Rehabilitation and Postoperative Management Practices After Osteochondral Allograft Transplants to the Distal Femur: A Report From the Metrics of Osteochondral Allografts (MOCA) Study Group 2016 Survey

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Context: We present the current spectrum of postoperative management practices for patients receiving distal femur osteochondral allograft (OCA) transplants.

Evidence Acquisition: The Joint Restoration Foundation database was examined in cooperation with the Metrics of Osteochondral Allografts study group to identify 121 surgeons who had performed at least 1 OCA transplant in the past year; 63% of surgeons responded.

Study Design: Clinical survey.

Level of Evidence: Level 3.

Results: Postoperative weightbearing restrictions ranged from immediate nonweightbearing with full weightbearing by 12 weeks to immediate weightbearing as tolerated. Most surgeons who performed fewer (<10) OCA transplants per year followed the most restrictive protocol, while surgeons who performed more (>20) OCA transplants per year followed the least restrictive protocol. One-third of surgeons with the most restrictive protocol were more likely to change their protocol to be less restrictive over time, while none of those with the least restrictive protocol changed their protocol over time. Fifty-five percent of surgeons permitted return to full activity at 26 weeks, while 27% of surgeons lifted restrictions at 16 weeks.

Conclusion: Characterization of the spectrum of postoperative management practices after OCA transplantation provides a foundation for future investigations regarding patient outcomes and associated cost to establish best practice guidelines. Fundamentally, surgeons with more experience with this procedure tended to be more aggressive with their postoperative rehabilitation guidelines. Most commonly, rehabilitation provided for some degree of limited weightbearing; however, the spectrum also included immediate full weightbearing practices.

Keywords: osteochondral allograft; cartilage; knee; rehabilitation; weightbearing

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Osteochondral allograft (OCA) transplantation is a valuable therapeutic option that effectively restores joint anatomy for an expanding set of indications.[4,39,45] Postoperative management, including rehabilitation recommendations, evaluation of healing progress, and temporal considerations for return to activity, are influential to outcomes and patient decision making.[3,10] A spectrum of approaches is required, as recommendations are dependent on numerous factors, including the involved anatomic region, patient-specific issues, and technical factors related to the transplant reconstruction. As such, no clear consensus on timing of rehabilitation and return to activity exists. A variety of protocols are described[3,6,8,18,22,24,29,30,33,35,37,47] and are fundamentally based on patient functional capacity, maximizing incorporation of the transplant tissue and protecting the joint while healing progresses. These approaches have developed without the support of technique-specific level 1 evidence but rather from an amalgam of basic science data and surgical recovery principles.[45] The origins of OCA transplantation have evolved from oncologic applications where massive grafts and more invasive surgical approaches are routine. As a result, the origins of rehabilitation and postsurgical recommendations stem from a recovery process focused on limiting stress to the massive allografts in patients frequently affected by the nature of such debilitating disease and its treatments.[36]

To better appreciate the current range of rehabilitation practice patterns, a survey of orthopaedic surgeons with current experience using the OCA procedure in the knee was undertaken. The specific goal was to describe the current spectrum of postoperative management practices particular to standard contained singular 15- to 27.5-mm core press-fit-type grafts to the distal femur. Postoperative activity recommendations were evaluated, including initial weightbearing status, time to full weightbearing, time to unrestricted activity, type of radiographic assessment of healing, and surgeon experience with these techniques, as well as surgeon practice changes regarding these protocols over time. This report describes the current spectrum of postoperative recommendations after OCA transplantation in the knee to catalog the standards of care.

