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Practice in rehabilitation after cartilage therapy: an expert survey

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Abstract

Background Current cartilage therapy modalities like microfracture, ACT/MACT, AMIC or osteochondral transplantation are important tools to treat symptomatic (osteo)chondral lesions of the knee joint. However, until now there exists no high-level evidence based accepted rehabilitation plan for the postoperative treatment.

Hypothesis/purpose This survey describes the predominantly used rehabilitation plan as implemented by expert musculoskeletal surgeons for operatively treated (osteo)chondral lesions.

Study design Survey and systematic review.

Methods An electronic questionnaire covering general and specific items concerning aftercare following cartilage therapy in the knee joint was designed and disposed to analyze rehabilitation programs among a population of expert musculoskeletal surgeons of the AGA (Society of arthroscopy and joint surgery). All instructors (304 in 01/2011) were included into the survey. A total of 246 (80.9 %) instructors answered the questionnaire.

Results The predominant used therapy to treat cartilage lesions is microfracture and for osteochondral lesions the osteochondral transplantation. Physiotherapy starts directly after surgery and takes more than 6 weeks. Most surgeons

do not immobilize patients after surgery and use partial weight-bearing for up to 5 weeks. The change from partial to full weight-bearing is done step-wise with a 20-kg/week increase. Free ROM is allowed by the majority of instructors (55 %) directly after surgery. A CPM-device is also used directly and up to 5 weeks. Swimming and biking are allowed after 6 weeks, running is allowed after 12 weeks and contact sports after 24 weeks. Most instructors do not use braces in the aftercare procedure, but nearly all (93 %) prescribe crutches. Typical drugs used during the aftercare are NSAID, Heparin and antibiotics. For most instructors (79 % respectively 75 %) knee stability and a straight leg axis are necessary for a successful cartilage therapy. If a concomitant therapy like ACL reconstruction or an osteotomy is performed, aftercare is mainly dependent on cartilage therapy (62 % respectively 59 % of instructors).

Conclusions Today there exists no detailed rehabilitation program for treatment after a cartilage-related operation on the basis of an evidence-based level I study. The reason might be that many variables contribute to a specific aftercare procedure. Therefore, the survey of experienced surgeons may help to identify the most promising rehabilitation regime for today, at least until evidence-based level I studies are accomplished.

Keywords Cartilage · Therapy · Survey · Aftercare

Introduction

Articular cartilage and osteochondral defects in adults do not heal, can lead to pain and may dispose a predisposition for osteoarthritis. Therefore, especially symptomatic lesions are treated today with cartilage reconstructive

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techniques like ACI/MACT [1, 2], microfracture [3], autologous Matrix-induced chondrogenesis (AMIC) [4] and osteochondral transplantation [5, 6].

Cartilage therapy is mostly performed in the knee joint. Several studies show promising results of those operations. However, less is known about the most successful aftercare procedure. In many articles, 6 weeks without or partial weight-bearing combined with free range of motion and the use of a continuous passive motion (CPM) device is recommended. This is mainly on the basis of level IV evidence-based studies [7–13]. Today only a few studies exist, which are based on a randomized-prospective approach. Ebert et al. [14] and Wondrasch et al. [15] described results after MACT with two different aftercare procedures. Two study arms were compared: in one an accelerated weight-bearing procedure was followed, and in the other a more common delayed program was used. Both studies showed improved results for the accelerated procedure without negative influences on cartilage quality in MRI. However, the follow-up was only 3 months and 2 years, respectively. In addition, not a single parameter was compared but a complete aftercare procedure with several differing confounders. However, it is almost impossible to handle several parameters like weight-bearing, increase of load after load rejection, motion, active/passive exercises, braces and drugs in a controlled randomized trial. It was even not possible until today to establish a meta-analysis regarding one topic, the CPM treatment after cartilage therapy, because of low quality of current studies [16]. The aim of this survey was therefore to identify and demonstrate current aftercare procedures for cartilage therapies in the knee.

