

MaioRegen

Biojoint System



Chondro+



Slim



Prime

A **SYSTEM** TAILORED
TO YOUR PATIENT'S NEEDS



Cartilage and Osteoarthritis

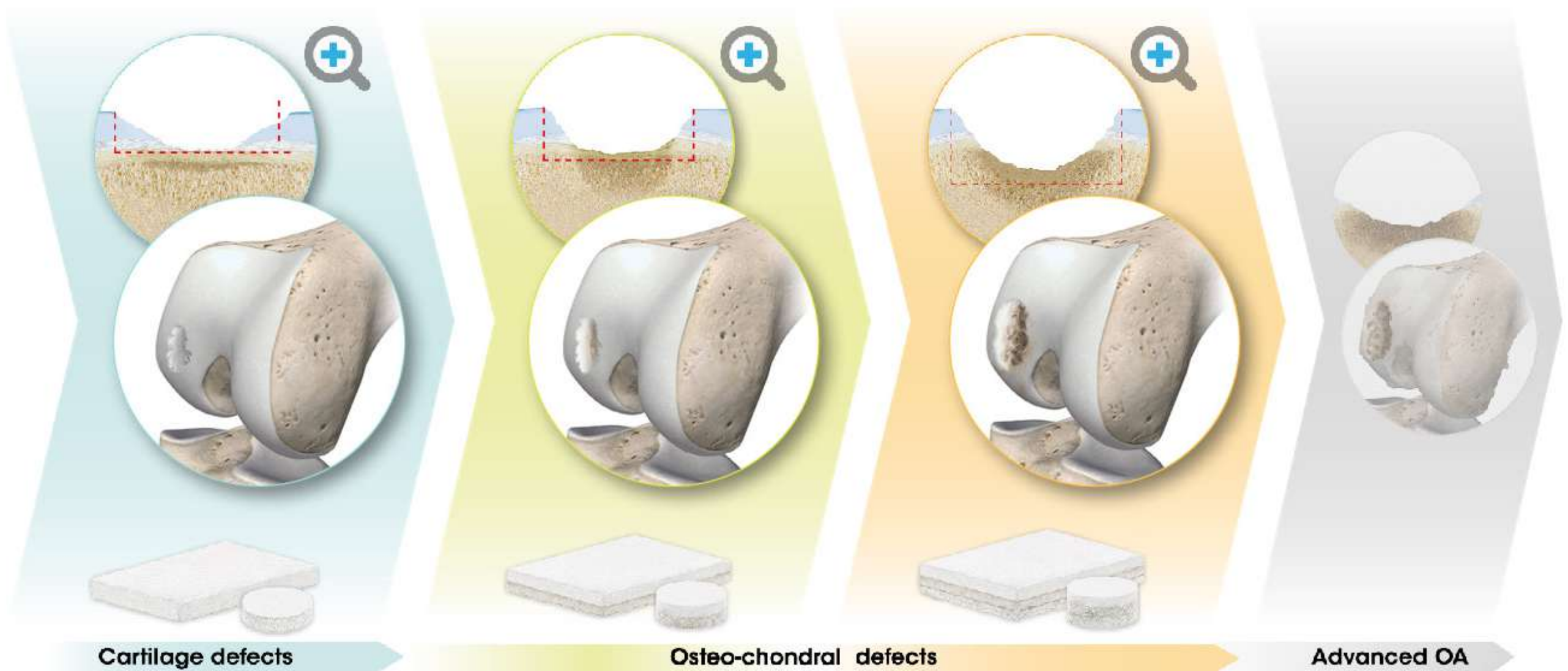
Lesions involving cartilage and sub-chondral bone, if left untreated, are serious risk factors for osteoarthritis (OA).

OA is a condition of slow biologic progression: this degenerative disease develops, through the stages of Pre-OA and Early-OA, to the final condition of severe osteoarthritis.

Each stage of the pathology should be targeted with a specific treatment: either conservative for preliminary early stages, or surgical whenever a restoration of the tissues is possible, before the need for a total knee replacement.



Clear Clinical Indications based on the specific Disease Stage



Clear Clinical Indications based on the specific Disease Stage

MaioRegen
Biojoint System
Chondro+



Chondral lesions, with mild or no impairment of subchondral bone tissue.



MaioRegen
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Osteo-chondral lesions with moderate bone impairment
(Outerbridge grade III or IV, ICRS grade IVa).



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Biojoint System
Prime



Deep osteo-chondral lesions with severe bone impairment
(Outerbridge grade IV, ICRS grade IVa IVb).



Biomimetic Structure

MaioRegen

Biojoint System

Chondro+

Cartilage layer
100% equine collagen



1



Calcified cartilage
60% equine collagen
40% Mg-hydroxyapatite



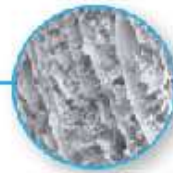
1+

MaioRegen

Biojoint System

Slim

Cartilage layer
100% equine collagen



1



Calcified cartilage
and Sub-chondral
bone plate
60% equine collagen
40% Mg-hydroxyapatite



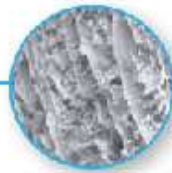
2

MaioRegen

Biojoint System

Prime

Cartilage layer
100% equine collagen



1



Calcified cartilage
and Sub-chondral
bone plate
60% equine collagen
40% Mg-hydroxyapatite



2

Spongy bone layer
30% equine collagen

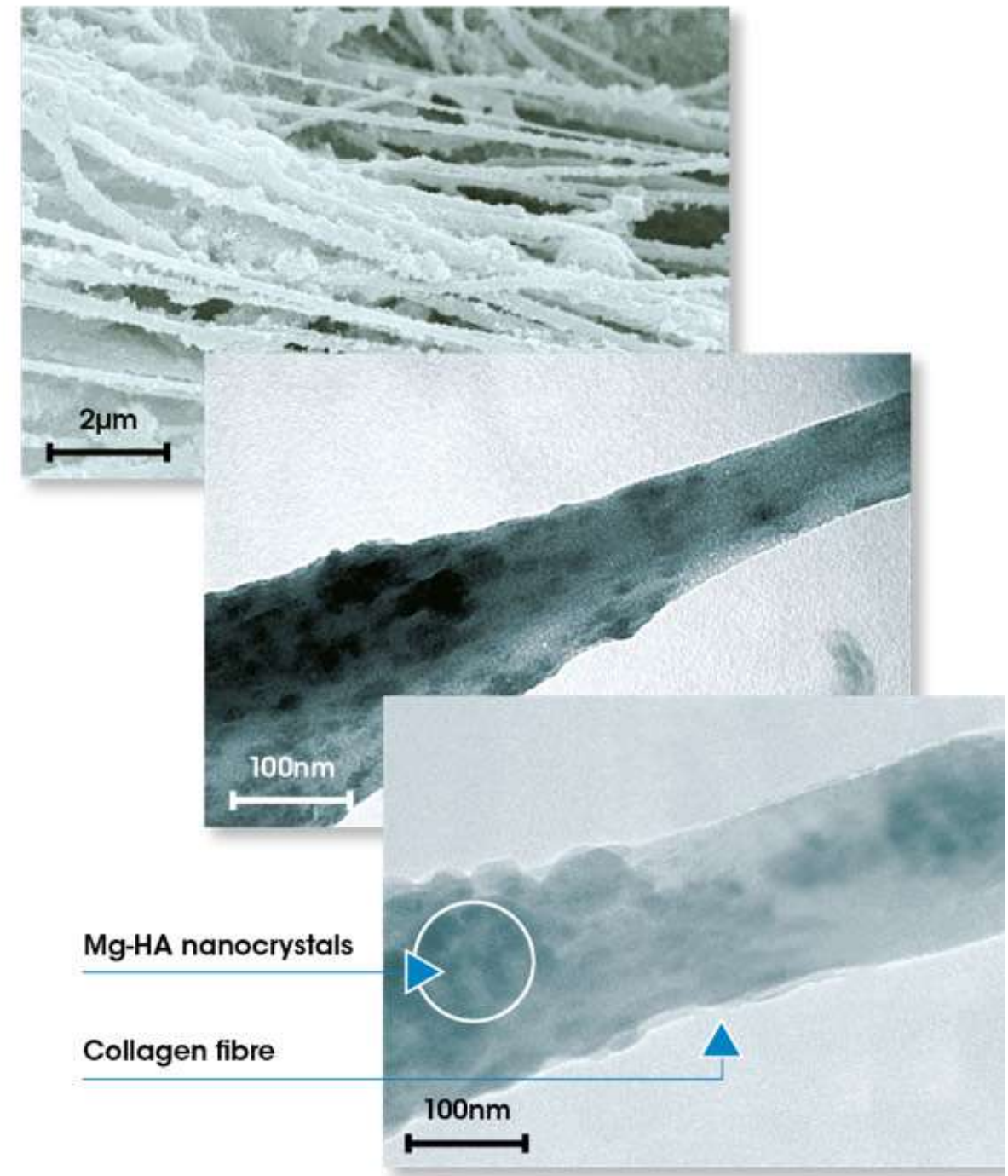


3

MaioRegen is a **biomimetic scaffold**, able to drive effective tissue repair thanks to its peculiar structure and chemical composition.