METHODS

The Joint Restoration Foundation database (JRF Ortho) was examined in cooperation with the Metrics of Osteochondral Allografts (MOCA) study group to identify 121 surgeons who could be reached directly and who had performed at least 1 OCA transplant in the past year. Electronic letters were sent to encourage participation in an online survey (see the Appendix, available in the online version of this article) from February 10 to April 8, 2016. Follow-up emails were sent on 2 occasions as reminders of this request. This confidential, self-administered survey gathered information regarding surgeons' experience with OCA transplantation and rehabilitation protocol prescriptions including initial weightbearing status on the index limb, progression to full weightbearing, time to permitting unrestricted activity, changes to rehabilitation protocol, and follow-up imaging modality. Data were deidentified and collated by KDH Research & Communication, Inc.

Rehabilitation protocols that included immediate nonweightbearing (NWB) with progression to full weightbearing by 6 or 12 weeks were defined as "most restrictive." Protocols that included immediate toe-touch weightbearing (TTWB) with progression to full weightbearing by 12 weeks were defined as "intermediate." Protocols with immediate weightbearing as tolerated (WBAT) were defined as "least restrictive." Those protocols that were in the chosen category of "other" were assigned to the categories above (most restrictive, intermediate, least restrictive) based on whether they included some form of immediate NWB, immediate TTWB, or immediate WBAT.

RESULTS

Surgeon Demographics

The survey was completed by 63% (76/121) of surgeons who were contacted, and the majority of responders provided an answer for all of the questions. Most responders (33/74, 45%) learned to perform the procedure as fellows, although 31% (23/74) were self-taught and 22% (16/74) received peer training. The largest group of responders (33/76) had at least 10 years of experience with OCA transplantation (Figure 1a). Fifty-eight percent of surgeons (44/76) performed 10 or fewer OCA transplants per year, although those performing more than 20 per year (14/76) represented almost 1 in 5 (Figure 1b).

Postoperative Rehabilitation Protocols

The spectrum of postoperative weightbearing restrictions ranged from immediate prolonged NWB to immediate WBAT (Figure 2). The most restrictive protocols, immediate NWB with progression to full weightbearing (FWB) by 6 or 12 weeks, were prescribed by 52% (40/76) of surgeons. Intermediate protocols, TTWB with progression to FWB by 6 or 12 weeks, were prescribed by 24% (18/76) of surgeons. The least restrictive protocol, immediate WBAT, was prescribed by 5% (4/76) of surgeons. In addition, 19% (14/76) listed a modification of these protocols as an alternative to the 5 presented options, described as "other" in Figure 2. The most restrictive "other" protocols ranged from NWB for 3 weeks to 2 months. Intermediate "other" protocols included TTWB for 2 to 12 weeks, progressing to WBAT or to FWB after 4 to 6 weeks. The least restrictive protocols in the "other" group included 25% weightbearing or foot-flat protected weightbearing for 4 weeks.

Postoperative continuous passive motion (CPM) machine use varied widely, with some recommendations dictated by insurance concerns. Approximately one-half of participants prescribed CPM rarely (21%) or never (27%), and the other half prescribed a CPM most of the time (21%) or always (24%).

Return to Unrestricted Activity

The time before returning to full activity ranged from 6 weeks to 6 months, although 8% (6/75) of responders restricted activity for over 6 months or had other protocols ("others," Figure 3). These "others"