Methods

To collect data on surgical procedures and especially postoperative aftercare for chondral and osteochondral defects in the knee (exclusion of patellofemoral lesions), an electronic questionnaire consisting of six different categories (A–F) was developed. Each of the six categories contains different subdivisions, which are exclusively related to the knee joint. Each subdivision has multiple choice answering possibilities whereof only one could be marked with a cross in general. There are only two categories with multiple answering possibilities (D, E). The questionnaire was exclusively completed by instructors of the Society of arthroscopy and joint surgery (AGA), the biggest European arthroscopy society. To become an instructor of the AGA it is necessary to verify at least 500 arthroscopies (in authority), more than 80 times open surgery of the large joints (in authority), two times instructor on an AGA arthroscopy course, publications on arthroscopic topics and two references of other AGA instructors

(one of them has to be member of the AGA board). At time of the survey there were 304 AGA instructors, all of whom were included. In category A, the instructors were requested to specify their kind of treatment for cartilage and osteochondral defects and the period of patient hospitalization. Category B is related to postoperative physiotherapy, weight-bearing and allowed range-of motion. Category C analyzes the recommended sport in the time-course of the rehabilitation procedure. Category D identifies the frequency of used medical aids. Category E detects the use of perioperative drugs like NSAID and heparin after surgery. The last category (F) contains aftercare modalities of concomitant ligament pathologies and axial deformities. The questionnaire could be electronically submitted and completed and was preliminary disclosed on the AGA-website. To localize a requested collective of all 304 instructors, every instructor had to register through identification upon submission. All AGA instructors were asked to fill out an interactive questionnaire via e-mail including a link to the mentioned website. To achieve a presentable return rate, the e-mail was dispatched for a total of three times. Recurrent questionnaire completions by the same participant were excluded, using the first complete response. The completed questionnaires were analyzed by the AGA cartilage research committee and processed anonymously for further analysis. Frequency distributions of the answers were described using Graph Pad Prism (Prism software, USA) and were shown in percentage (ratio of the respondents).

Results

246 of the 304 contacted instructors (80.9 %) completed and submitted the form. One instructor had to be dropped out of the further analysis because he only performs hip surgery.

Therapy for cartilage lesions

The predominant chosen therapy for isolated cartilage lesions is the microfracture technique (Fig. 1a). 113 of 245 (46 %) perform this technique often and 97 of 245 (40 %) mostly/ever. In contrast, only 32 of 245 (13 %) perform the MACT technique often and 12 of 245 (5 %) mostly/ever. Other techniques like osteochondral transplantation or the AMIC procedure have no relevance for most instructors.

Therapy for osteochondral lesions

In contrast, the favorite method regarding the treatment of osteochondral lesions is the osteochondral transplantation. 68 of 245 (28 %) do this therapy often and 44 of

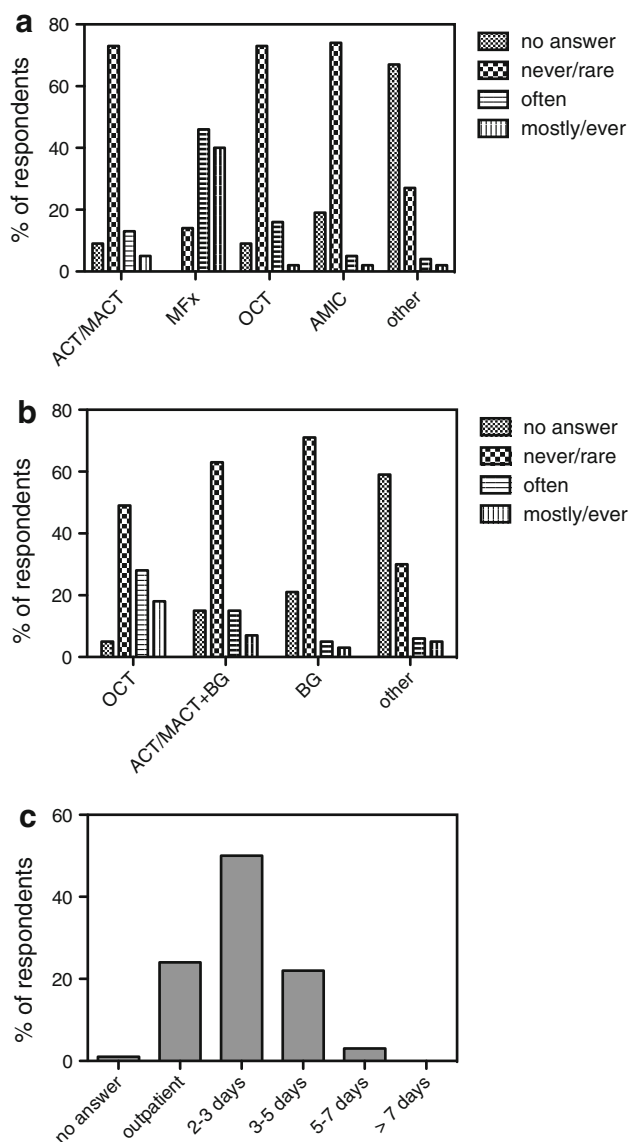


Fig. 1 **a** Surgical therapy for chondral lesions. Percentage of surgeons using a certain cartilage repair technique. The predominant therapy for isolated cartilage lesions is the microfracture technique. **b** Surgical therapy for osteochondral lesions. Percentage of surgeons using a certain osteochondral repair technique. The favorite method regarding the treatment of osteochondral lesions is the osteochondral transplantation. **c** Durance of hospitalization in percentage. The majority of patients get an inpatient treatment (75 %). The prevalent stay in the hospital is 2–3 days (50 %)

