee implants were not found on the AAOS website.

**Miscellaneous Knee Procedures**

**Minimally Invasive Knee Replacement**

Minimally invasive approaches to knee surgery have been investigated with the intention of limiting surgical dissection without compromising the surgical procedure or patient outcomes. Minimally invasive surgical (MIS)
approaches involves two developments: a smaller incision and a new technology approach (Vail, 2004). The MIS TKR incision is 4–6 inches long (AAOS, 2014). The main difference between a traditional approach and the MIS approach is the method in which the surgeon exposes and gains access to the joint—a minimally invasive approach has a smaller incision and avoids patella eversion and quadriceps muscle splitting. Furthermore, a minimally invasive approach to the knee should not violate the extensor mechanism or the suprapatellar pouch (AAHKS, 2004; Haas, et al., 2004; Tria and Coon, 2003). Modifications of the medial parapatellar, subvastus and midvastus approaches applying MIS techniques have been published in the literature (Scuderi, et al., 2004); however, patient selection criteria have not been clearly established. Less invasive surgical implants (e.g., unicompartamental knee arthroplasty) use different components and incision methods and should be evaluated as a separate type of less invasive surgery.

Surgical techniques for minimally invasive approaches have been facilitated by the use of smaller instrumentation; nonetheless, choice of prosthetic type is limited. In addition, MIS methods involve the risk of inaccurate implant positioning and possible additional complications, due to a restricted operative field. Incorrect positioning or orientation of implants during TKR, poor soft tissue balancing, and improper alignment of the limb can lead to accelerated wear, loosening and decreased overall performance of the implant (DiGioia, et al., 2004). Malalignment alone can lead to abnormal patellar tracking, increased polyethylene wear, early loosening, and poor functional outcome (Chin, et al., 2007).

Literature Review: Minimally invasive surgical techniques are difficult to evaluate in the scientific literature because of the multiple definitions describing the techniques, various approaches, and lack of reported long-term data. Comparing clinical outcomes across studies is difficult. Evidence in the medical literature evaluating minimally invasive approaches to knee replacement includes randomized, controlled trials; both retrospective and prospective case series; and comparative studies, in addition to published literature reviews. Most studies involve small patient populations and evaluate short term outcomes, ranging from the immediate post-operative period to approximately two and a half years following surgery (Lai, et al., 2014; Essving, et al., 2012; Kim, et al., 2011; Kashyap and Ommeren, 2008; Juospons, et al., 2008; McAllister and Stepanian, 2008; Schroer, et al., 2008, Huang, et al., 2007; Tashiro, et al., 2007; Kolisek, et al., 2007; Dalury and Dennis, 2005; Laskin, et al., 2005; Laskin, et al., 2004; Haas, et al., 2004; Muller, et al., 2004; Tria and Coon, 2003). Long-term health benefits are under investigation and few studies have established a clear benefit from minimally invasive approaches of TKR.

When compared to traditional total knee replacement, studies have suggested that minimally invasive approaches result in faster functional recovery and improved knee range of motion (Bonutti, et al., 2010; Khanna, et al., 2009; Kashyap and Ommeren, 2008; Schroer, et al., 2008; Huang, et al., 2007; Tashiro, et al., 2007; Haas, et al., 2004; Muller, et al., 2004; Tria and Coon, 2003). However, these results are not consistently reported. The results of some studies suggest short term functional outcomes are comparable or not significantly different when compared to standard TKR (Karachalios, et al., 2008; Lüiring, et al., 2008; McAllister and Stepanian, 2008; Kolisek, et al., 2007; Dalury and Dennis, 2005; Bonutti, et al., 2004).

Minimally invasive surgery is also associated with a learning curve and longer operative times for MIS TKR have been reported when compared to the standard approach (Khanna, et al., 2009; Karachalios, et al., 2008; Kolisek, et al., 2007; Tashiro, et al., 2007; Tria and Coon, 2003). Increased length of surgery may lead to a higher rate of complications in some patients (e.g., thromboembolism, infection). Ghandi et al. (2011) reported the results of meta-analysis of RCTs to compare complication rates between MIS TKR and standard TKR. A total of nine RCTs were included in the review. The authors noted a statistically significant increase in complication rates for the MIS group when compared to standard TKR and that MIS TKR failed to demonstrate any clinical benefit. Whitehead (2006) reported that recent efforts to shorten the incision in total knee arthroplasty have added significant risk, but little benefit. In a trial comparing the effects of severity of preoperative varus deformity on radiograph accuracy for subjects who underwent MIS TKR, Niki et al. (2009) reported MIS techniques decreased radiographic accuracy of implant alignment, particularly in patients with severe varus deformity.