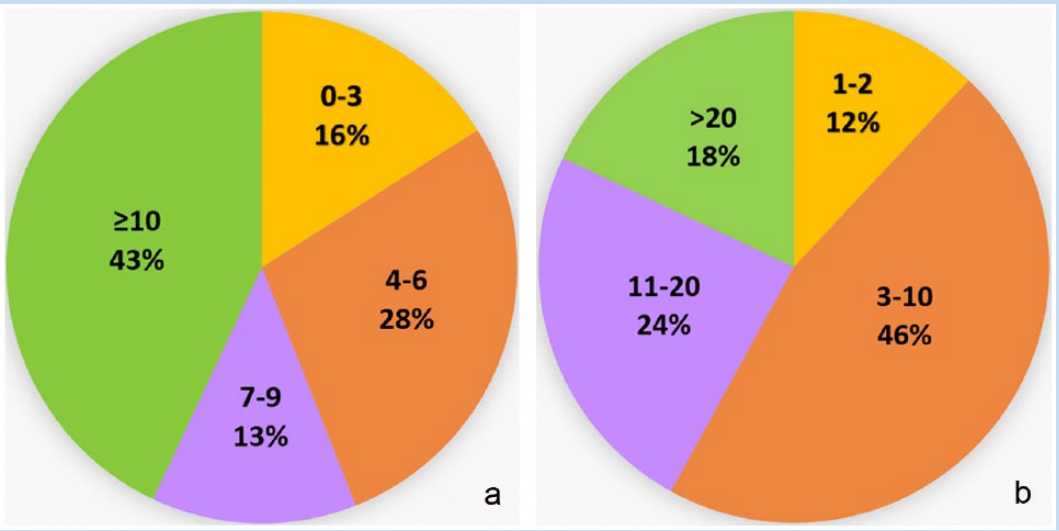

Figure 1. (a) Surgeons' years of experience in osteochondral allograft (OCA) transplantation. (b) Number of OCA transplants performed per year.

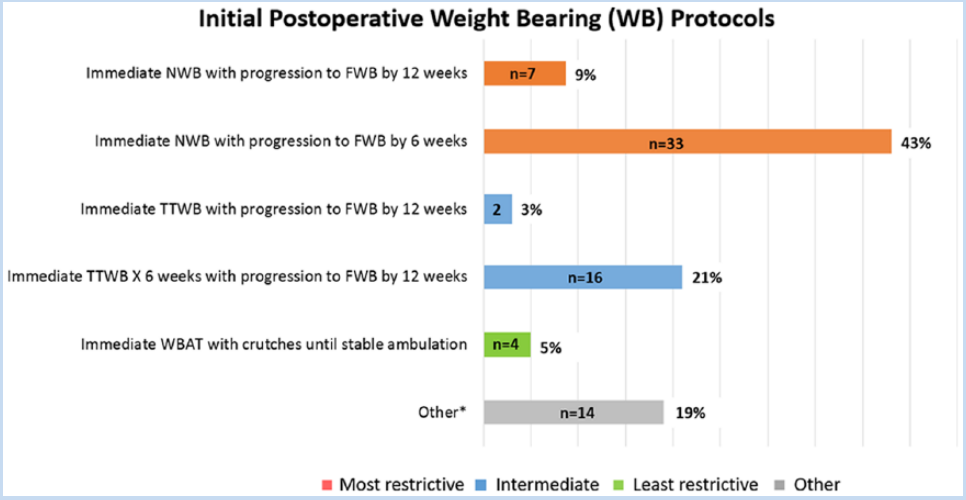

Figure 2. Postoperative weightbearing protocols from most restrictive to least restrictive. FWB, full weightbearing; NWB, nonweightbearing; TTWB, toe-touch weightbearing; WBAT, weightbearing as tolerated.

included lifting restrictions based on magnetic resonance images at 6 (n = 1) or 9 (n = 1) months, lifting restrictions at 8 (n = 1) or 12 (n = 2) months, or were based on functional capacity (ie, no restrictions by 12 weeks for nonathletes or by 6 to 8 months for athletes based on quadriceps strength; n = 1). The majority of surgeons permitted unrestricted activity at 26 weeks, followed by surgeons who lifted restrictions at 16 weeks. Regardless of the rehabilitation protocol, most surgeons prohibited unrestricted activity until at least 26 weeks.

The restrictiveness of the rehabilitation protocol was related to the number of OCA transplantations performed per year. Those surgeons with the most restrictive rehabilitation protocols generally performed 10 or less OCA transplantations per year, while those with the least restrictive protocols generally performed more than 20 per year (Figure 4).

The time to return to full activity also varied by initial rehabilitation protocol (Figure 5). Nine percent of surgeons with the most restrictive protocols allowed return to full activity at 12 weeks, compared with 50% in the least restrictive group. Similarly, 59% of those with the most restrictive protocol waited until 26 weeks or longer for return to full activity, compared with 17% in the least restrictive group.