245 (18 %) mostly/ever (Fig. 1b). Autologous chondrocyte transplantation (ACT) methods with bone-grafting is the second option for AGA instructors. Other methods like bone-grafting without ACT are used rarely.

Inpatient/outpatient treatment

The majority of patients get an inpatient treatment 183 of 245 (75 %), whereas 59 of 245 (24 %) get an outpatient

one (Fig. 1c). The prevalent stay in hospital is 2–3 days (123 of 245; 50 %).

Physiotherapy

Most instructors recommend starting physiotherapy at the first postoperative day (170 of 245; 70 %) and physiotherapeutic treatment for more than 6 weeks (135 of 245; 55 %) (Fig. 2a).

Weight-bearing and immobilization

Most instructors do not immobilize their patients (206 of 245; 84 %) (Fig. 2b). However, 30 of 245 instructors (12 %) immobilize patients for the first postoperative days. 126 of 245 instructors (51 %) allow partial weight-bearing directly after surgery, whereas the other instructors start with partial weight-bearing after 1–3 weeks (22 %), after 3–5 weeks (11 %) and after 5–7 weeks (11 %). The most often used period of partial-weight-bearing is 3–5 weeks (41 % of instructors), respectively, 5–7 weeks (33 % of instructors). Regarding the change of partial- to full weight-bearing the majority of instructors recommend a step-wise load increase (75 % of instructors) with 20 kg/week (64 % of instructors).

Range of motion, CPM and active exercises

Range of motion is unlimited directly after surgery by most instructors, 134 of 245 (55 %). However, if a range of motion limitation is used most instructors use a step-wise increase of flexion (43 of 245; 18 %) (Fig. 2c). Active exercises are allowed directly after surgery (60 % of instructors). 24 % of instructors start active exercises 1–3 weeks after surgery, the minority later than 3 weeks. The majority of instructors (195 of 245; 80 %) use continuous passive motion (CPM) splints in their aftercare and start directly (169 of 245; 69 %) after surgery. The CPM device is predominantly used for 3–5 weeks (88 of 195; 45 %). A use longer than 5 weeks is rare (31 of 195; 16 % of instructors).