The chemical biomimetism is given by nucleation of Mg-HA nanocrystals into the collagen fibres, which resembles the biological neo-ossification process. The characteristic orientation of collagen fibres on the other hand provides the geometrical biomimetism*.



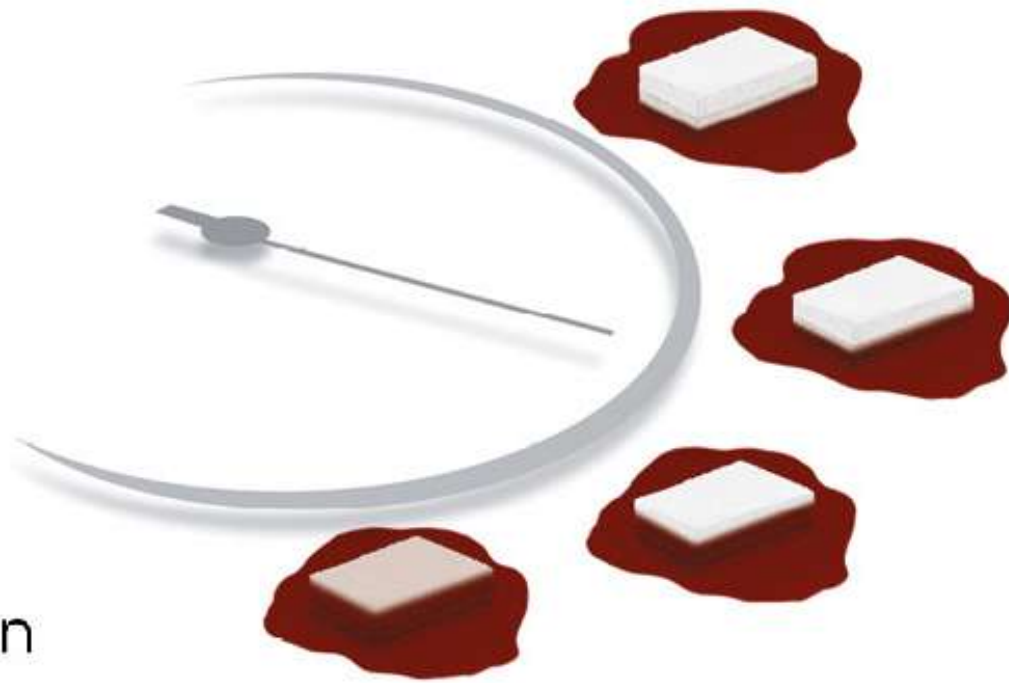
* Tampieri A. et al. J. Biomed. Mater. Res. (2003); 67A:618-625.

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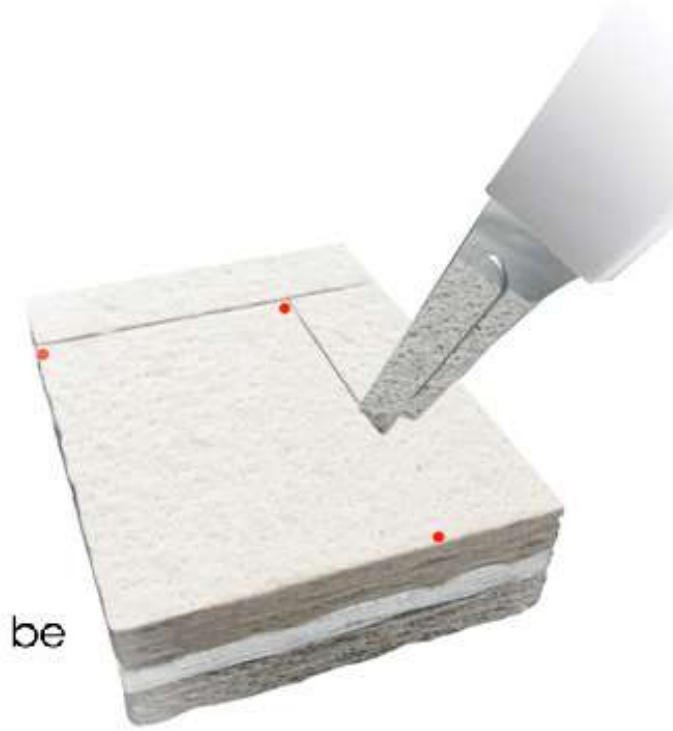
Sequence of progressive SEM enlargements, highlighting both the micro- and nano-structure of MaioRegen sub-chondral layer.

Smart Features



Hydration

High porosity and good hydrophilic properties to quickly absorb biological fluids.



Conformability

Perfectly adaptable and easy to be cut to fit lesion size.



Flexibility

Flexible and elastic when wet.

Degradability

MaioRegen is a resorbable material that degrades while driving the tissues regeneration.



Proof of Concept in Animal Models

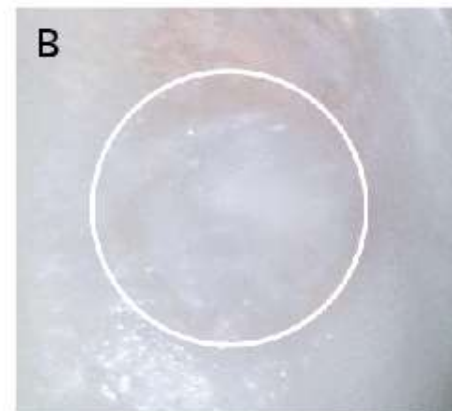
Product efficacy has been demonstrated on proof-of-concept sheep and horse models.

MaioRegen demonstrated to favour bone and cartilage regeneration process in relevant animal models.*

UNTREATED DEFECT



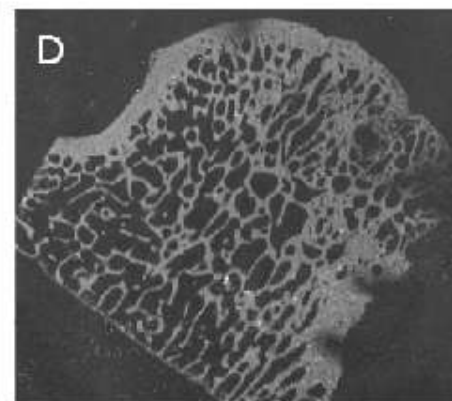
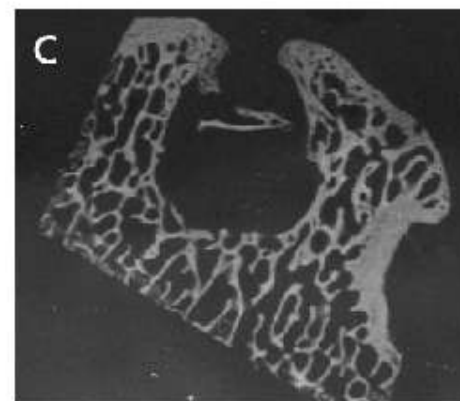
MAIOREGEN



6 Months post operation.

Newly formed cartilage-like tissue in the control group (A).