Additionally, decreased length of hospitalization stay has been reported for patients who have undergone MIS TKR (Shankar, 2006), while for other similar patient groups there have been reports of minimal differences in length of stay (Kolisek, et al. 2007). Comparison of perioperative outcomes such as shorter incision length, reduced tourniquet time and less intraoperative blood loss has been reported in the literature as well.
Radiograph analysis of component positioning has also been performed in some studies with varying results; some suggest MIS TKR results in a high incidence of malpositioning (Huang, et al., 2007; Fisher, et al., 2003) while others report results are comparable to standard approaches with no significant differences in alignment (Bonutti, et al., 2010; Juosponis, et al., 2008; Kashyap and Ommeren, 2008; McAllister, et al., 2008; Chin, et al., 2007; Dalury and Dennis, 2005; Muller, et a., 2004).

Revision rates and implant survival rates vary. Barrack et al. (2009) reported the results of a consecutive series of first-time revision TKRs during a three year period (n=237), 44 subjects had an initial MIS TKR and 193 had a standard TKR. The authors noted the time to revision was significantly shorter for the MIS group compared to the standard TKR group (14.8 versus 80 months) and the authors were concerned regarding the high prevalence of MIS failures in a 24 month period of time. MIS knees were almost twice as likely to have instability or malrotation as a cause of failure.

There are a number of randomized controlled trials (RCTs) evaluating MIS TKR in the published scientific literature (Lai, et al., 2014; Tasker, et al., 2014; Kim, et al., 2011; Varela-Egocheaga, et al., 2010; Wulker, et al., 2010; Pan, et al., 2010; Hernandez-Vaquero, et al., 2010). A majority are limited by small sample populations and short-term outcomes. Lai et al. (2014) reported the results of a prospective RCT comparing clinical and radiographic results of primary TKR (n=33) and mini-subvastus approach (n=35). At an average follow-up of 28 months following surgery there were no significant differences in Knee Society function score, Oxford knee score, and range of motion. In addition the authors noted reduced access and visibility resulted in more technical errors and increased tourniquet time. Tasker et al. (2014) reported the results of a prospective RCT comparing MIS TKR (n=48) with TKR (n=54). The primary measured outcome was length of stay; secondary outcomes included WOMAC, KSS, Oxford scores, and knee ROM. Follow-up occurred at three, 12, and 24 months. The MIS group had a shorter length of stay and fewer surgical complications, there was no significant difference in operative time or alignment, and postoperative functional improvements were not statistically different between groups. In 2016 Unwin reported the medium term outcomes of this same group of subjects evaluated by Tasker et al. At a mean of six years follow-up both groups showed improvement in pain and function with no significant difference between groups. In addition, the authors reported there was no difference between groups for revision due to mal-alignment.

MIS unicompartmental knee replacement (UKR) has also been investigated and some authors have reported encouraging results (O'Donnell, et al., 2010; Pandit, et al., 2010.) Nonetheless, some of the reported outcomes are mixed. Kort et al. (2007) reported the results of a prospective case series involving 154 unicompartmental knee replacements (n=132 patients) using a minimally invasive approach and a phase-3 Oxford mobile bearing device. The authors noted that 11% of the unicompartmental arthroplasties in all patients needed a revision, resulting in a survival rate of 89% during a 2-7 year follow-up interval. Hamilton and colleagues (2006) reported the results of a retrospective cohort of 221 consecutive patients treated with a minimally invasive, medial unicompartmental arthroplasty, compared to patients who underwent a standard arthrotomy and routine patellar eversion. The authors reported a total reoperation rate of 11.3% in the MIS group compared to 8.6% in the standard arthrotomy group. The rate of aseptic loosening in the MIS group was reported to be 3.7% compared to standard group of 1.0%.

Professional Societies/Organizations: The American Academy of Orthopaedic Surgeons (AAOS, 2003) guideline on minimally invasive surgery states, “The American Academy of Orthopaedic Surgeons believes that 'Minimally Invasive Surgery' for total joint replacement is a promising, but evolving surgical technique that requires additional scientific evidence to validate its short and long-term safety and effectiveness, in comparison to conventional joint replacement methods.”