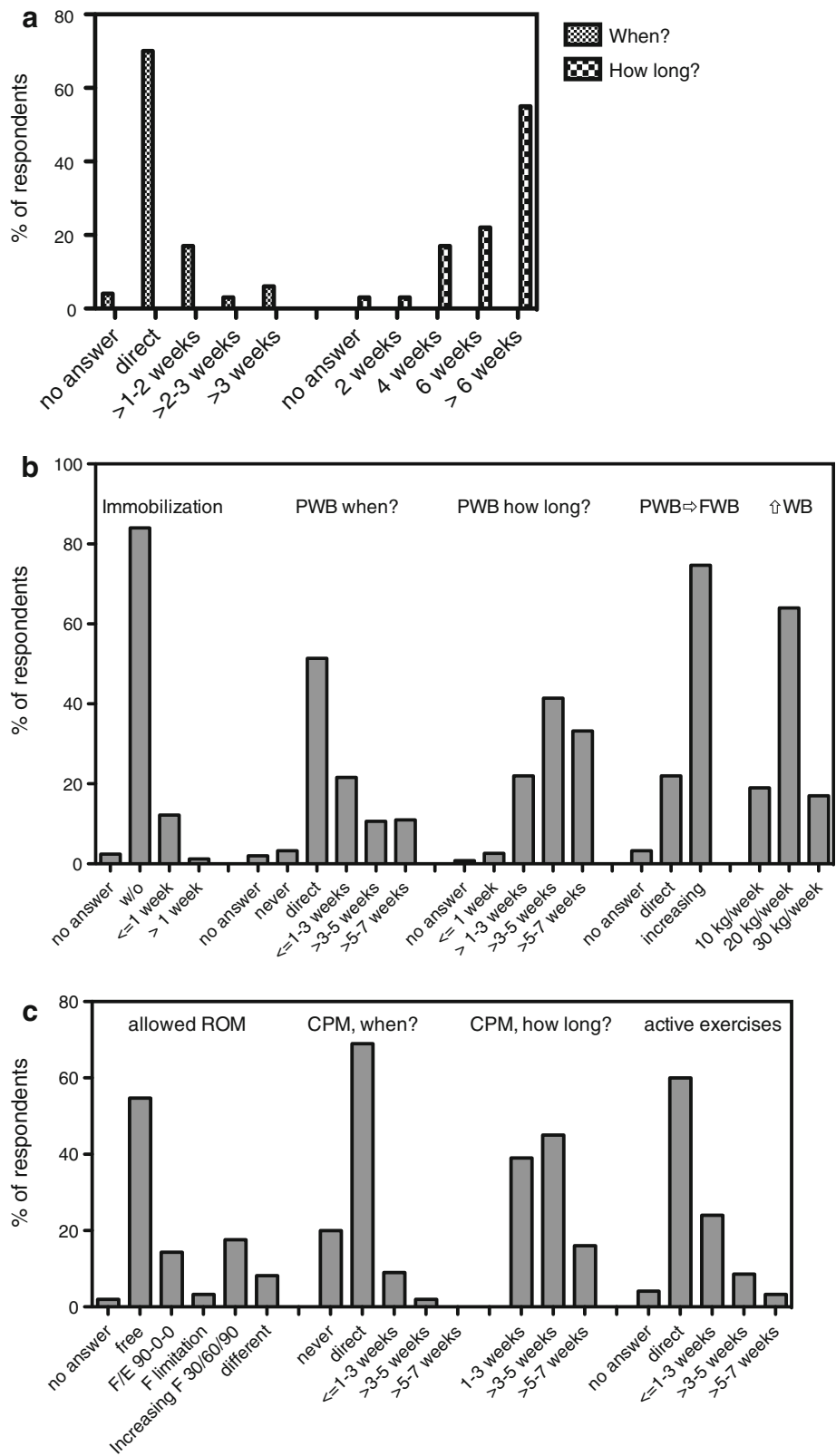
Sports in rehabilitation

The majority of instructors allow swimming and biking for more than 6 weeks postoperatively (127 of 245; 52 %, respectively 137 of 245; 56 %) (Fig. 3). Running is predominantly recommended after 12 weeks (118 of 245 instructors; 48 %) and contact sports more than 24 weeks after cartilage therapy (149 of 245 instructors; 61 %).

Medical aids

Medical aids are often used in aftercare procedure (Fig. 4). 93 % of instructors use crutches and 80 % a CPM device

Fig. 2 a Postoperative start and durance of physiotherapy. Most instructors recommend beginning physiotherapy at the first postoperative day (70 %) and treatment for more than 6 weeks (55 %). **b** Immobilization, partial (PWB) and full weight-bearing (FWB). Most instructors do not immobilize their patients (84 %). The majority of instructors allow partial weight-bearing directly after surgery (51 %) for 3–5 weeks (41 %). A step-wise load increase is recommended by most instructors (75 %) with 20 kg/week (64 %). **c** Range of motion (ROM) and continuous passive motion (CPM) use. Range of motion is unlimited directly after surgery by 55 % of the instructors. Most instructors use CPM splints (80 %) with a direct postoperative start (69 %). The device is mostly used for 3–5 weeks (45 %).



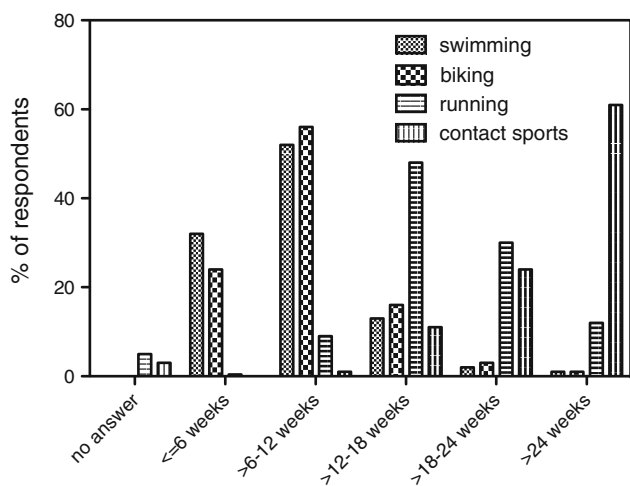


Fig. 3 Beginning of sports in rehabilitation. 6 weeks after surgery most instructors allow postoperative sport (swimming and biking). Contact sport is more restricted. It is allowed normally after 24 weeks

