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The Classic

Review of K.H. Pridie (1959) on "A method of resurfacing osteoarthritic knee joints"

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ABSTRACT

This classic discusses the original publication "A method of resurfacing osteoarthritic knee joints" by Dr K.H. Pridie (1959), where this pioneer surgeon described a newly developed method for the treatment of osteoarthritic joint surfaces of the knee, which he named subchondral drilling. This short and concise 11-line publication appeared in the Proceedings of the Congress of the British Orthopaedic Association. It has generated 464 citations since 1959, becoming part of the hundred most-cited publications in knee research. Pridie introduced in clinical experimentation the entity of *Marrow Stimulation Techniques* to liberate mesenchymal stem cells from cancellous bone. He was aware that the results induced, in terms of quality of the regrown tissue, was limited and "only" fibrocartilage. His idea might have been raised from the work of numerous animal researchers who confirmed repeatedly since 1905 that cartilage needed an osseous perforation to heal. Although the past 60 years brought modifications from the technique described in the original article, the concept of marrow stimulation introduced by Pridie remains the most frequently used in cartilage repair surgery today.

Introduction

It is 62 years that have passed since during the Congress of the BOA (British Orthopaedic Association), a British clinician and previous sportsman, K.H. Pridie (Fig. 1) [1], brought a personal study to the attention of British Orthopaedic surgeons dealing with his own clinical experience on a newly developed method for the treatment of osteoarthritic joint surfaces of the knee, which he named subchondral drilling, and which then appeared in the Proceedings of this meeting (Fig. 2) [2]. He had performed this clinical gesture associated with joint debridement based on a continuation of the work of previous authors like Magnuson [3].

Consideration

Historical perspective

Keen to find out when Pridie started to develop the drilling technique, we came across the story of a colleague of Pridie, Bruno Isserlin, 1912, a German, 6 years younger than K. Pridie (1906) who had started his medical study in Berlin in 1931 and because of Jewish origin he had been ex-matriculated a few days after the national socialists or the Nazis came into power January 30, 1933. He then escaped to Switzerland to continue medicine, but 1 year later, he left for England to finish his medical study. We must assume that he went into Orthopaedics in Bristol at the same hospitals in which Pridie was working. Isserlin wrote a paper in 1950 [4] for which Pridie had allowed him to use his clinical material on the Magnuson debridement in osteoarthritic knees operated on by Pridie himself. However, in this paper, we did not yet find any mentioning of "drilling." We must therefore assume that Pridie had developed the drilling technique only during the following 10 years.

Pridie, in his noticeably short article from 1959, says: "*If these sclerotic areas were drilled and the holes were not too far apart, smooth fibro-cartilage would spread over the surface*." This key sentence shows two things. First, he left the reader unsure regarding the size of the drill bit, but he was keen at maintaining the distance not too far between the drill holes. The senior author thinking back to his early clinical years remembers that because of the inability to reach the author in the early 70s (only later we had found out that he had already passed away in 1963), we adopted his method even in naked patellae and sometimes we would use too big drill bits (4.5 mm), which forced to respect greater hole distances. Here, we must mention the article from 1967 dealing as well with Pridie's material

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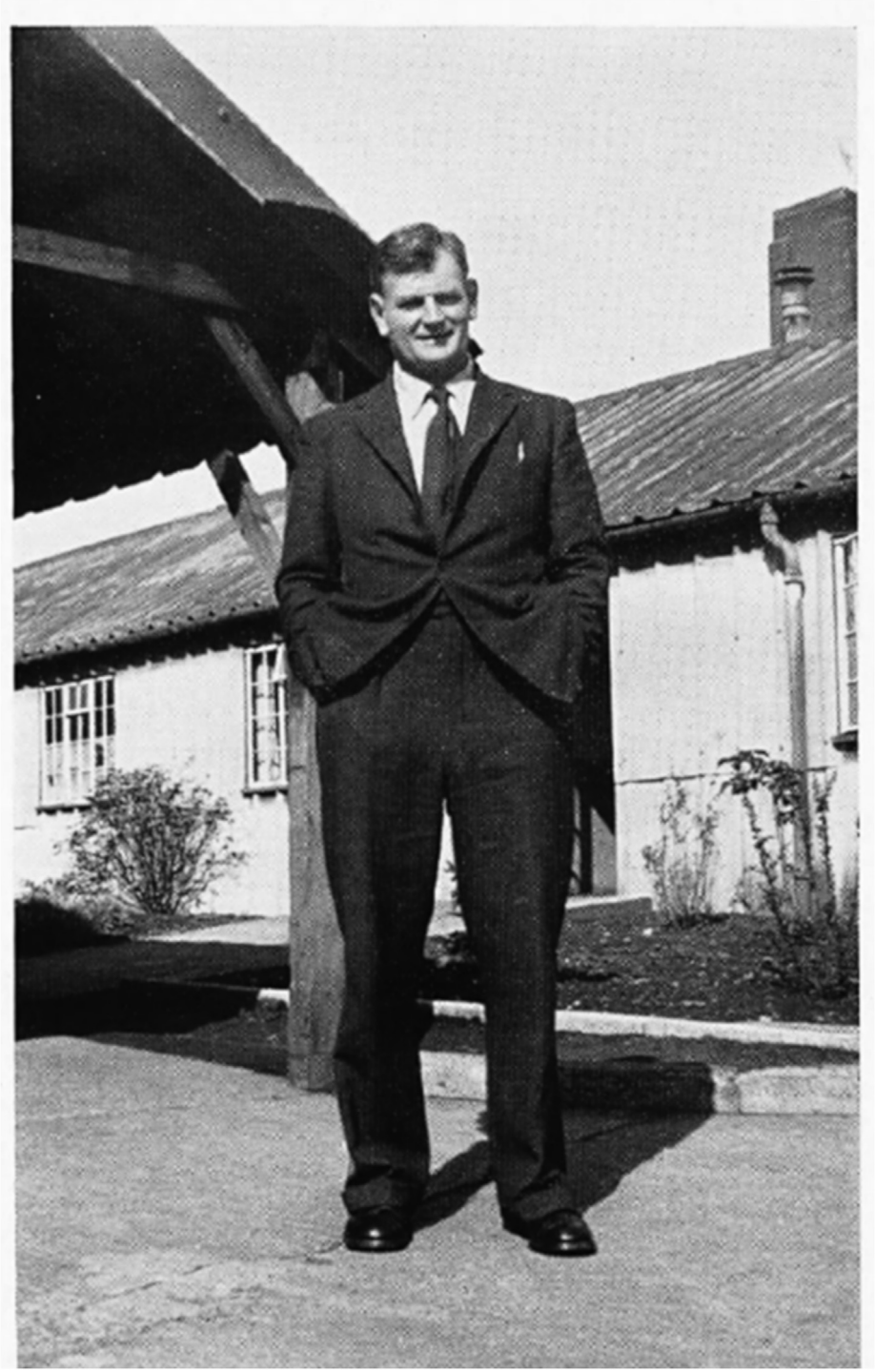