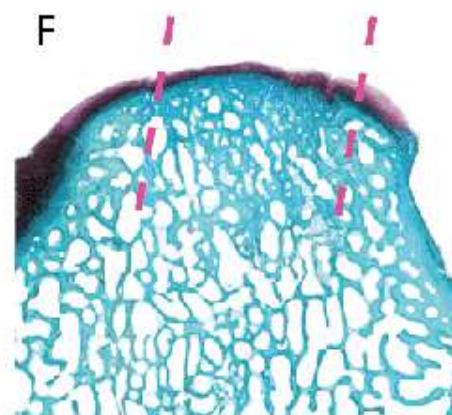
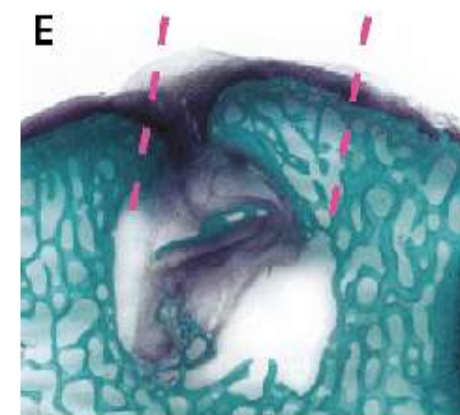
Full coverage of defect with newly formed smooth cartilaginous tissue (B).



Micro X-ray of the sagittal sections.

No spontaneous healing occurred (C).

Presence of newly-formed trabecular bone tissue (D).



Histologic study.

Fibrous tissue and evident bone gap (E).

Good integration of the scaffold with the host cartilage, new hyaline like tissue and well-structured subchondral bone (F).

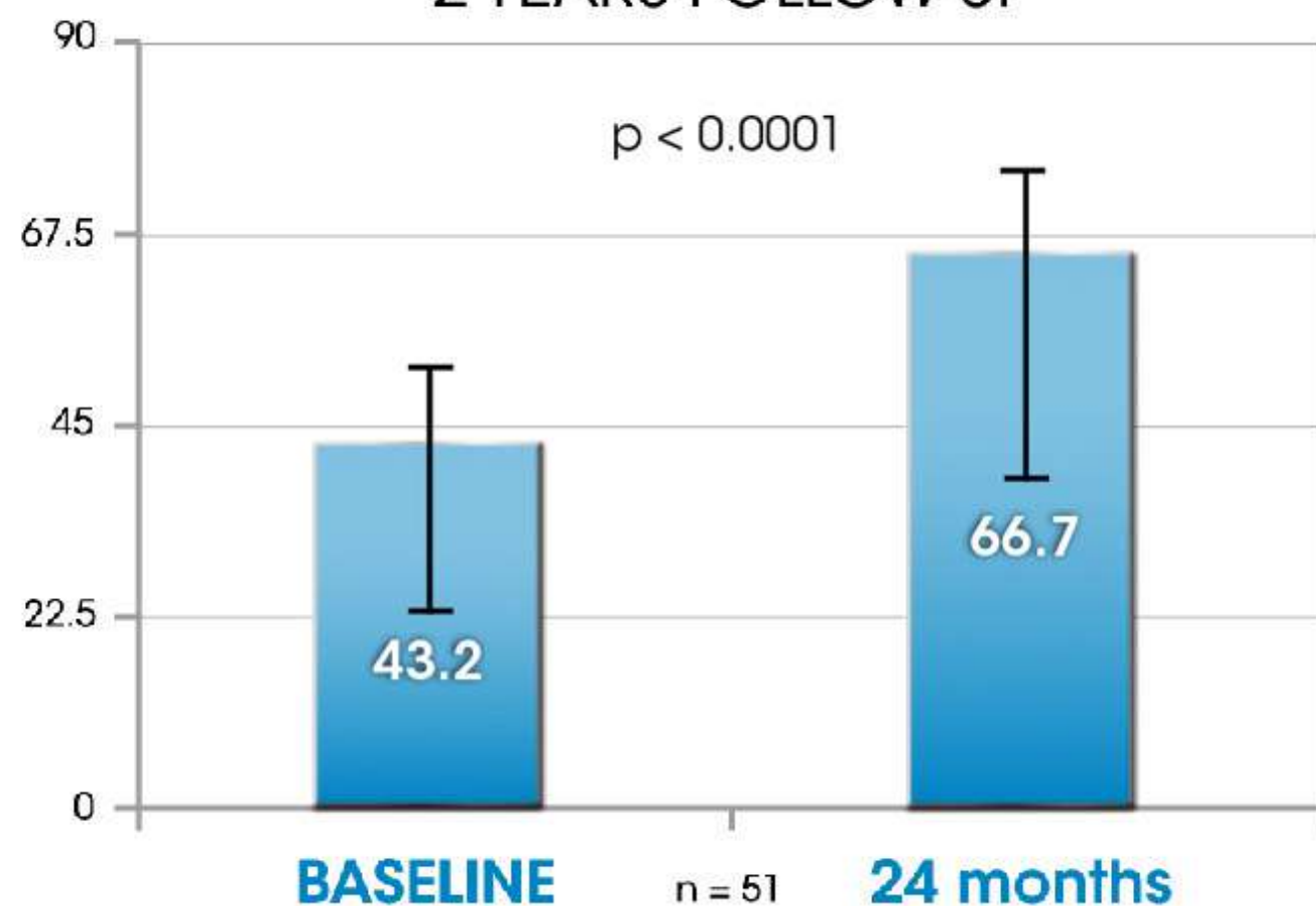
*Tampieri A. et al. Key Eng Materials (2008) – Vols. 361-363 pp. 927-930

Kon E. et al J. Orthopaedic Research (2009) - DOI 10.1002/jor.20958.

Evidence of MaioRegen Efficacy

Results from a Level of Evidence 1 RCT

IKDC SUBJ. SCORE 2 YEARS FOLLOW-UP



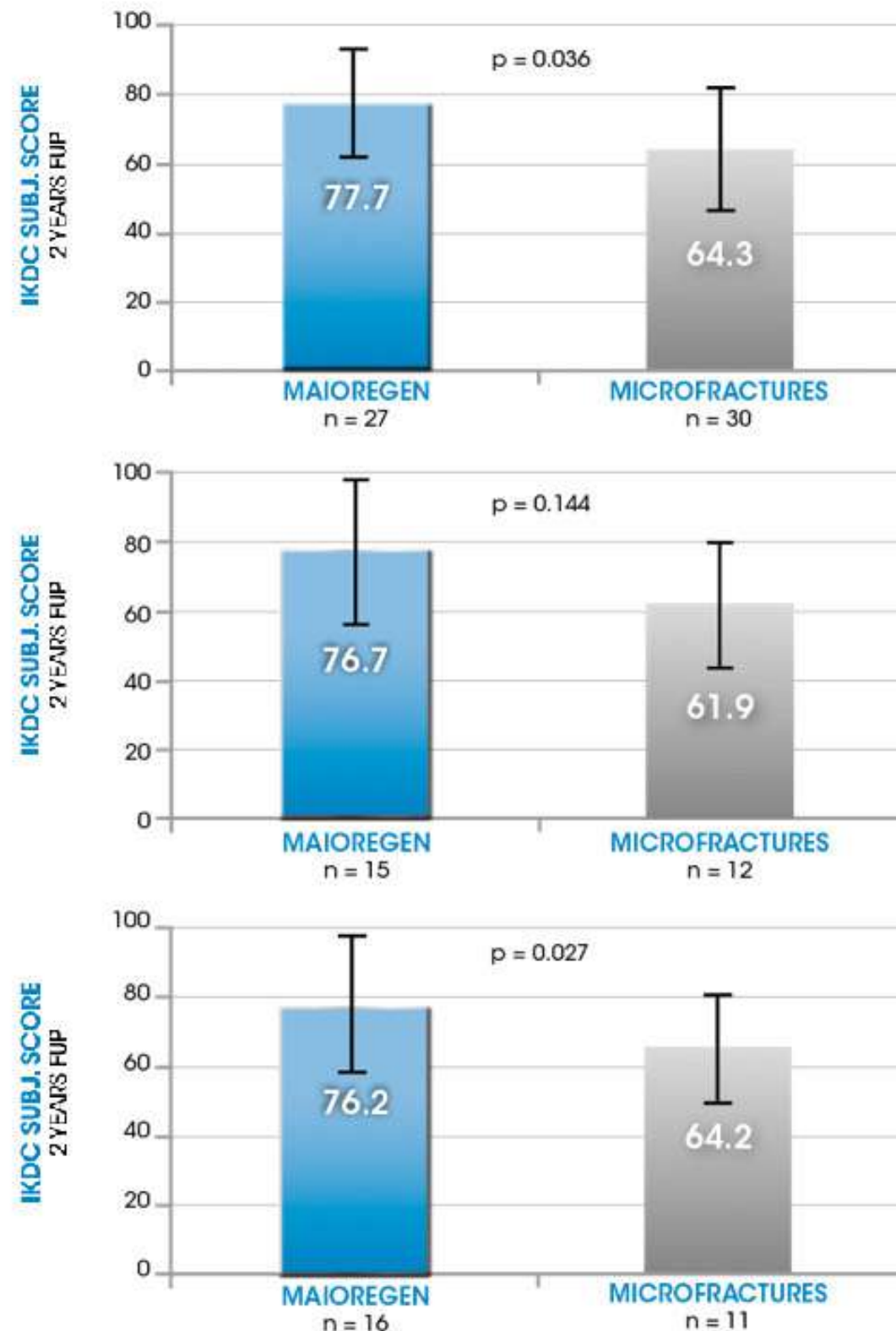
Statistical significant improvement in IKDC Subjective Score for patients treated with MaioRegen from baseline to 2 years follow-up.