Advisory statements regarding minimally invasive and small incision joint replacement surgery by the American Association of Hip and Knee Surgeons (AAHKS, 2004; updated 2008) indicate that same or better long-term outcomes have not been validated with less invasive knee replacement surgery, and there is not a great deal of significant scientific proof to support its use at this time. Scientific evidence and rigorous evaluation of minimally invasive joint arthroplasty techniques are needed before these techniques are recommended for more widespread clinical practice.
Use Outside of the US: The National Institute for Health and Care Excellence (NICE) issued a procedural guidance regarding mini-incision surgery for total knee replacement (March, 2010). The Institute concluded that current evidence on the safety and efficacy of mini-incision surgery for total knee replacement is adequate to support the use of this procedure provided that normal arrangements are in place for clinical governance, consent and audit.

Focal Knee Joint Resurfacing
Focal resurfacing of a knee joint defect is a surgical procedure in which a limited amount of bone is removed from the surface of the joint and then replaced with a metal or metal/plastic implant. It has been proposed as an alternative to unicompartamental or total knee replacement, involving less removal of the patient’s bone and theoretically allowing more normal joint function. Candidates for resurfacing are usually younger in age, physically active, and have focal articular defects (i.e., early stage OA changes that are isolated).

U.S. Food and Drug Administration (FDA): Two FDA approved knee resurfacing prosthesis include the HemiCAP™ Femoral Condyle System (Arthrosurface, Inc., Franklin, MA) and the UniCAP™ Unicompartmental Knee Resurfacing Implant (Arthrosurface, Inc., Franklin, MA). These devices are approved through the FDA 510(k) approval process as Class II devices and are intended to be used with bone cement.

Literature Review: Evidence in the peer-reviewed published scientific literature evaluating safety and efficacy of focal knee joint resurfacing using these or other similar devices is limited. Becher et al. (2011) published the results of a case series involving 21 patients who received a HemiCap device with average follow-up of 5.3 years. Boller et al. reported the results of a case series involving 19 subjects treated with a HemiCap device with an average follow-up of 34 months. Although there was improvement in pain and function scores, the studies were limited by small populations, lack of a control group and short to mid-term outcomes. Published data regarding the safety, efficacy and improved health outcomes with the use of this technology as an alternative to TKR or UKR is insufficient and precludes the ability to draw conclusions as this time.

Miscellaneous Knee Procedures Coding and Billing Information

The American Board of Internal Medicine’s (ABIM) Foundation Choosing Wisely® Initiative: No relevant statements.

Appendix 1 – Procedure to Coding Crosswalk

<table>
<thead>
<tr>
<th>Musculoskeletal Procedure/Orthobiologic</th>
<th>Intended Use (this list may not be all inclusive)</th>
<th>Application CPT/HCPCS Codes</th>
<th>Product HCPCS Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healing Response Technique</td>
<td>Knee ligament repair</td>
<td>29999</td>
<td></td>
</tr>
<tr>
<td>Matrix-induced autologous chondrocyte implantation:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• MACI® (Vericel Corporation, Cambridge, MA)</td>
<td>Treatment of articular cartilage defects, other than knee</td>
<td>23929, 24999, 27299, 27899, 29999</td>
<td>J7330 L8699</td>
</tr>
<tr>
<td>Autologous chondrocyte transplantation (e.g., Carticel®, MACI®) for lesions other than the femoral condyle</td>
<td>Treatment of lesions in any joint other than the femoral condyle of the knee , (e.g., tibia/patella, ankle, hip, shoulder)</td>
<td>23929, 24999, 27299, 27899, 29999</td>
<td>J7330 L8699</td>
</tr>
<tr>
<td>Autologous chondrocyte transplantation (e.g., Carticel®, MACI®)</td>
<td>Treatment of cartilage damage associated with generalized osteoarthritis</td>
<td>23929, 24999, 27299,</td>
<td>J7330 L8699</td>
</tr>
</tbody>
</table>
## Coding/Billing Information

### Note:
1) This list of codes may not be all-inclusive.
2) Deleted codes and codes which are not effective at the time the service is rendered may not be eligible for reimbursement.