Fig. 1. Picture of Kenneth Hampden Pridie (1906–1962) at Winford Orthopaedic Hospital (built 1930 - closed 1996), 9 miles away from Bristol. From "Eyre-Brook AL. Kenneth Pridie: an appreciation. Bristol medico-chirurgical journal" (1965) [1].

in which Insall [5,6] stated that he had modified the drilling technique then using a quarter-inch drill bit, which corresponds to 6.35 mm and which is bigger than Pridie probably had suggested. Unfortunately, Pridie did not let us know the diameter he used. But reading the Lecture written to his honour 1 year after his death by Mr. Eyre-Brook [1] whom we only came across when preparing this article, we guessed from the picture of the exposed condyle (Fig. 3) that it was most likely a drill bit not smaller than 3.5 mm that he used and with which he was able to get the type of biological resurfacing depicted in this intraoperative photograph with a continuous fibrocartilage layer. But it was much later that we learnt to preferably use smaller drill bits with the holes set closer to each other, also influenced by or in analogy to Steadman [7].

Second, Pridie was aware that the results induced, in terms of quality of the regrown tissue, was limited and "only" fibrocartilage. He had analysed macroscopically and microscopically four knee joints in which the clinical result was unsatisfactory and which he had to reexplore later for fusion, and he still found a fine layer of fibrocartilage and postulated that in those in which the clinical result was favorable, the lineage and coverage of the treated surfaces would supposedly be better. But this remained a hypothesis, yet to prove. Although diagnostic knee

The Classic: original publication

In 1959, this short and concise 11-line publication introduced in clinical experimentation the entity of Marrow Stimulation Techniques for cartilage repair.

PROCEEDINGS AND REPORTS OF COUNCILS AND ASSOCIATIONS

A method of resurfacing osteoarthritic knee joints—*Mr K. H. Pridie* (Bristol) had noticed that, after extensive " debridement " of knee joints in the manner described by Magnuson, the raw areas of bone became covered with smooth fibro-cartilage. Examination of serial sections of joints suggested that the articular cartilage derived its nutrition from the cancellous bone deep to it. When this subchondral bone became sclerotic the cartilage necrosed and the bare bone was exposed. If these sclerotic bone areas were drilled and the holes were not too far apart, smooth fibro-cartilage would spread over the surface. Four knee joints which were subsequently re-explored showed this to have happened, and it was emphasised that these four were explored only because they presented the worst results; the others must have been even better. *Mr G. Gordon* (Whitehaven) said that osteotomy to correct varus or valgus produced benefit because it increased the vascularity. *Mr Pridie* agreed that osteotomy was sometimes helpful.

THE JOURNAL OF BONE AND JOINT SURGERY

Fig. 2. Original publication of Kenneth Pridie, orthopaedic surgeon at Bristol Royal Infirmary and Winford Orthopaedic Hospital on "A method of resurfacing osteoarthritic knee joints" (1959) [2].

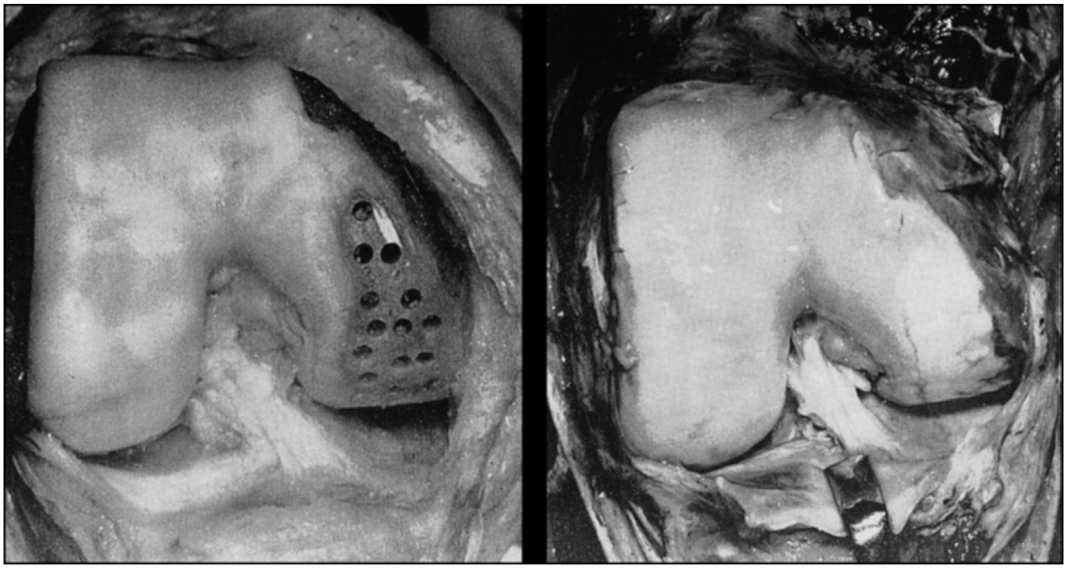


Fig. 3. Original photographic record collected by Pridie in a knee, which failed to give a good result and therefore allowed of inspection at a subsequent operation 1 year later, from "Eyre-Brook AL. Kenneth Pridie: an appreciation. Bristol medico-chirurgical journal" (1965) [1]. "*The osteophytic ridging was removed and the affected cartilage was shaved away. […] The drilling through the sclerotic subchondral bone reaches the vascular cancellous bone and was designed to allow vascular tissue to come to the surface. […] Immobilization for 10 days was followed by mobilizing physiotherapy and probably a manipulation would be needed 4 to 6 weeks after the operation, to assist in getting movements back in the knee*".

arthroscopy had been experimentally introduced 50 years prior, it was just 1 year before Pridie's death in 1962 that Watanabe in Japan had performed the first arthroscopic meniscectomy [8]. But arthroscopy yet had to arrive and being spread in Europe and North America and the world.