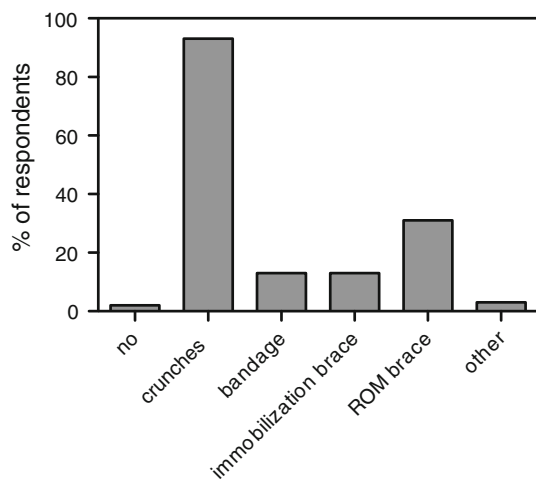


Fig. 4 Medical aids. Most instructors use crutches (93 %) and a CPM device (80 %) in their aftercare procedure. ROM braces are only used in 31 % of instructors

(Figs. 2c, 4). However, devices like bandages, braces and others are used to a lesser extent (up to 31 % of instructors).

Drug therapy

Non-steroidal anti-inflammatory drugs (NSAID) are prescribed by 160 of 245 (65 %) of the instructors routinely (Fig. 5). The majority of instructors (229 of 245; 93 %) use heparin for prophylaxis of thrombosis. Rivaroxaban and analogs are used by 11 of 245 (4 %) of the instructors as oral anti-thrombotic prophylaxis, whereas 5 of 245 (2 %) do not use an antithrombotic drug. A single-shot antibiotics is used perioperatively by half of all instructors. However, nearly 50 % do not use an antibiotics during cartilage

therapy routinely. In addition, drugs, which are routinely used by the instructors, are Metamizol (91 of 245; 37 %) and Paracetamol (70 of 245; 29 %) as painkillers and drugs for the protection against gastric ulcers (114 of 245; 47 %). COX2 selective NSAIDs are rarely used by AGA instructors (48 of 245; 20 %). Only 1 surgeon uses corticosteroids intraarticular after surgery and 5 do not use any drug routinely.

Knee stability and cartilage therapy

For 15 % of the instructors (37 of 245) it is not a premise in the treatment of a cartilage defect to treat concomitant knee instability (Fig. 6a). However, for the majority (194 of 245; 79 % of instructors) the treatment of both, instability and cartilage defect, is important. If concomitant instability is treated, 21 % (52 of 245) of instructors stabilize the knee before cartilage therapy, 59 % (144 of 245) together with cartilage therapy and 4 % (9 of 245) after cartilage therapy. The aftercare procedure for most instructors is dependent on cartilage therapy (153 of 245; 62 %).

Knee malalignment and cartilage therapy

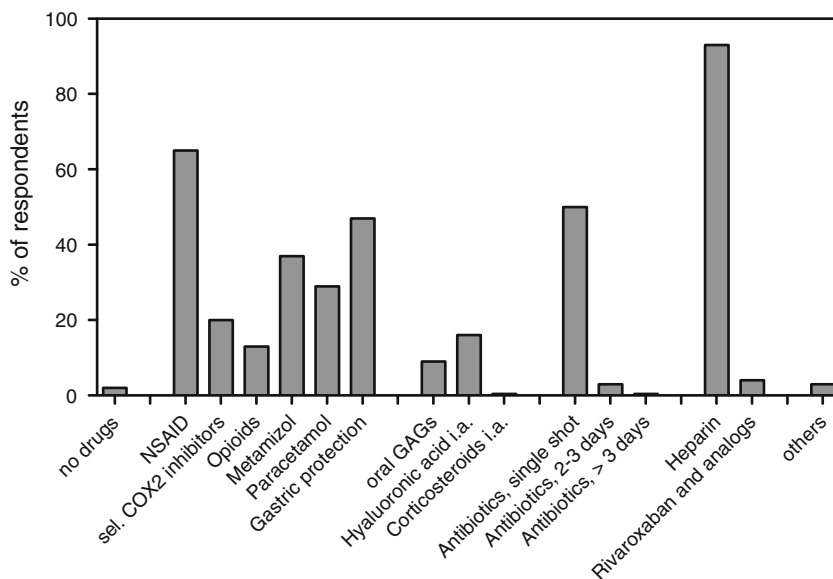
In the case of an accompanying axis deviation (like varus deformity) most surgeons (75 %) recommend a correction together with cartilage therapy (Fig. 6b). However, there is no consensus and proof which extent of malalignment can be tolerated and which not. Most instructors suggest a correction in patients with more than 5° of varus (31 %) and valgus (26 %) malalignment. Minority of instructors (13 %) corrects the axis for deviations exceeding 3° varus. At least 25 % of instructors do the correction for malalignments exceeding 3° valgus. Only 18 % of instructors perform a correction for any kind of malalignment in combination with cartilage therapy.