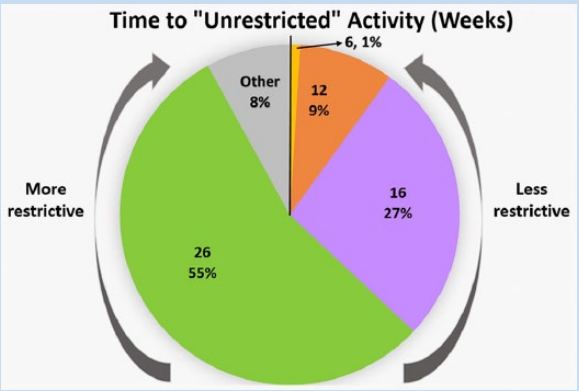

Figure 3. Number of weeks until unrestricted activity was allowed.

Changes in Rehabilitation Protocols

Approximately one-half of surgeons (37/76, 49%) altered their rehabilitation protocols over time during their years performing OCA transplantations, and 51% reported no change. Of these, the vast majority (33/37, 89%) prescribed less restrictive (more rapid) rehabilitation with earlier weightbearing or sooner unrestricted activity, while only 11% (4/37) became more restrictive. Thirty-five percent of surgeons with the most restrictive protocol and 44% of those with intermediate protocols changed their protocol to be less restrictive over time, while far fewer surgeons in these groups changed to a more restrictive protocol over time (Figure 6). Interestingly, none of those with the least restrictive protocol changed their protocol over time to be more restrictive.

For those who changed their rehabilitation protocol over time, changes resulted from increasing surgeon comfort with the procedure (25/37) or were based on scientific literature (13/37), expert opinion/academic presentation (11/37), or patient demands and expectations (9/37) (Figure 7). Other reasons included clinical experience (4/37). More than 1 reason for the protocol change was noted by 49% of those who changed their protocol over time.

The change in rehabilitation protocol over time did not appear to be a factor of the surgeons' years of OCA transplantation experience (Figure 8). There was also no clear correlation between surgeons' experience in years and time to unrestricted activity: Of surgeons who performed more than 10 OCA procedures per year, 57% allowed full activity after 12 weeks and 50% did not allow full activity until after 6 months. Similarly, of surgeons who performed 3 or less OCA procedures per year, 14% allowed full activity after 12 weeks and 17% allowed full activity after 26 weeks (there were no surgeons in the "after 6 months" group).

Postoperative Imaging Evaluation

Sixty-six percent (50/76) of surgeons always obtained postoperative imaging, and 21% (16/76) obtained postoperative imaging "most of the time." If imaging was obtained postoperatively, it was most often obtained by radiography (63/72, 88%), followed by magnetic resonance imaging (MRI) (25/72, 35%). In addition, 28% of surgeons used more than 1 imaging technique, usually MRI and radiography. Most surgeons employed follow-up imaging at 2 or more time periods, with a cumulative distribution of any imaging at 6 weeks (62%), 12 weeks (55%), 16 weeks (8%), 26 weeks (45%), and 12 months (50%). If patients were imaged at more than 1 time period, images were generally taken at 6 weeks (54%) or 12 weeks (49%) and at 26 weeks (41%) or 1 year (46%). Some surgeons obtained images at up to 4 time points (14%), and others obtained none (n = 1).