This short and concise, call it publication in the form of 11-line note, remained his only one, we know why. He passed away 4 years later in 1963 after a longstanding heart disease at the age of only 57 years although having been an eager sportsman all his life. He died during a conference while giving a paper on anterior spinal fusion. In his obituary [9–11] (with the initials A.L.E-B., corresponding to Mr. Eyre-Brook) we read: *"His forte was originality. His fertile brain was ever seeing problems from a somewhat novel angle, tackling them more energetically than was the former practice and as a rule with great success. He was a man full of ideas and enthusiasm. Rarely set in his ideas, he reveled in new conceptions, sometimes following them with a somewhat uncritical fervor-he was always willing to try things out. He loved the orthopaedic debate, and the meetings were enlivened by his frequent interventions. His contributions to the literature were more frequent in discussion than in straight papers. He often failed to record and collect adequate material fully to establish his claims and tended to move to fresh fields before the former pastures were fully cropped. He was more interested in*

treatment than in diagnosis, and fractures and osteoarthritis of the hip and knee were always his main interests, fields in which he made important and often striking contributions. He was a discus and hammer thrower and weight putter with international profile. He retained a great humility and a sense of humor."

Understanding the rise of the idea

But how was the scientific evidence that what he started to do would in fact have the potential to work? When studying this classic article, we raised the question how Pridie got motivated to start with the drilling technique, if it was born 1 day out of a somewhat frustrating experience with the many Magnuson's debridement cases operated upon during his clinical career? Or had he read about somewhere or heard of the drilling at some place? The fact that he did not engage in much or any writing himself would not have automatically meant that he did not read recent or older literature (Fig. 4). Here, we can only speculate, unable to ask those who were together with him or following him. He was a scientific person in the sense that he cared for prospective documentation of his cases that allowed Isserlin (1950) (4), Eyre-Brook (1965), and later Insall (1967) [5] to rely on his work in their publications.

If we try to put ourselves in his skin and browse through contemporary or passed writings of his time in the field, we come across an interesting article by Shands [12], 1931 mind, there was a war between. Shands collected all the science of animal work and experimentation done before him on cartilage repair, and he states: "*Before the work of Redfern in 1851, it was thought that hyaline cartilage possessed little or no power of regeneration. Since that time, the experimental studies on hyaline cartilage have shown that it possesses this property, but the investigators cannot agree as to the exact method by which it is brought about.*" Redfern [13] stated that healing originated from the intercellular substance and nuclear fibres **(**Fig. 5**).**

And with this statement of Shands, the discussion was opened. It was courageous for his time and questioned later. But his publication is worth studying, if already to satisfy one's interest in the initial history of cartilage repair. While in the publications of our past 20 years, this part is usually cut short, and we limit ourselves with referencing only to the quote of Hunter, and this is even more the case when presenting a paper at a meeting. Hunter published an article in 1743 [14,15], "Of the structure and disease of articulating cartilages" (Fig. 6), in which he said that "*ulcerated cartilage is a troublesome disease*" and "*once destroyed it nerver recovered.*" It was in this article that the *circulus articuli vasculosus*, or the vascular border of the joint, was first described.

If we want to search deeper, we may come across the interesting piece of experimental work in the early period of Gussenbauer [16], 1871, who was an assistant at "Chirurgische Klinik of Prof. Billroth in Wien" and who published a treatise "Ueber die Heilung per primam intentionem." Even if he already mentioned in this manuscript that "Wounds of the cartilage in which the bone was not broken did not heal," he did not show clearly a role of subchondral bone in cartilage healing. Shands [12] in his overview on the history of experimental, animal work studies quotes the work of numerous early cartilage animal researchers who confirmed repeatedly that it needed an osseous perforation to heal cartilage. Table 1 shows accumulation of repetitive early knowledge regarding the potential of subchondral bone to close and fill up cartilage wounds and defects without qualifying the type of tissue developing within these lesions.

Before World War I, most of the work [17–19] on regeneration of cartilage was initially undertaken on elastic, nonhyaline cartilage (ear, costal) and suggested healing from the perichondrium. In 1905, Fasoli [20] and Rimann [21] suggested for the first time that wounds in hyaline cartilage that reached the underlying bone might have the potential to heal. It is only after World War I, Ciociola [22] presented the first animal study in dogs comparing wounds of hyaline cartilage extending to the underlying bone to tangentially placed superficial wounds **(Fig. 7)** in dogs. This study, performed one century ago (1921), concluded to a healing to hyaline cartilage at 2 months when the subchondral bone was involved. In 1924, Ito [23] confirmed that exposition of the underlying cancellous bone promoted cartilage repair. In 1925, Haebler [24] recognised that the cartilage defect became filled with fibrous tissue.

Shands, 1931, in his own experiments, for the first time to our knowledge, uses a 5 mm burr to drill deep and to prove that the greatest amount of regeneration, however, is seen in those deep defects, which do involve the subchondral bone. "The defects in the cartilage were made either with a 5 mm burr through to the subchondral bone or with a scalpel."

Shands [12] reported the following sequence of events in repair of full-thickness cartilage defects: (1) fibrin;, (2) granulation tissue;, (3) connective tissue;, (4) cartilage cells in connective tissue (connective tissue cartilage); (5) fibrocartilage, and (6) new hyaline cartilage: "*In these regenerative changes the following tissues have been observed to appear: first, fibrin; second, granulation tissue; third, connective tissue; fourth, cartilage cells in connective tissue (connective tissue cartilage); fifth, fibrocartilage, and sixth, new hyaline cartilage. Regeneration of hyaline cartilage has been found in superficial defects not involving the subchondral bone. The greatest amount of regeneration, however, is seen in those deep defects which do involve the subchondral bone*" (Original publication of Alfred Rives Shands [1899–1981], orthopaedic surgeon at Duke University, Durham, NC. "The regeneration of hyaline cartilage in joints: an experimental study" [1931]).