### Articular Cartilage Repair

Experimental/Investigational/Unproven when autologous chondrocyte (e.g., Carticel®, MACI®), osteochondral autograft or allograft transplant is used for the treatment of articular cartilage defects in locations other than the distal femur within the knee:

<table>
<thead>
<tr>
<th>CPT® Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20962</td>
<td>Bone graft with microvascular anastomosis; other than fibula, iliac crest, or metatarsal</td>
</tr>
<tr>
<td>23929</td>
<td>Unlisted procedure, shoulder</td>
</tr>
<tr>
<td>24999</td>
<td>Unlisted procedure, humerus or elbow</td>
</tr>
</tbody>
</table>

### Treatment Options:

- **Osteochondral autograft transplantation**
- Treatment of articular cartilage defects involving joint surfaces other than the femoral condyle (e.g., patella)
- Codes: 20962, 23929, 24999, 27299, 27899, 28103, 28446, 29999

- **Osteochondral allograft transplantation**
- Treatment of articular cartilage defects involving joint surfaces other than the femoral condyle (e.g., patella)
- Codes: 20962, 23929, 24999, 27299, 27899, 28103, 28446, 29999

- **Osteochondral allograft using decellularized cartilage (e.g., Chondrofix)**
- Treatment of articular cartilage defects using allograft
- Codes: 20962, 23929, 24999, 27299, 27899, 28103, 28446, 29999

- **Osteochondral synthetic resorbable polymers:**
  - TruFit® cylindrical plug
  - TruGraft™ granules
- Treatment of osteochondral articular cartilage defects
- Codes: 23929, 24999, 27299, 27599, 27899, 29999

- **Ankle Subchondroplasty**
- Treatment of an ankle subchondral bone defect
- Codes: 27899, 29999, 77002

- **Minimally Invasive Knee Replacement**
- Knee replacement (i.e., total, partial)
- Codes: 27599

- **Focal resurfacing of a single knee joint:**
  - HemiCAP™
  - UniCAP™
- Knee arthroscopy
- Codes: 27438, 27440, 27442

[Other Codes table and descriptions]

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Medical Coverage Policy: 0515
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>27299</td>
<td>Unlisted procedure, pelvis or hip joint</td>
</tr>
<tr>
<td>27899</td>
<td>Unlisted procedure, leg or ankle</td>
</tr>
<tr>
<td>28103</td>
<td>Excision or curettage of bone cyst or benign tumor, talus or calcaneus; with allograft</td>
</tr>
<tr>
<td>28446</td>
<td>Open osteochondral autograft, talus (includes obtaining graft[s])</td>
</tr>
<tr>
<td>29999</td>
<td>Unlisted procedure, arthroscopy</td>
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</table>

**HCPCS Codes**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>J7330</td>
<td>Autologous cultured chondrocytes, implant</td>
</tr>
<tr>
<td>L8699</td>
<td>Prosthetic implant, not otherwise specified</td>
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**Healing Response Technique**

Experimental/Investigational/Unproven when used to report healing response technique:

<table>
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<tr>
<th>CPT®* Codes</th>
<th>Description</th>
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<tbody>
<tr>
<td>29999</td>
<td>Unlisted procedure, arthroscopy</td>
</tr>
</tbody>
</table>

**Ankle Subchondroplasty**

Experimental, investigational, unproven when used to report ankle subchondroplasty:

<table>
<thead>
<tr>
<th>CPT®* Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>27899</td>
<td>Unlisted procedure, leg or ankle</td>
</tr>
<tr>
<td>29999</td>
<td>Unlisted procedure, arthroscopy</td>
</tr>
<tr>
<td>77002</td>
<td>Fluoroscopic guidance for needle placement (e.g., biopsy, aspiration, injection, localization device) (List separately in addition to code for primary procedure)</td>
</tr>
</tbody>
</table>

**HCPCS Codes**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L8699</td>
<td>Prosthetic implant, not otherwise specified</td>
</tr>
</tbody>
</table>

**Miscellaneous Knee Procedures**

Experimental, investigational, unproven when used to report minimally invasive knee replacement or focal resurfacing of a single knee joint defect (e.g. HemiCAP, UniCAP):

<table>
<thead>
<tr>
<th>CPT®* Codes</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>27438</td>
<td>Arthroplasty, patella; with prosthesis</td>
</tr>
<tr>
<td>27440</td>
<td>Arthroplasty, knee, tibial plateau</td>
</tr>
<tr>
<td>27442</td>
<td>Arthroplasty, femoral condyles or tibial plateau(s), knee;</td>
</tr>
<tr>
<td>27599</td>
<td>Unlisted procedure, femur or knee</td>
</tr>
</tbody>
</table>

**HCPCS Codes**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1776</td>
<td>Joint device (implantable)</td>
</tr>
<tr>
<td>L8699</td>
<td>Prosthetic implant, not otherwise specified</td>
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</table>

References