The study has been conducted to assess the benefit provided by MaioRegen Prime (tri-layer) scaffold in 10 international centers.

Evidence of MaioRegen Superiority vs Microfractures

Results from a Level of Evidence 1 RCT



Deep Osteochondral Lesions

Statistically significant MaioRegen superiority: +12.4 points vs Microfracture in change from baseline of IKDC Subjective score.

Osteochondritis Dissecans

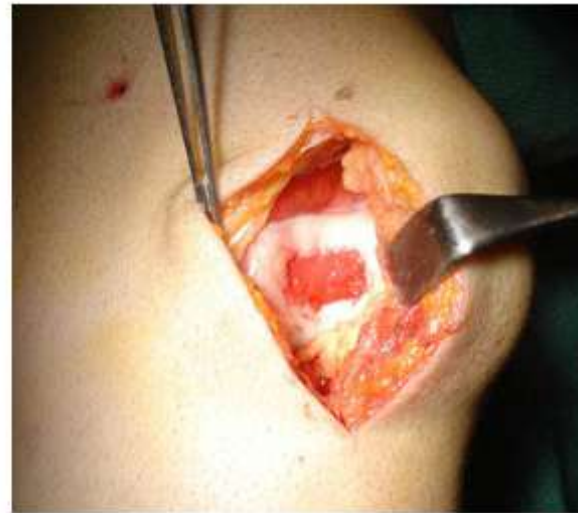
Clinically relevant improvement of MaioRegen: +12.0 points vs Microfracture in change from baseline of IKDC Subjective score.

Sport Active Patients

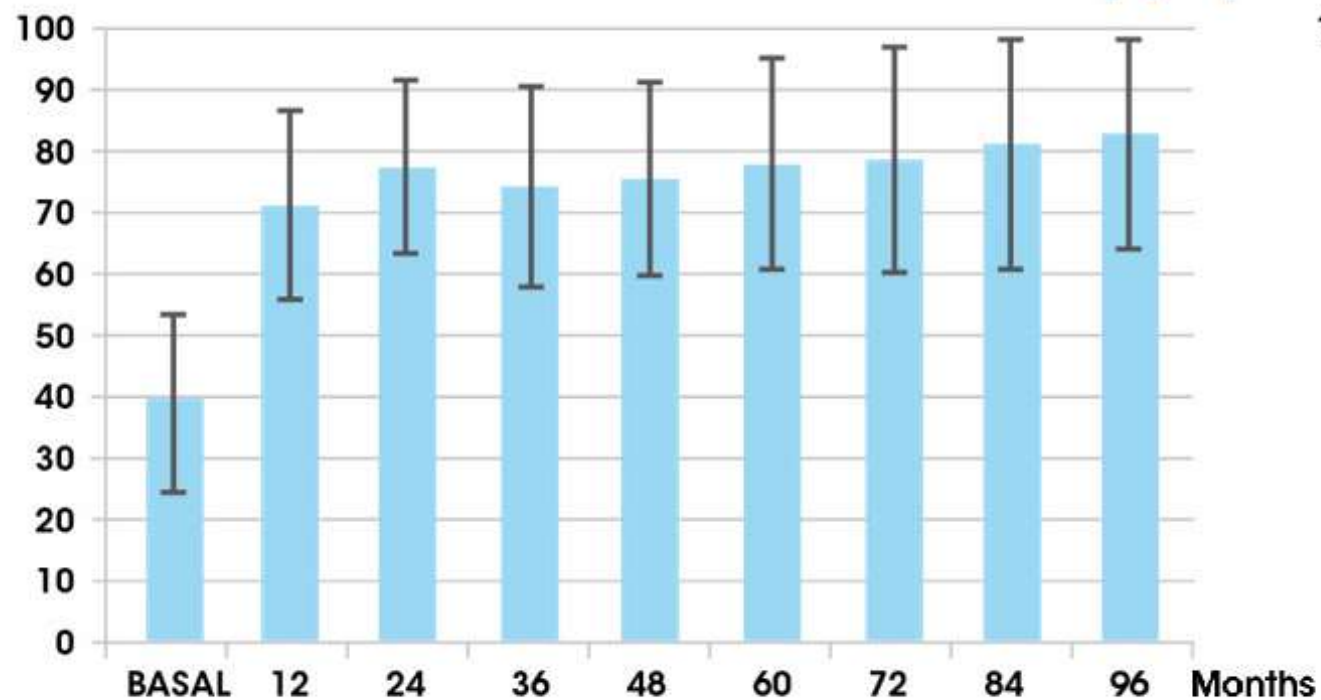
Statistically significant MaioRegen superiority: +16.0 points vs Microfracture in change from baseline of IKDC Subjective score.

Evidence of Long Term Stability

Clinical results of patients treated with MaioRegen are stable over time up to 8 years of follow-up.

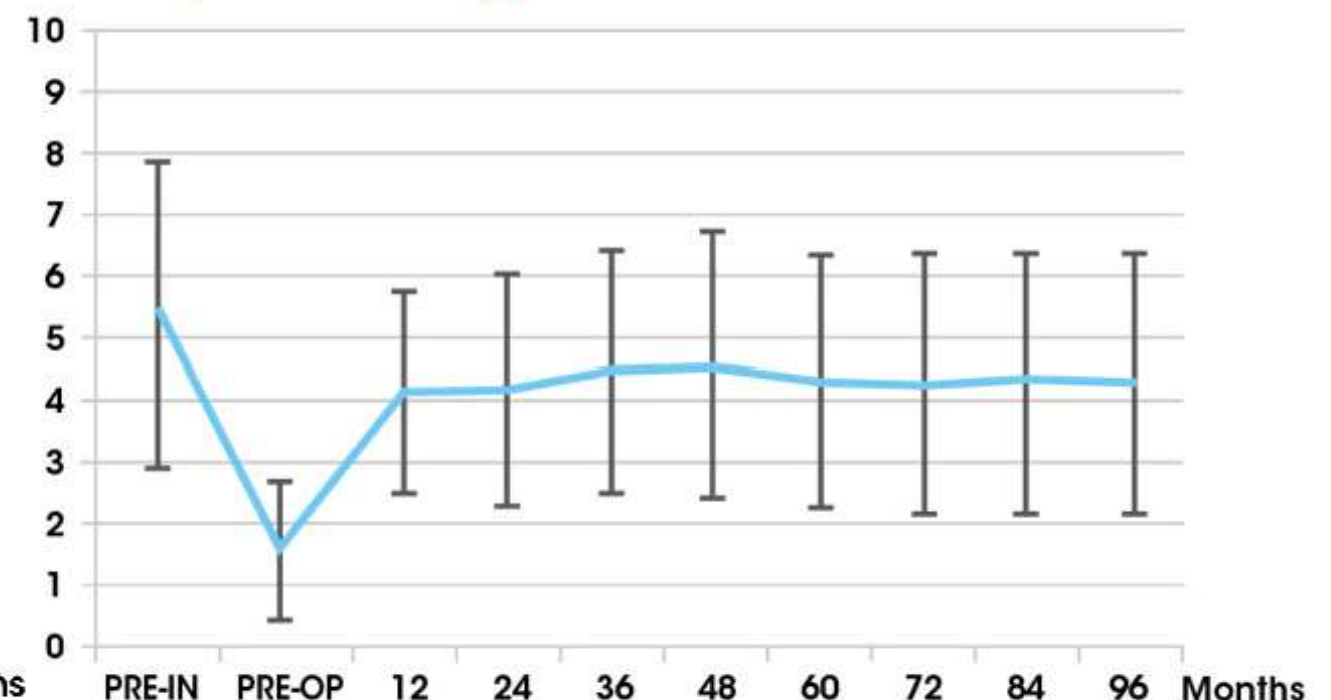


Pilot study (27 patients - 8 years follow up) *



IKDC subjective score

Significant improvement from pre-operative to 8 years follow-up (avg. +40 points).