De Palma's (1966) [25] autoradiographic studies of full-thickness defects in mongrels, appeared after Pridie's death, confirmed that sequence of events and demonstrated that the major proliferative activity is initially

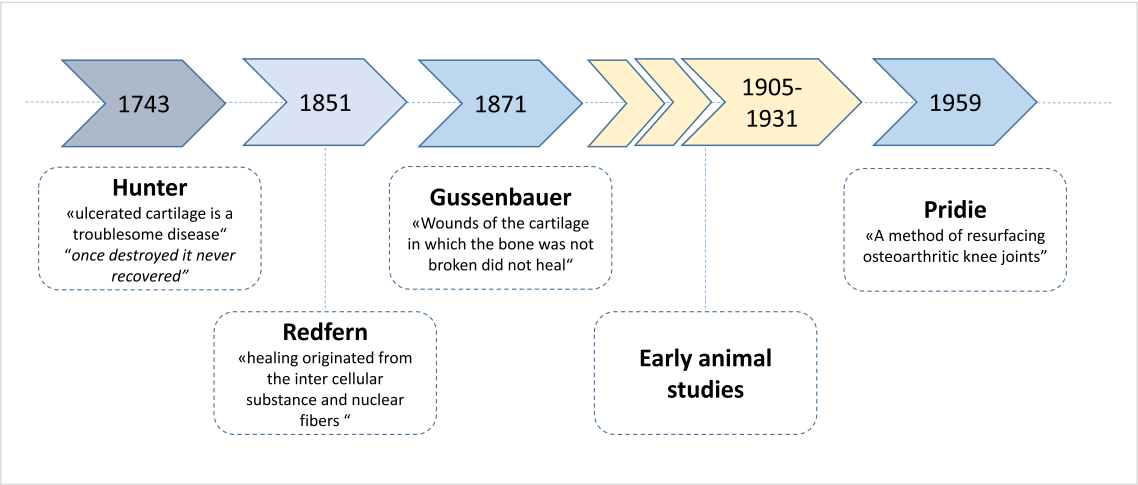
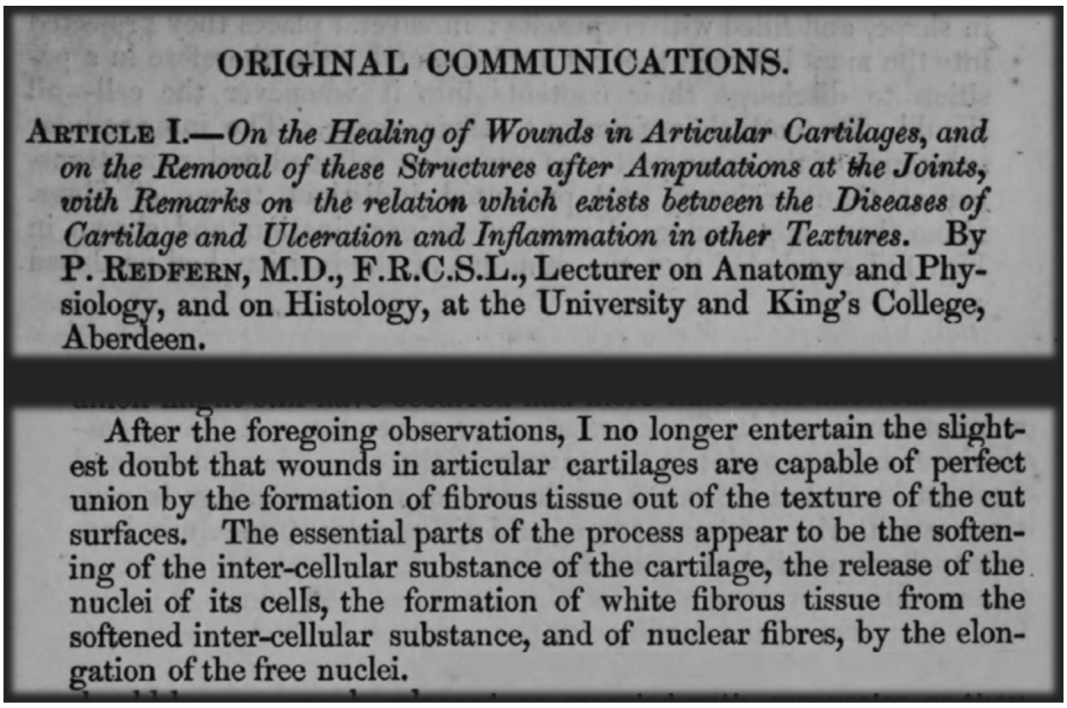


Fig. 4. Diagram picturing the historical landmarks that raised the idea for cartilage healing from bone marrow stimulation. Even if Gussenbauer suggested in 1871 that "Wounds of the cartilage in which the bone was not broken did not heal," he believed that only the periphery of cartilage could heal from perichondrium. It is only at the beginning of the 20th century, that animal studies, detailed in Table 1, were performed and proved a role of the subchondral bone in hyaline cartilage healing.

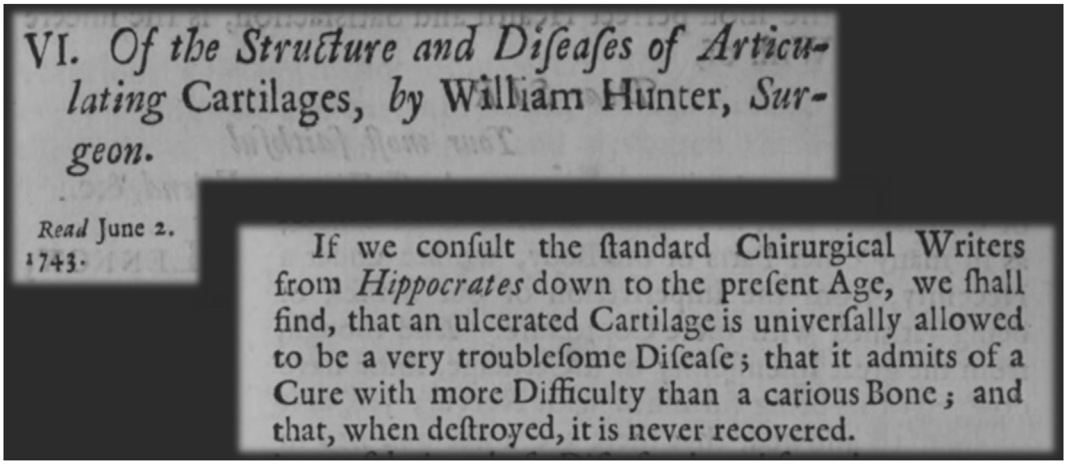


ORIGINAL COMMUNICATIONS.