If a varus mal-alignment is corrected, 33 % of instructors make an overcorrection to 62 % valgus (regarding the weight-bearing/Mikulicz line on the tibia plateau), 27 % of instructors make a correction to 55 % valgus and 40 % of instructors choose a straight axis (50 % or physiological varus). If there is a valgus mal-alignment the majority of surgeons (94 %) choose a straight axis (50 % or physiological varus). The minority of instructors (6 %) makes an overcorrection to a varus alignment.

If a high tibial osteotomy (HTO) is chosen, nearly all instructors (90 %) use an open-wedge technique, if a distal femoral osteotomy (DFO) is chosen 56 % of instructors use an open-wedge technique, whereas 44 % perform a closed-wedge osteotomy.

For most instructors the aftercare procedure is dependent on the cartilage therapy and not on the axis correction

Fig. 5 Used drugs during cartilage therapy. NSAID, an antibiotic (single-shot) and Heparin are the drugs which are used by most instructors



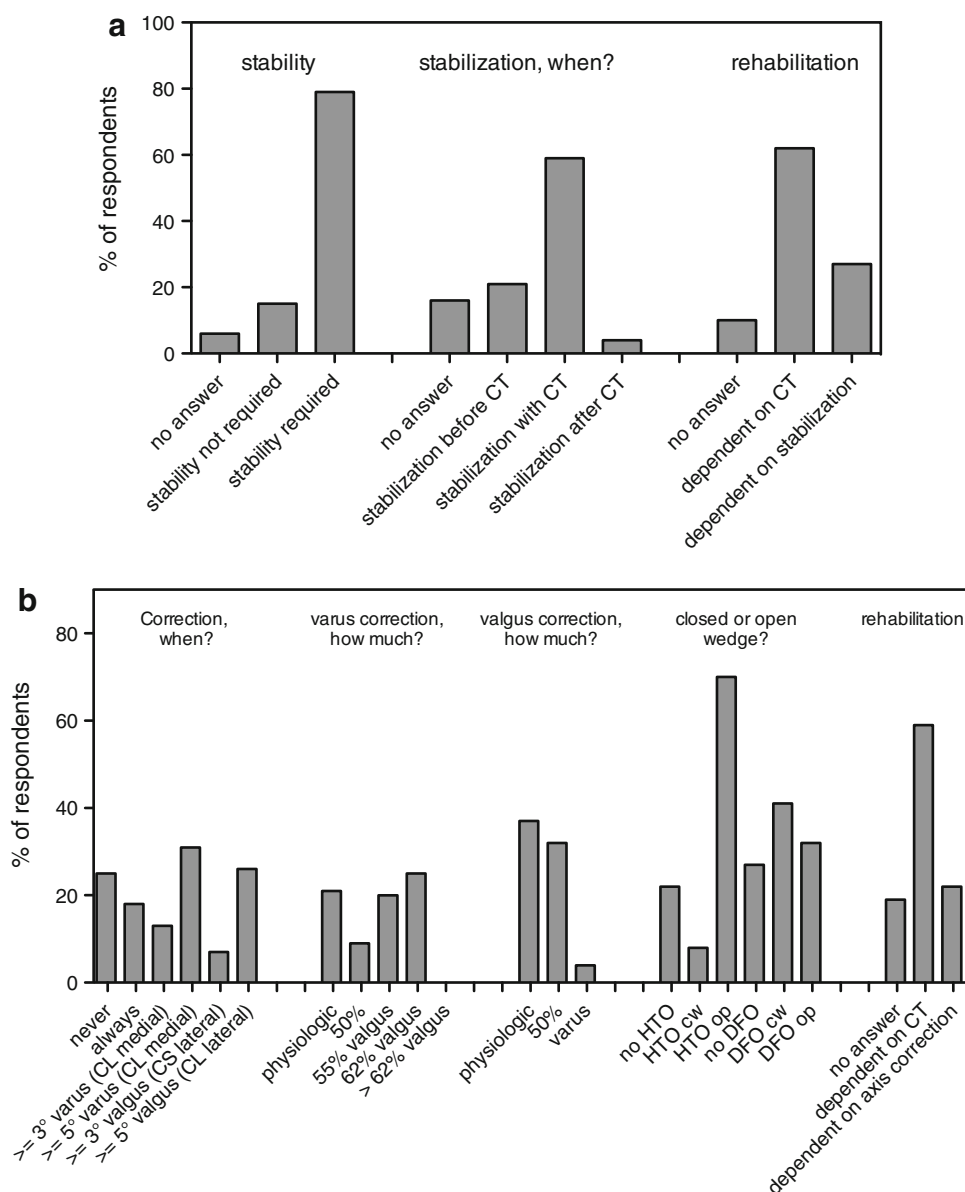
(59 % of instructors). In the minority the axis correction defined the after care (22 % of instructors).