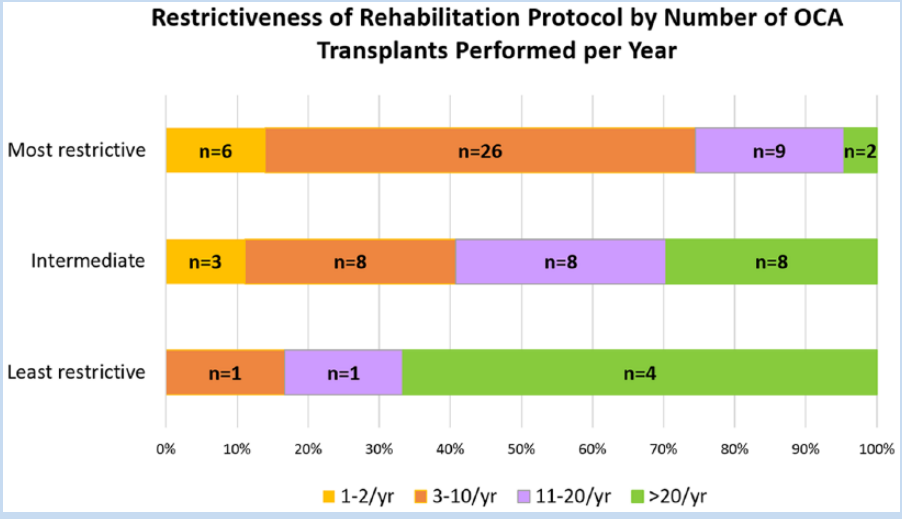

Figure 4. Restrictiveness of initial rehabilitation protocol (most to least) as a function of number of osteochondral allograft (OCA) transplantations performed per year.

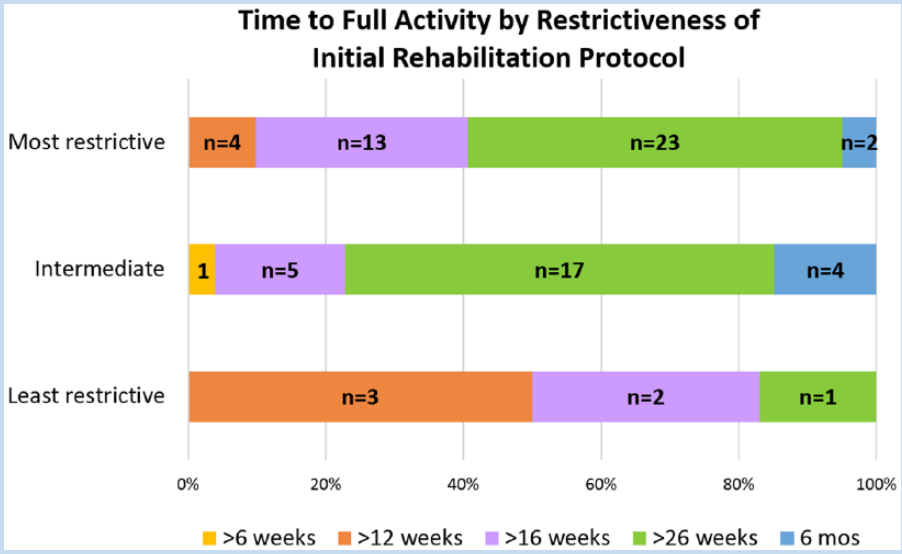

Figure 5. Dependence of time to unrestricted activity (weeks) on initial rehabilitation protocol (most restrictive to least restrictive).