ARTICLE I.—*On the Healing of Wounds in Articular Cartilages, and on the Removal of these Structures after Amputations at the Joints, with Remarks on the relation which exists between the Diseases of Cartilage and Ulceration and Inflammation in other Textures.* By P. REDFERN, M.D., F.R.C.S.L., Lecturer on Anatomy and Physiology, and on Histology, at the University and King's College, Aberdeen.

After the foregoing observations, I no longer entertain the slightest doubt that wounds in articular cartilages are capable of perfect union by the formation of fibrous tissue out of the texture of the cut surfaces. The essential parts of the process appear to be the softening of the inter-cellular substance of the cartilage, the release of the nuclei of its cells, the formation of white fibrous tissue from the softened inter-cellular substance, and of nuclear fibres, by the elongation of the free nuclei.

Fig. 5. Original publication of Peter Redfern (1821–1912), British anatomist and joint pathologist, "On the Healing of Wounds in Articular Cartilages" (1851) [13]. Redfern stated that cartilage healing originated from the intercellular substance and nuclear fibres.



VI. *Of the Structure and Diſeaſes of Articulating* Cartilages, *by* William Hunter, *Surgeon.*

Read June 2. 1743.

If we conſult the ſtandard Chirurgical Writers from *Hippocrates* down to the preſent Age, we ſhall find, that an ulcerated Cartilage is univerſally allowed to be a very troubleſome Diſeaſe; that it admits of a Cure with more Difficulty than a carious Bone; and that, when deſtroyed, it is never recovered.

Fig. 6. Original publication of William Hunter, Scottish anatomist, and obstetrician (1718–1783), "Of the structure and disease of articulating cartilages" (1743) [15]. Hunter stated that once cartilage was destroyed, it never recovered.

in the subchondral marrow spaces adjacent to the defect. Subsequent proliferation fills the defect with fibrous tissue, and new cartilage appears to develop through the stages of fibrous tissue metaplasia.

Has Kenneth Pridie been aware of that literature when he developed his idea of drilling deep into bone? Why did he select the most difficult situation, e.g., osteoarthrosis to start with and not tackle less important, singular cartilage lesions? Probably just for the simple reason that those isolated lesions were hidden to the eye of the clinician on plain radiographs, with arthroscopy not yet being available.

Another clinical pearl and proposed technique of which we were unaware until today we learn when immersing yourself in the reading of the First Kenneth Pridie Memorial and Honorary Lecture by Mr. A. L. Eyre-Brook, from 1960, which he named "An Appreciation"(1). He tells us that "*Pridie after the war got interested in that Cinderella called Osteoarthritis. With maturing experience, he had developed a very successful procedure by the time of his premature death. Synovectomy, part of the debridement, was done less regularly, and more attention was given to the femoral condyles with their eburnated surfaces and dense underlying bone. These surfaces were drilled so as to bring vascular tissue to the ischaemic sclerotic surfaces. Later, the drilling was extended to the tibial plateaux*." But at first, he collected experience in the topic of osteochondritis dissecans. We continue to quote Eyre-Brook: "*First, a passing reference to his treatment of the larger lesions of osteochondritis dissecans, where the replacement technique advocated by Mr. Smillie is not applicable because of the size and fragmentation of the lesion. Mr. Pridie would remove the sclerotic wall of the lesion down to healthy bleeding bone, fill the cavity with cancellous bone removed from the upper end of the tibia, and cover the surface with a layer of cartilage shaved off the femoral condyle, or perhaps partly from the discarded fragments. Then would follow six weeks immobilization of the knee, in extension, during which time the tibial articular surface would provide effective pressure on the cartilage graft overlying the cancellous bony filling. Movement would then be commenced, and full function would soon return. To his constant chagrin it never happened that re-exploration was warranted; a very satisfactory outcome, though frustrating to the experimental surgeon not willing to indulge in unnecessary operations.*" This technique

Table 1
Historical literature review of animal research on cartilage repair before 1959.

Year	Author	Country	Animal model	Location	Finding
1901	Marchand (17)	Germany	Dogs	Costal cartilage	Cartilage heals by proliferation of connective tissues from the perichondrium
1904	Matsuoka (18)	Germany	Rabbit	Ear	Cartilage heals by proliferation of connective tissues from the perichondrium
1905	Mori (19)	Japan	Rabbit	Ear	Cartilage heals by proliferation of connective tissues from the perichondrium
1905	Fasoli (20)	Italy	Rabbit	Femoral condyles	After 20 weeks, there was a complete repair of cartilage, which had been cut through to the bone
1905	Rimann (21)	Germany	Goats, dogs	Wrist, elbow	Metaplastic cartilage formation in the deep defects in cartilage after 31 days
1921	Ciociola (22)	Italy	Dogs	Femoral condyles	Wounds of cartilage extending to the underlying bone presented a definite transition from connective tissue to hyaline cartilage, and that the tangentially placed superficial wounds that did not reach the bone showed scarcely any reaction after 2 months
1924	Ito (23)	England	Rats, rabbits	Femoral condyles	Repair near the margins is good, but that nearer the centre is poor, unless the underlying cancellous tissue has been exposed.
1925	Haebler (24)	Germany	Dogs	Femoral condyles	When the subchondral bone was injured, as well as the cartilage, the cartilage defect became filled with fibrous tissue.
1931	Shands (12)	The United States	Dogs	Femoral condyles, elbow, wrist	Defects in the cartilage were made either with a 5 mm burr through to the subchondral bone or with a scalpel

shows how successful his approach has been and how innovative he was in two aspects. To be honest, we also have to credit to Smillie (1957) [26] who, 2 years before Pridie, had debated at the end of his article on refixation of OCD fragments presenting his Smillie pins, if for compensation of loss of bone substance in the depth of the pseudarthrotic area and for avoidance of too deep sinking in of the refixed fragment below the level of the surrounding cartilage surface… *"consideration has been therefore given to the possibility of adding autogenous or homogenous cancellous bone. This matter has not been pursued so far. It was felt that to complicate a procedure under trial with an additional manoeuvre of unknown effect was unjustifiable."* Smillie also referred to Wildey, 1914, who had published original work on his multiple drilling of opposed sclerotic fragments in an ununited fracture (nonunion) to introduce a new blood supply. Smillie in analogy to a nonunion theory of an OCD fragment believed *"there are special circumstances in Osteochondritis dissecans which make the method applicable to fill the space between the fragments with a blood clot which would be transformed into granulation tissue by capillaries growing out from the host and thus form a source of blood supply for the dense bony fragment."* No solution was offered however for cases where the crater was empty and refixation of deformed fragments not feasible anymore. And that is where Pridie got in with his technique that he never published and of which we only learn thanks to loyal friends giving credit to a colleague's work.