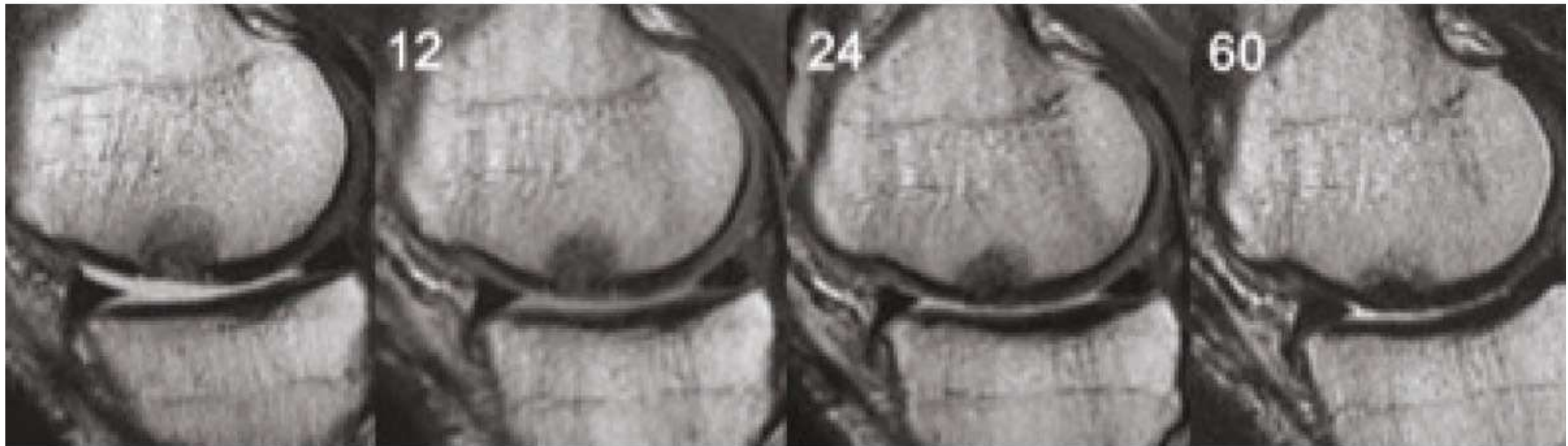


Tegner score

Improvement from pre-operative to 8 years follow-up (avg. +2.8 points).

Evidence of Long Term Stability

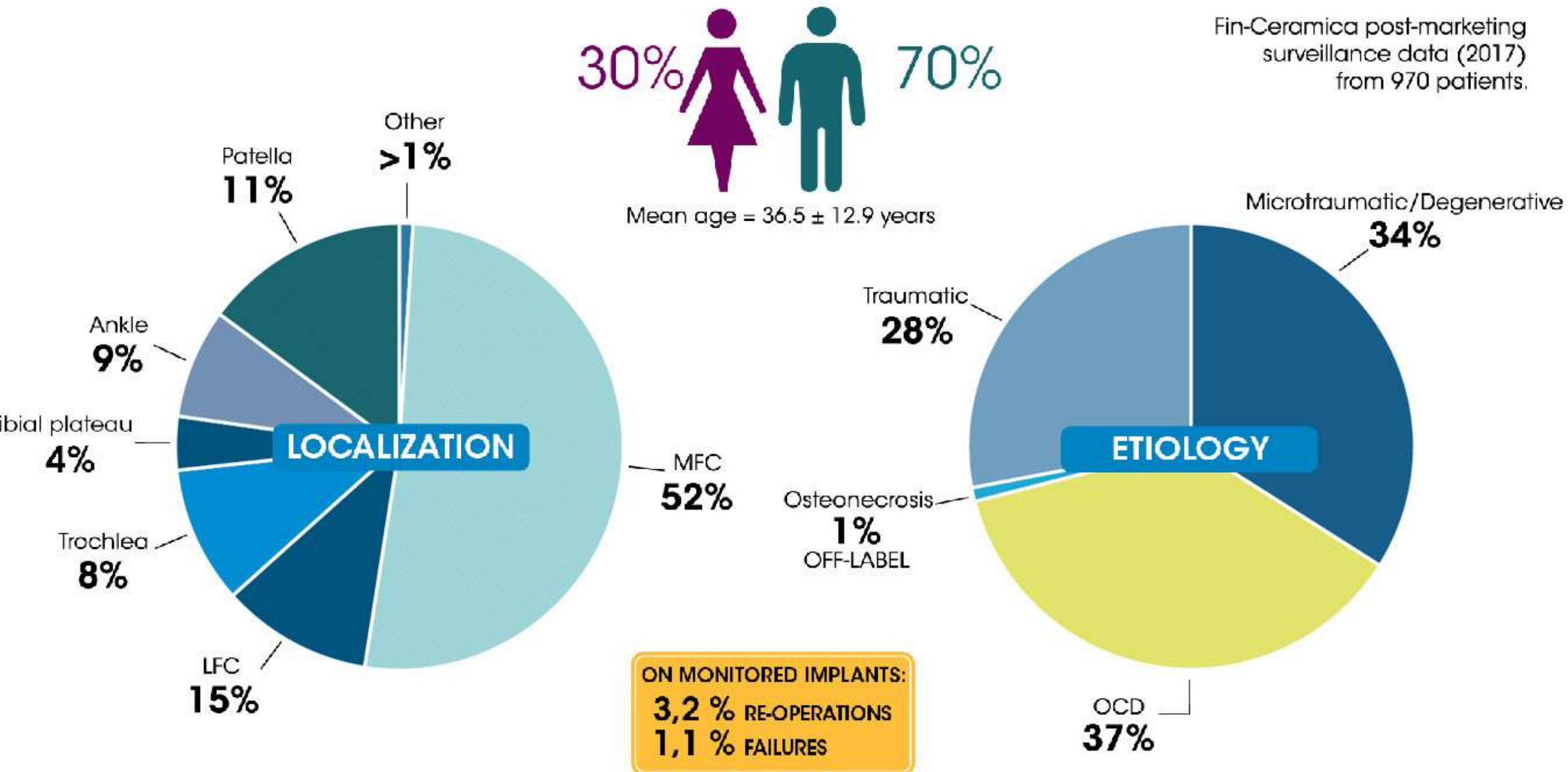
Magnetic resonance imaging at 6, 12, 24, and 60 months follow-up. As time goes by, the defect filling becomes almost complete and the subchondral bone edema progressively reabsorbs.*



* Kon E. et al. AJSM 2013 "Clinical Results and MRI Evolution of a Nano-Composite Multilayered Biomaterial for Osteochondral Regeneration at 5 Years".

Reliable and Safe

More than 6.000 MaioRegen have been implanted in 20+ countries



Adverse events incidence and failure rates are comparable to other analogous open joint surface surgeries. Finceramica post-marketing safety analysis shows that the most frequent adverse events are minor post-op symptoms (fever, swelling, pain), that spontaneously solve within one month after surgery.

MaioRegen Highlights



**MAIOREGEN
TURNS THE CLOCK
OF YOUR KNEE
BACK!**



4,500+ Patients
Treated



20+ Clinical
Publications



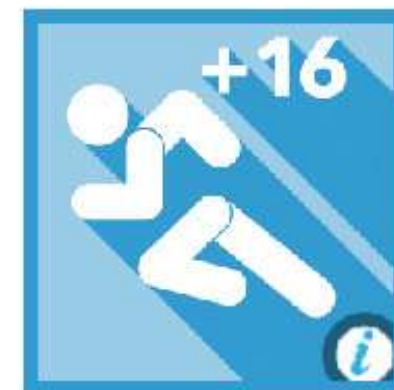
Level of Evidence 1
International RCT



+40 Points in IKDC Subj.
Score vs baseline at 8 Years
Follow-Up



+12 Points vs Microfracture
in IKDC Subj. Score for Deep
Osteochondral Lesions at 2
Years Follow-up



+16 Points vs Microfracture
in IKDC Subj. Score for Sport
Active Patients at 2 Years
Follow-up

FICHA TÉCNICA DE PRODUCTO MAIO REGEN

Marca Comercial:

MaioRegen

Diferentes configuraciones:

MaioRegen Prime

MaioRegen Slim

MaioRegen Chondro+

Fabricante:

Fin-ceramica Faenza S.p.A.