Discussion

Most AGA instructors perform the microfracture technique for cartilage and the osteochondral transplantation for osteochondral lesions. This is in accordance with a previous survey [17]. The use of the microfracture technique for cartilage defects in the knee is analyzed in many studies [18–20]. It was shown that results in clinical studies are satisfying, but the cartilage defect is not repaired with hyaline but with fibrocartilage [2, 21]. Therefore, long-term stability is limited [20]. In addition, current prospective randomized trials show better clinical and histological results for chondrocyte transplantation techniques [2, 21, 22]. Therefore, the predominant use of the microfracture technique is in contrast to these studies. The study quality regarding the success of an osteochondral lesion therapy is weaker because alternative methods beside osteochondral transplantation procedures are not standardized and accepted today. Techniques like bonegrafting or bonegrafting in combination with chondrocyte transplantation are performed infrequently and study quality is weak because of short follow-ups and absence of a control group [23, 24]. At least, the results after osteochondral transplantation are satisfying and there are several studies with long-term follow-ups [6, 25]. Therefore, the predominant use of this technique by the AGA instructors is in accordance with current literature. Postoperatively, the majority of instructors allow partial-weight-bearing directly after cartilage therapy and for a period of 4–6 weeks followed by a step-wise increase to full weight-bearing. However,

today the correlation between weight-bearing and cartilage regeneration is not analyzed in a prospective randomized study with a long-term follow-up. Ebert et al. [14] described in a randomized controlled trial that patients with accelerated postoperative weight-bearing in comparison with “traditional” postoperative weight-bearing had a reduction in knee pain (VAS), had an improved function and also no differences in MRI regarding graft complications. The same patients were followed up after 5 years [26]. At this time patients that were treated by the accelerated protocol had a better VAS score than patients treated by the traditional postoperative weight-bearing protocol and had comparable clinical scores and MRI results. Wondrasch et al. [15] also performed a prospective randomized trial to compare an accelerated with a delayed weight-bearing procedure. In this study the follow-up was up to 2 years. As conclusion they described that an accelerated weight-bearing protocol did not jeopardize the healing graft in MRI and leads to a good clinical outcome. However, clinical outcome was not better in the accelerated group. Compared with the AGA survey, most instructors allow similar weight-bearing as used in the accelerated weight-bearing protocol by Wondrasch and also Ebert. Therefore, these results of the survey are in accordance to these evidence based level I studies. However, there are concerns. In the study of Wondrasch et al. there was only a 2-year follow-up described. It would be interesting if there are differences in the cartilage quality after 10 years and more (long-term follow-up), which will be the most important prognostic factor for the success of a cartilage therapy, in particular because in early MRI examinations a bone edema was seen in the accelerated group. In the study by Ebert et al. an advantage of an accelerated weight-bearing was the reduced knee pain after

Fig. 6 a Knee stability and cartilage therapy. For most instructors (79 %) a stable knee is necessary in cartilage therapy. If it is not stable the majority (59 %) performs a knee stabilization procedure together with cartilage treatment. The rehabilitation procedure is for 62 % of the instructors dependent on the cartilage therapy and not on the stabilization procedure. **b** Limb alignment and cartilage therapy. Most instructors recommend an axis correction together with cartilage therapy if the deviation is 5° varus/valgus or more. In a varus knee majority of instructors will overcorrect the axis to a valgus knee (weight-bearing line crosses the tibia plateau at 62 %). In contrast, in a valgus knee a straight leg axis is intended after correction. Most surgeons use an open-wedge technique for a HTO (90 %) and DFO (56 %). For most instructors the aftercare procedure is dependent on the cartilage therapy and not on the axis correction (59 %)



5 years. However, this is in contrast to the Wondrasch study. Taken together, there are only a few studies regarding the topic of cartilage therapy and weight-bearing; even the quality of prospective randomized trials is limited.