First, he removed the sclerotic deep wall surrounding the OCD focus and filled the cavity with cancellous bone. This technique has later been adopted by L. Johnson et al., published in Cartilage in 2014 [27] , but we did not find a mentioning of Pridie's precursor work as brought to the attention by Eyre-Brook in 1960 because he was probably unaware of it.

Second, regarding "the covering of the cancellous graft in the OCD defect with a layer of cartilage shaved off the femoral condyle, or perhaps partly from the discarded fragments," it seems to us that this is the first utilisation of "minced cartilage" or a technique that would resemble the one popularised by K. Stone with his "Paste Technique" who as well seems to have been unaware of Pridie's work when looking at the literature references. In 1983, Albrecht experimented with cartilage fragments to close osteochondral defects [28].

How did Pridie know that his drilling technique for osteoarthritis in the knee worked? Because he saw highly satisfied patients in his follow-ups and in the few patients, he had to reoperate because of not fulfilled satisfaction he had to proceed to a fusion of the knee he got reassured, but how? We read what he discovered at reoperation: "It was now seen that a smooth white surface of fibrocartilage had replaced the "tramlines" of eburnated bone." And Eyre-Brook continues: "*At the end of the first operation the femoral condyle somewhat resembled a sieve; but two years later, when the knee was re-explored, the fibro-cartilaginous circles over the perforations showed up as some of the most normal and smooth portions of the femoral condyle and they were fusing to form confluent sheets*."

Scientific and societal impact

Based on Pridie's observation, surgeons worldwide started to apply his method and named it in their operating room (OR) reports after him. But we all were unaware that he had left footsteps in the marrow stimulation techniques of which he had been a two-fold innovator. The description of his technique in OA Joints and in OCD by Eyre-Brook is unique because since Pridie's first clinical experimentations, the entity of *Marrow Stimulation Techniques* to liberate mesenchymal stem cells from cancellous bone has evolved on various occasions and has reappeared in variable treatments. But after 1959, it took almost 15 years for his technique to be adopted and repeated by those influential surgeons following him (**Fig. 8**).

Ficat in 1979 [29] described "Spongiolization" through which the dense and sclerotic cancellous bone of the patella was removed, and the defect left void. Johnson has promoted Abrasion Chondroplasty. Steadman [7,30] proposed various instruments and changed the drilling to the arthroscopically easier microfracturing. He merits having also collected a lot of experience from translational, veterinarian work, mainly in horses with his co-workers Rodkey and Briggs [7,30]. Chen, Buschmann et al. however in 2011 [31] suggested that drilling is preferable to picking with more stem cells being mobilised to the surface. AMIC, developed in 2003 by Behrens [32], attempts to catch the cells released from the drill holes under a sutured or glued collagen I/III membrane resulting in a more substantial fibrocartilage layer. In 2017, Martin and Jakob [33] presented a new technique, called "Osteochondroisation" in which after curettage and removal of the sclerotic layer and the subchondral plate in the depth of a chronic cartilage defect, they filled in small pieces of locally retrieved and crushed cancellous bone and covering it with a collagen membrane. They showed how this not

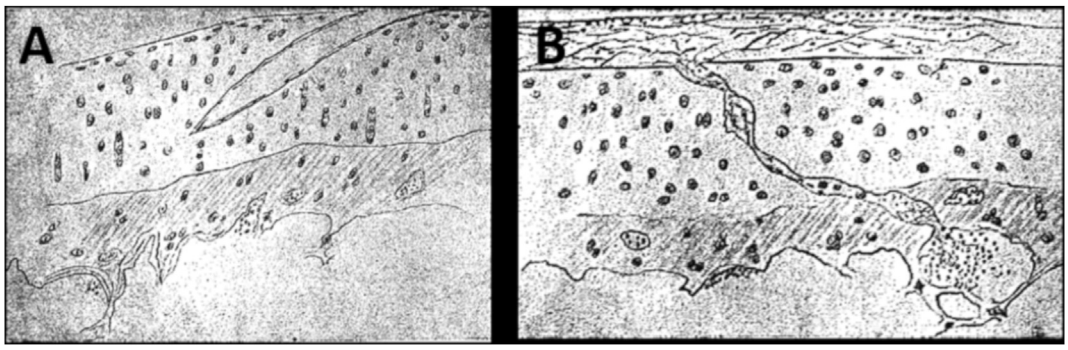


Fig. 7. Original illustrations of the work of Filippo Ciociola [22], pathologist at the University Of Naples, Italy. In this animal study performed one century ago (1921), the author compared for the first time two different types of wounds in hyaline cartilage of dogs: tangentially placed superficial wounds (A) vs. wounds extending to the underlying bone (B). The authors suggested a definite transition to hyaline cartilage after 2 months when the subchondral bone was involved.

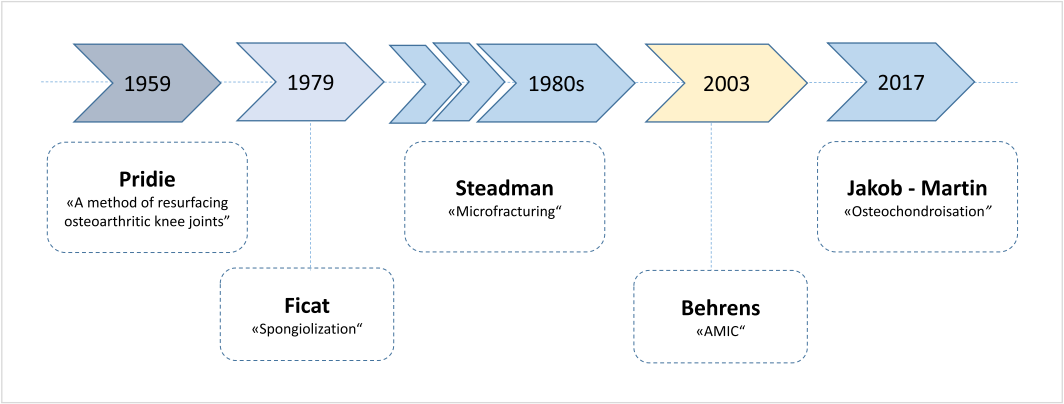


Fig. 8. Diagram picturing the historical footsteps over the last 60 years, since the introduction of the original concept of marrow by K.H. Pridie in 1959.

only filled the osseous void with bone creating a new subchondral plate but also the cartilaginous defect with fibrocartilage to the level of neighbouring cartilage. This followed the work and long experience of K. Stone [34] who "reused" local cartilage and bone debris from the area of the defect as an *articular cartilage paste graft technique* that was filled in the defect. But it also goes well with Pridie's and Johnson's OCD technique. All these techniques are consistent with the sense of the "Mottainai" spirit, a term introduced by Japanese environmentalists to convey the sense of regret over waste and to encourage reusing and repairing.