Dirección:

Vía Granarolo, 177/3- 48018 Faenza (RA) - Italy

Referencias:

Ver Anexo I

Clasificación:

Tipo III

Descripción:

Implante multicapa tridimensional de colágeno que mimetiza la matriz extracelular del cartilago y hueso subcondral

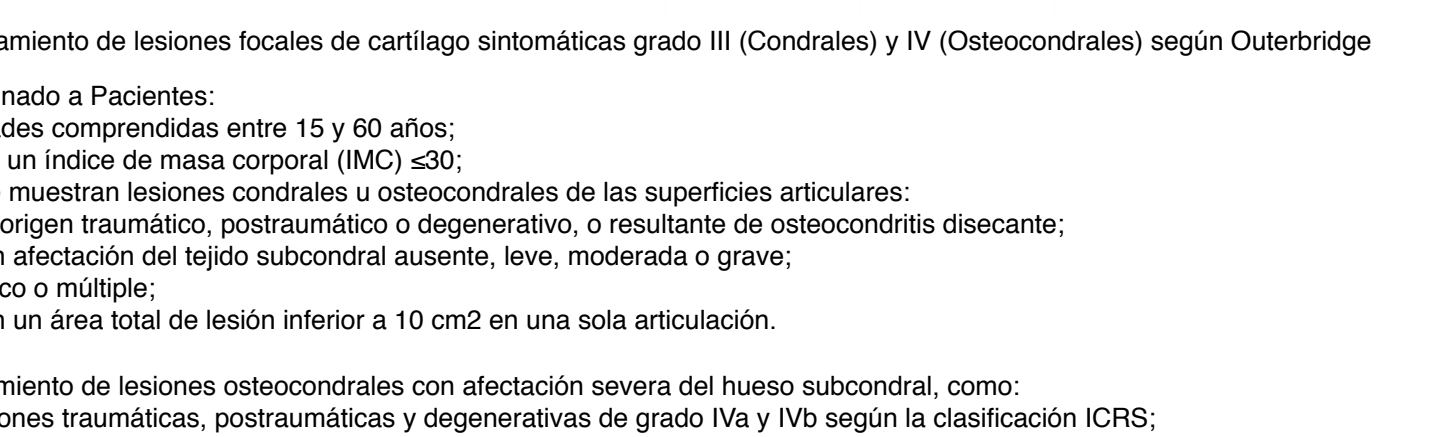
Indicación:

Tratamiento de lesiones focales de cartilago sintomáticas grado III (Condrales) y IV (Osteocondrales) de la escala de I.C.R.S.

Método acción:

La composición química particular permite que la línea de dispositivos MaioRegen imite la matriz extracelular del cartilago y el tejido osteocartilago. Los dispositivos de alta porosidad y buena hidrofiliicidad favorecen la rápida absorción de los líquidos biológicos (y componentes celulares relacionados) con los que entran en contacto durante la implantación, facilitando su adaptación al sitio de la lesión. La composición y la macro, micro y nanoestructura de los dispositivos favorecen los procesos de reparación de la superficie articular y permiten la reabsorción fisiológica mediada por células de los biomateriales implantados junto con el proceso de remodelación del tejido recién formado.

Imagen de producto:



Material/ Composición: Implante multicapa tridimensional de colágeno de origen animal tipo I (capa superficie articular 100% colágeno tipo I) y Magnesio-Hidroxiapatita altamente porosa (capa contacto hueso suncondral 30% colágeno tipo I + 70% Mg-HA Porosa)

Indicaciones: .Tratamiento de lesiones focales de cartilago sintomáticas grado III (Condrales) y IV (Osteocondrales) según Outerbridge

Destinado a Pacientes:

- edades comprendidas entre 15 y 60 años;
- con un índice de masa corporal (IMC) ≤30;
- que muestran lesiones condrales u osteocondrales de las superficies articulares: o de origen traumático, postraumático o degenerativo, o resultante de osteocondritis disecante; o con afectación del tejido subcondral ausente, leve, moderada o grave; o único o múltiple;
- o con un área total de lesión inferior a 10 cm2 en una sola articulación.

MaioRegen Prime: tratamiento de lesiones osteocondrales con afectación severa del hueso subcondral, como:

- lesiones traumáticas, postraumáticas y degenerativas de grado IVa y IVb según la clasificación ICRS;
- lesiones de grado IV según la clasificación de Outerbridge;
- lesiones en etapa temprana de osteoartritis (OA temprana según la definición de Luyten, Knee Surg Sports Traumatol Arthrosc., 2012) y lesiones de grado I y II según la clasificación de Kellgren y Lawrence, en ausencia de osteofitos;
- Lesiones resultantes de la osteocondritis disecante

MaioRegen Slim: .Tratamiento de lesiones osteocondrales con afectación moderada del hueso subcondral, como:

- lesiones traumáticas, postraumáticas y degenerativas de grado IVa según la clasificación ICRS;
- lesiones de grado IV según la clasificación de Outerbridge;
- lesiones en etapa temprana de osteoartritis (OA temprana según la definición de Luyten, Knee Surg Sports Traumatol Arthrosc., 2012) y lesiones de grado I y II según la clasificación de Kellgren y Lawrence, en ausencia de osteofitos.

MaioRegen Chondro+: .Tratamiento de lesiones del cartilago con alteración leve o nula del hueso subcondral, como:

- Lesiones traumáticas y postraumáticas de grado III según la clasificación ICRS y de grado III-IV según la clasificación de Outerbridge.

Contra indicaciones: No utilice el dispositivo en caso de:

- alergia establecida al colágeno equino y a las sales de fosfato cálcico;
- edad menor de 15 años y mayor de 60 años;
- obesidad (Índice de masa corporal: IMC > 30);
- lesiones condrales u osteocondrales con un área total superior a 10 cm2 por articulación tratada;
- lesiones en espejo;
- osteoartritis avanzada;
- infección sistémica o localizada;
- enfermedades inflamatorias sistémicas (por ejemplo, artritis reumatoide) o locales (por ejemplo, sinovitis);
- hipercalcemia;
- enfermedad ósea degenerativa sistémica o vascular (por ejemplo, osteonecrosis);
- trastornos de la coagulación o condiciones que impiden la curación;
- trastornos metabólicos que pueden afectar la reparación del tejido esquelético;
- trastornos del sistema inmunológico que pueden comprometer la reparación del tejido esquelético;
- tratamiento de quimioterapia y/o radioterapia en curso.

Envasado: Sistema de barrera estéril además de embalaje protector por fuera, esterilizado mediante rayos gamma

Medidas caja: 15 x 11 x 3,7 cm

Peso: 92gr / caja

Conservación y Almacenamiento: Almacenamiento en condiciones estándar de higiene sanitaria. Proteger de la contaminación. Mantener en temperatura entre 10°C y 30°C

Garantía de calidad: CE 0373 // ISO 9001:2015 // ISO 13485:2016

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ANEXO I: Referencias de Producto MaioRegen