Commonly CPM devices are used postoperatively following cartilage surgery. The use of a CPM device is also recommended by most instructors. However, the influence of this device on cartilage quality of the regenerate tissue is not proofed. In a metaanalysis Fazalare et al. [16] hypothesized that postoperatively, the use of CPM devices improves the outcomes of cartilage therapy. Multiple medical databases were searched for Level I through IV evidence-based studies by the authors. Four Level III studies were identified that met inclusion criteria for their hypothesis. However, no randomized, controlled studies

were identified. As a result, a metaanalysis could not be performed because of the heterogeneity of the procedures and outcome measures. Unfortunately, the clinical evidence (only four studies) to support the use of CPM devices was lacking despite the common clinical practice of CPM use after knee cartilage surgery [16]. However, an interesting in vivo animal study on healing of osteochondral lesions compares CPM with immobilization and intermittent active motion. In this study only in the CPM group hyaline cartilage characteristics were shown in the regeneration tissue [27].

Predominantly administered drugs are NSAIDs' and heparin. It is very interesting that NSAIDs are recommended by most surgeons in our survey because there are some analyses, which show effects of these drugs on

cartilage hemostasis and chondrocytes. Ou et al. [28] showed negative effects of ibuprofen and indomethacin on cartilage in a rat osteoarthritis model, whereas Celecoxib did not show any effect on cartilage collagen metabolism. Especially Hashizume et al. showed negative effects of NSAIDs regarding cartilage degeneration. In contrast, Lakey et al. [29] showed protective effects of Sulfasalazine, a special NSAID, on cartilage metabolism. Taken together, NSAIDs seem to play a role in cartilage metabolism maybe especially during regeneration processes. Therefore, it is at least doubtful to use these drugs for a longer time. The second often-administered drug is heparin against thrombosis. For the cartilage regeneration process heparin is probably without a negative effect. On the contrary, it was shown that bovine knee chondrocytes produced more GAGs and collagen in matrices with increasing concentrations of heparin [30]. The newer oral antithrombotic drugs like Rivaroxaban are so far not often used. Most surgeons use a single-shot antibiotics to prevent infections. As example it is known that a quinolone like Ofloxacin show chondrotoxicity even by a single oral administration in a rat model [31, 32]. However, in most cases Cephalosporin and Clindamycin are the main choice for a single-shot antibiotics. For these antibiotics negative effects on cartilage or chondrocytes are not known till today.

Most instructors do an additional correction of axis malalignment in case of cartilage surgery. This is in accordance with a new study of Bauer et al. [33], but level of evidence is only IV (no control group) and therefore the benefit is limited. In addition, the authors described a MACT procedure in the context of osteoarthritis. Majority of instructors perform a correction starting at 5° valgus or varus malalignment. However, until now there is no evidence for this procedure and is mainly based on experiences from knee replacement. Most instructors do an overcorrection for a varus malalignment to a valgus knee and a physiological or 50 % correction in case of a valgus knee. This is in accordance to the treatment of unicompartamental osteoarthritis, which is shown in many studies [34]. However, it is not proved today if this transfer is allowed. In contrast, the above-mentioned study by Bauer et al. [33] recommended a neutralizing osteotomy for a varus knee without overcorrection. However, an overcorrection control-group is missing in this study. Other studies do not exist regarding cartilage lesion, respectively, surgery and osteotomies around the knee.

The preferred surgical procedure for a HTO in the survey is the open wedge technique. This is in accordance with the literature in which this technique is today the preferred and most described one [35–41]. The open-wedge technique with angle-stable plates for HTO is a safe procedure with a low complication rates [36]. In contrast, in this survey there was no preference for either open- or closed-wedge technique regarding the DFO.

If a concomitant knee joint instability is present it is recommended by the majority of instructors to treat also the instability. Most instructors perform both procedures at the same time. The treatment of a concomitant instability seems to be reasonable to protect new cartilage tissue by avoiding abnormal knee kinematics. However, until now this is not evidence based. In contrast, Kessler et al. [42] and others showed no decrease in the osteoarthritis rate of knees with ACL reconstruction (non-anatomical) in comparison with conservatively treated ACL-deficient knee joints. To what extent these results are transferable to the combination cartilage therapy and knee instability is not known. However, it is possible that anatomical ACL reconstruction techniques with a restored normal knee kinematic [43] show better results regarding osteoarthritis rate and cartilage protection.

Conclusion

There is a great need for well-conducted, high-level evidence-based studies to learn more about all properties of an aftercare procedure following cartilage surgery. Up to this point it is only possible to use aftercare procedures based on clinical experiences. The best available source of information therefore is a survey of experienced surgeons as presented here.

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