Today, marrow-stimulating techniques with their successors are the most frequently used cartilage repair techniques with 60–80% good to excellent results [27].

Lessons learnt

Looking at the clinical observation of Pridie, born as an idea in the "clinical laboratory," presumably such a sequence of events is not possible anymore because nowadays it is thought to be more appropriate to develop an idea first in the laboratory, then lead it to a preclinical, if possible, animal study and according to the rules of "Translational Medicine" guide it then into a clinical study, limited in numbers as a pilot study to start with. Only then, after a minimal number of 2–5 years, follow-up with reconfirmed results and biopsies analysed would it be possible to adopt this new surgical technique, but usually it would take many more years until Health Systems and Insurances would accept its application and come up for reimbursement. Plus, Ethical Guidelines would make the way Pridie proceeded difficult to reproduce and would render publication in Journals impossible. We leave it up to the reader to judge if this is good for progress in our field or maybe hindering it?

Although one would think this to correspond to today's standard, there seem however to exist some serious doubts. Goldberg et al. (2017) [35] in a systematic review on cartilage repair with mesenchymal stem cells searching the results of initially 2880 articles, of which 239 were included for analysis have explored the full spectrum of evidence from in vitro studies, through animal studies to translational human clinical trials and found little evidence of connectivity between in vitro, animal, and the human work. They did not find a single group of scientists that reported studies in all three categories. They concluded that there was a clear lack of connectivity and of what they called synergistic evidence. They speculate that the drivers for progress in this field are largely motivated by patient demand, surgeon inquisition, and a regulatory framework that is learning at the same pace as new developments take place.

If accepting this difficulty within translational medicine to date, there might be, one could conclude, some room left for observational studies "à la Pridie," which should leave the odd clinician with a bit of satisfaction or at least a smile. It is obvious that today, in any kind of project and clinical study, the Ethical Committee support must be granted. An incidental observation apart is the fact that there is one literature reference only mentioned in this 10-line Proceedings Report, the one of Magnuson. And another thing strikes us: instead of up to 10 co-authors, which we routinely observe more and more today, even for a case report being submitted, we take note that here, there is one author only, the presenter at the meeting and another one who participated in the discussion following Pridie's "Reading" of the paper, the one of Mr. G. Gordon from Whitehaven who said that "osteotomy to correct varus or valgus produced benefit because it increased vascularity. Mr. Pridie agreed that osteotomy was sometimes helpful." Although the statement of the only and single so-called co-author in Pridie's note was in support for further development of osteotomy, this was reconfirmed in the times following on and on.

Future directions

Those among us who have adopted his techniques in their clinical practice may be unaware that they were Pridie's techniques, may see

their successes in another light after reading this and when they, as well as like Pridie, got insured in their practice without doing harm to a patient's knee. Bringing to the attention the work of an utterly unique person was the idea of the authors of this "Classic" or "Landmark" Article, which presents and digs out techniques that are not only efficient and efficacious but also economic and that have not lost validity until today.

We conclude with two quotations and start with these words of Eyre-Brook:

"This brief survey of the more important contributions that Mr. Pridie made to orthopaedic surgery is now concluded, and the man being greater than his work, I should like to finish by referring to some appreciation of Mr Pridie made in letters I have received. Some have admired his patent enjoyment of life, others stress his colorful personality, and to another he was "That shock-headed figure with his provocative ideas". Philip Wiles wrote that *"He lived his life as he enjoyed it and orthopaedic surgery was only a part; that is the way it should be"*. Yes, a unique personality and a man of many parts and wisdom.

The second is the sobering statement of E. Hunziker, one of the Key Cartilage scientists of our time. *«We have to face the bleak fact that extraordinarily little progress in this area has been made since the bone-marrow stimulation technique, of which microfracturing/microdrilling is a variant, that was introduced by Pridie in the 1950ies. Although research activity in this area has been indefatigably sustained, no significant progress has been made since Pridie's invention. (OARSI 2014)"*.

The rest is orthopaedic history…

Patient consent

Patient consent for publication not required.

Authors' contributions

R.P.J. conceived the idea and was involved into article writing. R.M. undertook the historical literature research, was involved into manuscript writing, created the figures and table, and edited this article.

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Ethics

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Declaration of competing interest