Listado Modelos de Producto:			
MAIOREGEN			
REFERENCIA	DESCRIPCIÓN	UDI	FABRICANTE
01600286	MaioRegen Prime 3,0 x 4,0 x 0,6 cm	18054188160970	Fin-ceramica Faenza S.p.A.
01600288	MaioRegen Prime 2,0 x 3,0 x 0,6 cm	18054188161007	Fin-ceramica Faenza S.p.A.
01600275	MaioRegen Prime Ø = 1,5 cm H = 0,6 cm	18054188161236	Fin-ceramica Faenza S.p.A.
01600285	MaioRegen Prime Ø = 1,2 cm H = 0,6 cm	18054188160963	Fin-ceramica Faenza S.p.A.
01600291	MaioRegen Prime Ø = 1,8 cm H = 0,6 cm	18054188161069	Fin-ceramica Faenza S.p.A.
01600287	MaioRegen Slim 3,0 x 4,0 x 0,4 cm	18054188160987	Fin-ceramica Faenza S.p.A.
01600289	MaioRegen Slim 2,0 x 3,0 x 0,4 cm	18054188161014	Fin-ceramica Faenza S.p.A.
01600282	MaioRegen Slim Ø = 1,5 cm H = 0,4 cm	18054188161311	Fin-ceramica Faenza S.p.A.
01600290	MaioRegen Slim Ø = 1,2 cm H = 0,4 cm	18054188161045	Fin-ceramica Faenza S.p.A.
01600292	MaioRegen Slim Ø = 1,8 cm H = 0,4 cm	18054188161076	Fin-ceramica Faenza S.p.A.
01600400	MaioRegen Chondro+ 3,0 x 4,0 x 0,2 cm	18054188160994	Fin-ceramica Faenza S.p.A.
01600401	MaioRegen Chondro+ 2,0 x 3,0 x 0,2 cm	18054188161021	Fin-ceramica Faenza S.p.A.
01600403	MaioRegen Chondro+ Ø = 1,2 cm H = 0,2 cm	18054188161052	Fin-ceramica Faenza S.p.A.
01600404	MaioRegen Chondro+ Ø = 1,8 cm H = 0,2 cm	18054188161083	Fin-ceramica Faenza S.p.A.
01600405	MaioRegen Chondro+ Ø = 1,5 cm H = 0,2 cm	18054188161090	Fin-ceramica Faenza S.p.A.

Cell-Free Biomimetic Osteochondral Scaffold for the Treatment of Knee Lesions

Clinical and Imaging Results at 10-Year Follow-up

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Background: Cell-free devices have been introduced to restore osteochondral defects, avoiding the limitations of cell-based procedures. Among these, an osteochondral scaffold made of type I collagen and hydroxyapatite has been investigated with promising results up to medium-term follow-up. However, the clinical and imaging results over time still need to be documented.

Purpose: To evaluate the clinical outcome and tissue maturation at long-term follow-up after the implantation of the osteochondral scaffold.

Study Design: Case series; Level of evidence, 4.

Methods: A total of 24 patients (7 women, 17 men; age, 36 ± 9.5 years) underwent surgical implantation of the osteochondral scaffold and were prospectively evaluated before surgery, at 2-, 5-, and 10-year follow-up. The mean defect size was 2.9 ± 1.4 cm². Patients were evaluated using the International Knee Documentation Committee (IKDC) subjective and objective scores, and the activity level was documented with the Tegner score. Magnetic resonance imaging (MRI) evaluation involved the use of the magnetic resonance observation of cartilage repair tissue score combined with 5 more variables focused on the bone layer.

Results: A statistically significant improvement of all clinical scores was documented from the baseline to the final evaluation. The IKDC subjective score improved from the preoperative level to 2 years (41 ± 13.2 and 77.1 ± 14.6 , respectively) ($P < .0005$), with stable results up to 10 years (77.4 ± 19.4). The IKDC objective score changed from 52% of normal and nearly normal knees before the treatment to 84% at 10 years ($P < .0005$). Tegner sports activity at the final evaluation (3.8 ± 1.7) was higher compared with the preoperative level (1.6 ± 1.1 ; $P < .05$), but it remained significantly lower compared with the preinjury level (5.5 ± 2.6 ; $P < .05$). Treatment failed in 1 patient. Persisting graft alterations were observed on MRI scans, although without correlating with the clinical outcome.

Conclusion: The regenerative potential of this scaffold is limited, as demonstrated by the signal alterations persisting over time on MRI scans. On the other hand, the clinical improvement was significant and stable over time both in terms of subjective and objective outcomes, including activity level, with overall good results.

Keywords: knee; cartilage; osteochondral scaffold; long term

Lesions of articular knee cartilage have poor self-healing capacity and can lead to persistent symptoms and impaired joint function. Moreover, if left untreated, they can further degenerate and lead to osteoarthritis.^{23,32} Several surgical techniques have been developed to address these lesions, although there is no agreement about the best option.^{7,14,17} In this context, there is an increased awareness of the role of subchondral bone in the pathogenetic process of articular surface lesions and, therefore, on the possibility of restoring any damaged osteochondral tissue as a single anatomic and functional unit. Several studies showed poorer results and

higher failure rates when chondral restoration was performed in the presence of subchondral bone changes,^{12,25} supporting the need for osteochondral solutions.

Different options are available to address osteochondral defects, including osteochondral autograft transplantation,¹⁵ fresh osteochondral allograft,^{4,36} and autologous chondrocyte implantation (ACI) techniques with bone augmentation.^{26,27} However, all these approaches present some drawbacks: those involving the transfer of autologous tissue can have a certain degree of donor-site morbidity, which mainly limits their use to small defects. Osteochondral allograft is an effective option for larger size defects, but they have limited availability in most countries. ACI/matrix-associated autologous chondrocyte transplantation (MACT) techniques require a 2-step surgery, with related higher costs and morbidity. For these reasons, cell-free

A multilayer biomaterial for osteochondral regeneration shows superiority vs microfractures for the treatment of osteochondral lesions in a multicentre randomized trial at 2 years

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Abstract

Purpose The increasing awareness on the role of subchondral bone in the etiopathology of articular surface lesions led to the development of osteochondral scaffolds. While safety and promising results have been suggested, there are no trials proving the real potential of the osteochondral regenerative approach. Aim was to assess the benefit provided by a nanostructured collagen–hydroxyapatite (coll-HA) multilayer scaffold for the treatment of chondral and osteochondral knee lesions.

Elizaveta Kon and Giuseppe Filardo: these authors equally contributed to this manuscript.

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Methods In this multicentre randomized controlled clinical trial, 100 patients affected by symptomatic chondral and osteochondral lesions were treated and evaluated for up to 2 years (51 study group and 49 control group). A biomimetic coll-HA scaffold was studied, and bone marrow stimulation (BMS) was used as reference intervention. Primary efficacy measurement was IKDC subjective score at 2 years. Secondary efficacy measurements were: KOOS, IKDC Knee Examination Form, Tegner and VAS Pain scores evaluated at 6, 12 and 24 months. Tissue regeneration was evaluated with MRI MOCART scoring system at 6, 12 and 24 months. An external independent agency was involved to ensure data correctness and objectiveness.

Results A statistically significant improvement of all clinical scores was obtained from basal evaluation to 2-year follow-up in both groups, although no overall statistically

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Multilayered biomimetic scaffolds for cartilage repair of the talus. A systematic review of the literature

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ABSTRACT

Objective: The aim of the present review was to analyze the available evidence in the literature on the clinical and radiological outcomes of multilayered biomimetic scaffolds in the treatment of osteochondral lesions of the talus (OLTs).

Design: A systematic search was performed in three databases to identify clinical trials, where the multilayered biomimetic scaffolds were used for the treatment of OLTs. The PRISMA guidelines were followed. Qualitative analysis of the relevant data of the included studies was executed. The methodological quality of the analyzed studies was assessed with a modified Coleman Methodology Score (CMS).

Results: A total of 10 studies with 87 patients were included in the analysis. Only three multilayered biomimetic scaffolds have been investigated in clinical trials for the treatment of OLTs. The worst clinical and radiological outcomes, as well as safety profile were observed for the TruFit scaffold (Smith & Nephew, Andover, MA, USA), which had already been withdrawn from the market. The other two scaffolds (MaioRegen, Fincera, Italy; Agili-C, CartiHeal, Israel) performed significantly better in the majority of the reviewed studies, especially in the clinical aspect. The radiological findings, the improvements of MOCART scores, the completeness of lesions' fill, and the structure of regenerated tissue were much more inconsistent.

Conclusions: Two of the multilayered biomimetic scaffolds demonstrated an adequate potential in the treatment of complex OLTs. However, limited studies availability and their low level of medical evidence request further high-level investigations before the clinical decision making for such scaffolds in the treatment of OLTs can be defined.

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Contents

1. Introduction	1
2. Methods	2
3. Results	3
4. Discussion	3
Funding	6
Declarations of interest	6
References	6

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1. Introduction

Approximate daily incidence of ankle injuries is 1 in 10,000 people [1]. Osteochondral lesions of the talus (OLTs) occur in up to

Clinical Results and MRI Evolution of a Nano-Composite Multilayered Biomaterial for Osteochondral Regeneration at 5 Years

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Investigation performed at the Rizzoli Orthopaedic Institute, Bologna, Italy

Background: Several cartilage lesions involve the subchondral bone, and there is a need for biphasic scaffolds to treat the entire osteochondral unit to reproduce the different biological and functional requirements and guide the growth of the 2 tissues.