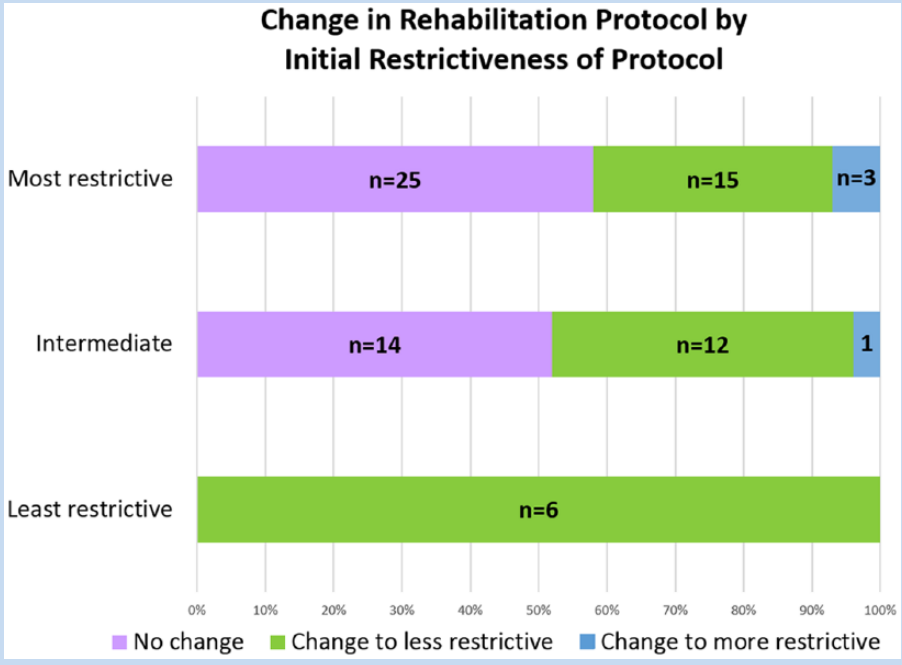

Figure 6. Dependence of change in rehabilitation protocol (to less restrictive, no change, to more restrictive) on the initial rehabilitation approach (most restrictive to least restrictive).

DISCUSSION

This survey was not designed to evaluate efficacy, although evidence related to accelerated rehabilitation after cartilage procedures is accumulating. If it is shown that rehabilitation protocols known to improve global patient metrics can be balanced with concerns for biological healing, the burden of surgical intervention and patient perioperative restrictions may be reduced. Thus, for patients treated with isolated press-fit contained femoral allograft transplants, a less restricted weightbearing and motion program could be favorable clinically. While postoperative protocols after OCA transplantation will certainly evolve over time, studies that directly link specific protocol designs to OCA incorporation,

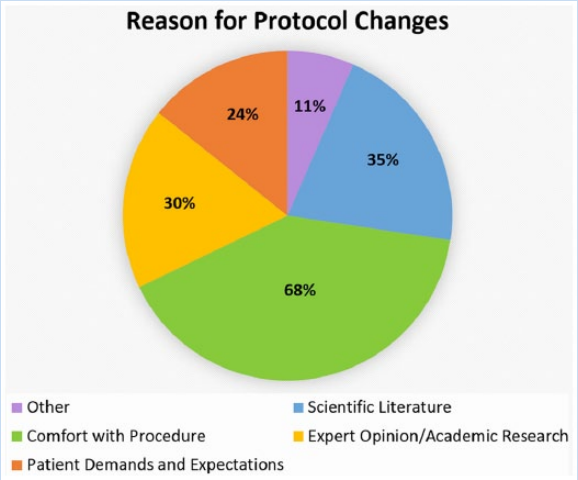

Figure 7. Reasons given for change in rehabilitation protocol by those respondents who changed their protocol over time. Many respondents chose more than 1 reason for the protocol change.

sustained cartilage viability and matrix production, and specific patient outcomes measures are ripe for further consideration.

In the 1980s, rehabilitation protocols after anterior cruciate ligament (ACL) repair generally included being NWB for at least 6 weeks, motion limited until 3 to 6 months in a brace for protection, and delays in FWB until 16 weeks and return to full activity until over 9 months.[41] Since that time, more accelerated protocols have become common,[35,36,38,40] with no ill effects on pain[40] or function.[11,35,38,40] While ACL reconstruction and graft incorporation is not analogous to the healing and graft incorporation required for osteochondral transplants, positive outcomes from accelerated ACL rehabilitation suggests a historical precedent for considering a more permissive OCA rehabilitation prescription.