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References

[1] Eyre-Brook AL. Kenneth Pridie: an appreciation. Bristol Med Chir J 1965;80(3):37–41. pmid 14324100.
[2] Pridie KH. A method of resurfacing osteoarthritic knee joints. Proceedings of the British Orthopaedic Association. J Bone Joint Surg (Br). 1959;41:618–9. https://doi.org/10.1302/0301-620X.41B3.616.
[3] Magnuson PB. Joint debridement: surgical treatment of degenerative arthritis. Surg Gynecol Obstet 1941;73:1–9.
[4] Isserlin B. Joint debridement for osteoarthritis of the knee. J Bone Joint Surg (Br). 1950;32-b(3):302–6. https://doi.org/10.1302/0301-620X.32B3.302.
[5] Insall JN. Intra-articular surgery for degenerative arthritis of the knee. A report of the work of the late K. H. Pridie. J Bone Joint Surg Br 1967;49(2):211–28. pmid 6026508.
[6] Insall J. The Pridie debridement operation for osteoarthritis of the knee. Clin Orthop Relat Res 1974;(101):61–7. pmid 4837919.
[7] Steadman JR, Rodkey WG, Briggs KK. Microfracture: its history and experience of the developing surgeon. Cartilage 2010;1(2):78–86. https://doi.org/10.1177/1947603510365533.
[8] DeMaio M. Giants of orthopaedic surgery: Masaki Watanabe MD. Clin Orthop Relat Res 2013;471(8):2443–8. https://doi.org/10.1007/s11999-013-3052-1.
[9] Eyre-Brook AL. Obituary K.H. Pridie. Br Med J 1963;1(5341):1349–50.
[10] Eyre-Brook AL. Kenneth Hampden Pridie. J Bone Joint Surg (Br). 1963;45-B(3):609–11. https://doi.org/10.1302/0301-620X.45B3.609.
[11] Eyre-Brook AL. Kenneth Hampden Pridie. Bristol Med Chir J 1963;78:102–3.
[12] Shands Jr AR. The regeneration of hyaline cartilage in joints: an experimental study. Arch Surg 1931;22(1):137–78. https://doi.org/10.1001/archsurg.1931.01160010142009.
[13] Redfern P. On the healing of wounds in articular cartilages, and on the removal of these structures after amputations at the joints, with remarks on the relation which exists between the diseases of cartilage and ulceration and inflammation in other textures. Monthly J Med Sci 1851;4(21):201–15. https://www.researchgate.net/publication/284668711_On_the_Healing_of_Wounds_in_Articular_Cartilages_and_on_the_Removal_of_These_Structures_after_Amputations_at_the_Joints_with_Remarks_on_the_Relation_Which_Exists_between_the_Diseases_of_Cartilage_and_/fulltext/5b52990da6fdcc8dae343392/284668711_On_the_Healing_of_Wounds_in_Articular_Cartilages_and_on_the_Removal_of_These_Structures_after_Amputations_at_the_Joints_with_Remarks_on_the_Relation_Which_Exists_between_the_Diseases_of_Cartilage_and_.pdf?origin=publication_detail.pdf.
[14] Peltier LF. Of the structure and disease of articulating cartilages - William Hunter. Clin Orthop Relat Res 1995;(317):3–6. pmid 7671493.
[15] Hunter W. Of the structure and disease of articulating cartilages. Phil Trans Roy Soc Lond 1743;(42):514–21.
[16] Gussenbauer C. Ueber die Heilung per primam intentionem. Langenbeck's Arch für klin Chir. 1871;XII:791–813.
[17] Marchand F. Healing of Cartilage Wounds, Der Process der Wundheilung mit Einschluss der Transplantation. Deutsche Chirurgievol. 18. Stuttgart: Ferdinand Enke; 1901.
[18] Matsuoka M. Die Regeneration des Knorpelgewebes. Virchows Arch path Anat 1904;175:32–45. https://doi.org/10.1007/BF01947814.
[19] Mori M. Studien uber Knorpelregeneration, nach experimentellen Untersuchungen am Kaninchenohr. Deutsche Zeitschrift für Chirurgie. 1905;76:220–33.
[20] Fasoli G. Sul comportamento delle cartilagini nelle ferite. Arch Sci Med 1905;29:365–414.
[21] Rimann H. Experimenteller Beitrag zur Lehre von der Entstehung der echten, freien Gelenkkörper. Virchows Arch path Anat 1905;180:446–62. https://doi.org/10.1007/BF01967904.
[22] Ciociola F. Contributo allo studio della riparazione delle ferite delle cartilagini articolari. Policlinico; sezione chirurgica 1921;28:229.
[23] Ito LK. The nutrition of articular cartilage and its method of repair. Br J Surg 1924;12:31–42. https://doi.org/10.1002/bjs.1800124505.
[24] Haebler C. Experimental study of the regeneration of joint cartilage. Beiträge z klin Chir 1925;134:602–40.
[25] DePalma AF, McKeever CD, Subin DK. Process of repair of articular cartilage demonstrated by histology and autoradiography with tritiated thymidine. Clin Orthop Relat Res 1966;48:229–42. pmid 5334343.
[26] Smillie IS. Treatment of osteochondritis dissecans. J Bone Joint Surg (Br). 1957;39-b(2):248–60. https://doi.org/10.1302/0301-620X.39B2.248.
[27] Johnson LL, Delano M, Spector M, Pittsley A, Gottschalk A. The long-term clinical outcomes following autogenous bone grafting for large-volume defects of the knee: 12- to 21-year follow-up. Cartilage 2014;5(2):86–96. https://doi.org/10.1177/1947603513518216.
[28] Albrecht F, Roessner A, Zimmermann E. Closure of osteochondral lesions using chondral fragments and fibrin adhesive. Arch Orthop Traum Surgery 1983;101(3):213–7. https://doi.org/10.1007/BF00436773.
[29] Ficat RP, Ficat C, Gedeon P, Toussaint JB. Spongialization: a new treatment for diseased patellae. Clin Orthop Relat Res 1979;(144):74–83. pmid 535254.
[30] Steadman JR, Rodkey WG, Singleton SB, Briggs KK. Microfracture technique forfull-thickness chondral defects: technique and clinical results. Operat Tech Orthop 1997;7(4):300–4. https://doi.org/10.1016/S1048-6666(97)80033-X.
[31] Chen H, Chevrier A, Hoemann CD, Sun J, Ouyang W, Buschmann MD. Characterization of subchondral bone repair for marrow-stimulated chondral defects and its relationship to articular cartilage resurfacing. Am J Sports Med 2011;39(8):1731–40. https://doi.org/10.1177/0363546511403282.
[32] Russlies M, Rüther P, Köller W, Stomberg P, Behrens P. Biomechanische Eigenschaften von Knorpelersatzgewebe nach verschiedenen Methoden der Knorpeldefektbehandlung beim Schaf. Zeitschrift fur Orthopadie und ihre Grenzgebiete 2003;141(4):465–71. https://doi.org/10.1055/s-2003-41560.
[33] Martin R, Jakob RP. Osteo-Chondroisation, a clinical working hypothesis for chronic, purely cartilaginous defects in the knee. In: ISAKOS congress 2017 Shanghai; 2017 [Poster].
[34] Stone KR, Walgenbach AW, Freyer A, Turek TJ, Speer DP. Articular cartilage paste grafting to full-thickness articular cartilage knee joint lesions: a 2- to 12-year follow-up. Arthroscopy 2006;22(3):291–9. https://doi.org/10.1016/j.arthro.2005.12.051.
[35] Goldberg A, Mitchell K, Soans J, Kim L, Zaidi R. The use of mesenchymal stem cells for cartilage repair and regeneration: a systematic review. J Orthop Surg Res 2017;12(1):12–39. https://doi.org/10.1186/s13018-017-0534-y.