Purpose: To evaluate the results of a cell-free collagen-hydroxyapatite osteochondral scaffold at midterm, and to use magnetic resonance imaging (MRI) analysis to document the imaging evolution of the tissue regeneration process through 5 years of follow-up.

Study Design: Case series; Level of evidence, 4.

Methods: Twenty-seven patients (9 women, 18 men; mean age, 34.9 ± 10.2 years) treated for knee chondral or osteochondral lesions (size, $1.5\text{--}6\text{ cm}^2$) were followed for 2 and 5 years and were clinically evaluated using the International Knee Documentation Committee (IKDC) and Tegner scores. An MRI evaluation was performed at both follow-ups in 23 lesions, and the magnetic resonance observation of cartilage repair tissue (MOCART) score and specific subchondral bone parameters (bone regeneration, bone signal quality, osteophytes or upcoming bone front, sclerotic areas, and edema) were analyzed.

Results: A statistically significant improvement in all clinical scores was observed from the initial evaluation to the 2- and 5-year follow-ups, and the results were stable over time. The mean IKDC subjective score improved from 40.0 ± 15.0 to 76.5 ± 14.5 (2-year follow-up) and 77.1 ± 18.0 (5-year follow-up) and the mean Tegner score from 1.6 ± 1.1 to 4.0 ± 1.8 (2-year follow-up) and 4.1 ± 1.9 (5-year follow-up). The MRI evaluation showed a significant improvement in both the MOCART score and subchondral bone status from 2 to 5 years. At 5 years, complete filling of the cartilage was shown in 78.3% of the lesions, complete integration of the graft was detected in 69.6% of cases, the repair tissue surface was intact in 60.9%, and the structure of the repair tissue was homogeneous in 60.9% of the cases. No correlation was found between MRI findings and clinical outcome.

Conclusion: This osteochondral scaffold was used for the treatment of chondral and osteochondral knee defects with a single-step procedure. The study results highlighted the safety and potential of this procedure, which offered a good clinical outcome with stable results at midterm follow-up. Although the MRI findings improved over time, some abnormalities persisted, but no correlation was found between the imaging and clinical results.

Keywords: knee; articular cartilage; articular cartilage resurfacing; magnetic resonance imaging; osteochondral scaffold

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The possibility of treating defects of the articular surface in which tissue damage is extended also to the subchondral bone, involving 2 different tissues characterized by different intrinsic healing capacities, is very attractive. Several cartilage lesions are in fact osteochondral: some primary, such as osteochondritis dissecans (OCD), osteonecrosis, or traumatic osteochondral lesions, and others secondary, such as chronic or large chondral lesions in which the underlying subchondral bone plate presents concomitant changes of either overgrowth or bone loss.^{12,30}

The need for biphasic scaffolds for the treatment of the osteochondral unit, to reproduce the different biological and functional requirements and guide the growth of the 2 tissues, has been highlighted by several authors.[§]

[§]References 9, 10, 14, 16, 22, 23, 25, 33, 35.

■ KNEE

Treatment of osteochondral lesions in the knee using a cell-free scaffold

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The treatment of osteochondral lesions is of great interest to orthopaedic surgeons because most lesions do not heal spontaneously. We present the short-term clinical outcome and MRI findings of a cell-free scaffold used for the treatment of these lesions in the knee. A total of 38 patients were prospectively evaluated clinically for two years following treatment with an osteochondral nanostructured biomimetic scaffold. There were 23 men and 15 women; the mean age of the patients was 30.5 years (15 to 64). Clinical outcome was assessed using the Knee Injury and Osteoarthritis Outcome Score (KOOS), the Tegner activity scale and a Visual Analogue scale for pain. MRI data were analysed based on the Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) scoring system at three, 12 and 24 months post-operatively. There was a continuous significant clinical improvement after surgery. In two patients, the scaffold treatment failed (5.3%). There was a statistically significant improvement in the MOCART percentage scores. The repair tissue filled most of the defect sufficiently. We found subchondral laminar changes in all patients. Intralesional osteophytes were found in two patients (5.3%). We conclude that this one-step scaffold-based technique can be used for osteochondral repair. The surgical technique is straightforward, and the clinical results are promising. The MRI aspects of the repair tissue continue to evolve during the first two years after surgery. However, the subchondral laminar and bone changes are a concern.

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The treatment of osteochondral lesions is of great interest to orthopaedic surgeons because most lesions do not heal spontaneously, and they may predispose the joint to the development of secondary osteoarthritis (OA).¹ Various surgical techniques have been developed in an attempt to deal with the poor capacity of articular cartilage to repair.² Several procedures which aid the recruitment of bone marrow cells have been used to treat local cartilage defects. In this type of procedure, mesenchymal stem cells (MSCs) migrate in the fibrin network of the blood clot.³ However, the clot is not stable enough to withstand tangential forces.⁴

The most frequently used procedure is the microfracture technique, including abrading the tidemark and creating small holes perpendicular to the subchondral bone plate to allow bleeding into the defect.⁵ This usually results in the formation of unstructured fibrous fibrohyaline repair tissue which lacks the biomechanical and viscoelastic features of hyaline cartilage. The potential short-term symptomatic improvement is usually followed by failure of the repair tissue and potentially by a gradual progression to OA.⁶

Since 1987, autologous chondrocytes have been implanted in chondral lesions of the human knee.⁷ To this end, cartilage is harvested from a non-weight-bearing area of the joint, such as the intercondylar notch or the edge of the trochlea. It is then digested, and the isolated chondrocytes are propagated *in vitro* in monolayer culture conditions. This procedure was proposed by Brittberg et al⁷ in 1994 and called autologous chondrocyte implantation (ACI). It has gained wide support for the repair of focal articular cartilage lesions.⁸ However, during *in vitro* propagation of the chondrocytes dedifferentiation of the cells can occur, and these fibroblast-like chondrocytes subsequently show different biosynthetic properties from the original cartilage cells in the knee joint.⁹ Further, autologous chondrocyte implantation is not universally successful.¹⁰

Recently, there has been interest in the role of subchondral bone in cartilage repair. Careful consideration of subchondral bone in the treatment of articular surface damage is required when evaluating the results over time. The articular cartilage and its supporting bone should be viewed as a single osteochondral

Arthroscopic Implantation of a Cell-Free Bilayer Scaffold for the Treatment of Knee Chondral Lesions: A 2-Year Prospective Study

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Abstract

Objective. The main objective of this study is to assess the safety and clinical efficacy of a cell-free bilayer scaffold (MaioRegen Chondro+ by Fin-Ceramica) in patients affected by chondral knee lesions of different origin and localization. **Design.** Thirty-one patients with focal chondral lesions of the knee were arthroscopically treated with MaioRegen Chondro+. All patients were prospectively evaluated for a minimum of 2 years using the International Knee Documentation Committee (IKDC) Questionnaire and the Tegner Activity Scale. Cartilage repair was assessed based on the Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) 2.0 score at 12 months. Follow-up at 36 months was available for 25 out of 31 patients. **Results.** From baseline to 6-, 12-, and 24-month follow-up, IKDC score significantly improved by 19.5 ± 7.27 (95% confidence interval [CI]: 16.9–22.2, $P < 0.001$), 30.8 ± 7.63 (95% CI: 28.0–33.6, $P < 0.001$), and 36.2 ± 8.00 points (95% CI: 33.3–39.2, $P < 0.001$), respectively. Tegner scores documented a substantial clinical improvement as early as 12 months after surgery (change of -0.6 ± 0.62 ; 95% CI: -0.8 to -0.4 , $P < 0.001$), reaching the preinjury values. There was a statistically significant increase in the MOCART scores ($P < 0.001$). Comparable results were observed regardless of preintervention demographic characteristics, lesion site or etiology, or the number of treated sites. Notably, the significant clinical benefit was maintained in a subset of patients who reached 3-year follow-up. No adverse events were reported in the entire analyzed population. **Conclusion.** MaioRegen Chondro+ is a safe and effective device for the treatment of knee chondral lesions, enabling a significant clinical improvement for at least 2 years.

Keywords

articular cartilage, knee, cartilage regeneration, cartilage repair, cell-free bilayer scaffold

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