It is now well known that immobilization leads to deleterious changes in articular cartilage[2,46] as well as muscle atrophy,[32] joint stress,[1] and deep vein thrombosis and arthrofibrosis.[28,34] Similar to ACL repair, accelerated rehabilitation after cartilage surgery may be safe and tends to suggest improved outcomes.[12-17,28] In direct comparisons of different weightbearing protocols after matrix-induced autologous chondrocyte implantation, accelerated weightbearing resulted in improvements in pain and function compared with traditional rehabilitation protocols, with no increased risk of graft delamination or failure.[13-17] Similarly, equivalent cartilage repair resulted from NWB and WBAT protocols after osteochondral autograft transfer during second-look knee arthroscopy.[28] Ebert et al[12] further identified that the acceleration of weightbearing from 8 to 6 weeks was not detrimental to matrix-induced autologous chondrocyte implantation.

Review of patient cohort studies specifically (Table 1) and a survey of review articles[4,5,7,9,20,21,23,25,26,31,36,42,45] regarding OCA transplantation to the distal femur reveal postoperative protocols that range from immediate NWB in the first 6 to 8 weeks to variations of TTWB, along with different range of motion restrictions.[3,6,8,11,18,22,24,29,30,33,35,37,47]

Few investigators report immediate WBAT for contained OCA. Brown et al[3] prescribed immediate WBAT with early unlimited open-chain range of motion after single dowel press-fit grafting techniques to the distal femur. They reported excellent graft incorporation using computed tomography scanning at 6 months, with an associated improvement in Knee injury and Osteoarthritis Outcomes Score and International Knee

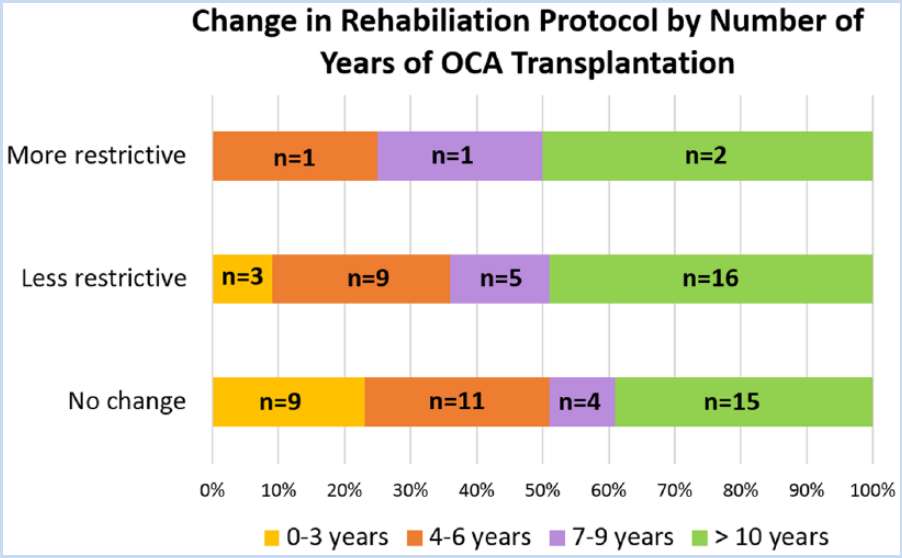

Figure 8. Change in rehabilitation protocol (more restrictive, less restrictive, no change) as a function of experience with osteochondral allograft (OCA) transplantation (years).

Table 1. Review of patient cohort studies regarding osteochondral allograft transplantation

Study	No. of Patients	Graft ± Fixation	Weightbearing	Brace	CPM	Activity
McDermott et al[37]	95		NWB 7-10 days, PWB 6-12 months	6-12 months		
Davidson et al[11]	67	D/PF	PWB (crutches) 6 weeks, FWB 6 weeks	3 weeks	3 weeks	Sports and full activity at 6 months
Bugbee and Convery[6]	55	D/PF or S/F	NWB 6-12 weeks		Yes	ADL by 4 months, impact at 6 months
Gross et al[24]	60	S/F	WB in brace at 8 weeks	Cast 2 weeks, custom WB orthosis 1 year	2-3 days	WB when osteotomy healed (if osteotomy needed)
Chu et al[8]	43	S/PF or S/F	NWB 12+ weeks		Yes	Progressive WB after 12 weeks
Garrett[22]	17	D/PF, S/F	NWB 6 weeks, PWB 3-4 months		Yes	Gradual return to moderate activity
LaPrade et al[30]	23	D/PF	NWB for 8 weeks	Exercises with knee immobilizer for 8 weeks	8 weeks	Low-impact activities for 12 months
Krych et al[29]	43	D/PF	NWB or TTWB for 4-6 weeks		4-6 weeks	On individual patient basis based on lower extremity strength
Levy et al[33]	129	D/PF or S/F	TTWB for 8-12 weeks	Closed-chain exercises at 4 weeks, full active ROM by 8-12 weeks		Progressive WB at 12 weeks, normal activities at 6 months
Williams et al[47]	19	D/PF	TTWB for 8 weeks	Hinged brace for 8 weeks, unloader brace for 8 weeks to 4 months	6 weeks	Supervised rehabilitation until 4-8 months
McCulloch et al[35]	25	D/PF	TTWB on crutches for 6 weeks		6 weeks	
Emmerson et al[18]	66	D/PF or S/F	Protected WB for 12 weeks		While in hospital	Closed-chain exercises at 4 weeks, full activity at 3-4 months, sports and recreation at 4-6 months
Brown et al[3]	34	D/PF	Immediate WB	1 week minimum, full open-chain passive ROM		Immediate open-chain ROM

ADL, activities of daily living; CPM, continuous passive motion; D, dowel; F, fixation; NWB, nonweightbearing; PF, press fit; PWB, partial weightbearing; ROM, range of motion; S, shell; TTWB, toe-touch weightbearing; WB, weightbearing.

Documentation Committee score maintained through a minimum 2 years postoperatively. Limiting restrictions and accelerating return to activity may therefore be applicable in the setting of small singular contained press-fit dowel grafts for femoral condyle defects.

It is important to recognize that rehabilitation after transplantation of other types of grafts (non-press-fit, shell) and at other locations (patellofemoral, tibial) need to be tailored at the discretion of the surgeon- and patient-specific needs.[38,40,44] Other important considerations for design of postoperative rehabilitation protocols, not necessarily specific to OCA, must also be considered. The type of defect (eg, diagnosis and etiology, size, meniscal status, alignment) and other patient-specific factors must be weighed. For example, Kosiur and Collins,[28] in considering autograft transplant, did not allow accelerated rehabilitation with congruent ACL surgery.

Use of a CPM machine, bracing, and/or physical therapy rehabilitation exercise programs also vary widely. There are no standardized guidelines for CPM use after cartilage surgeries.[27] Fazalare et al[19] performed a systematic review of CPM use after various knee cartilage surgeries but could not find clinical evidence for its use despite basic science support and anecdotal reports of its benefit. Partial weightbearing is an improvement over CPM as it provides a stimulus to develop repair tissue as well as maintaining muscle strength.[43] However, excessive loading must be avoided until tissue repair is complete.[43]

The limitations of this study include response bias inherent in a survey questionnaire; there were likely differences in the way each question was interpreted by the respondent, which would affect data reliability. Similarly, the survey was not formally tested for validity, and the sample size was modest, resulting in small numbers in subgroupings, the latter precluding statistical comparisons.

CONCLUSION

Characterization of the spectrum of postoperative management practices after OCA transplantation provides an understanding of current standards of care while providing a potential foundation for future investigations. This review did not attempt to measure patient outcomes, cost, or surgical success. It was limited to postoperative management strategy approaches, as measured by the use of various rehabilitation protocols. If the accumulating evidence that rehabilitation principles known to improve global patient metrics can be balanced with concerns for biological healing, the burden of surgical intervention and perioperative restrictions on our patients may be reduced and improved.

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