

REVIEW

Body-Self Unity With a New Hip or Knee: Understanding Total Joint Replacement Within an Embodiment Framework

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Medical research increasingly makes use of embodiment concepts to understand how illness disrupts unity of body and self. However, few have applied embodiment concepts in total joint replacement (TJR), an effective treatment for end-stage arthritis. In considering why a troubling proportion of TJR recipients have continued pain and functional limitation, we ask: what role might be played by the embodied experience of living with an implant? Relevant theoretical models and prior research on embodiment in musculoskeletal health and transplantation are reviewed. Our findings suggest a research agenda with implications for addressing suboptimal outcomes in TJR.

Introduction

Many doors have opened in the study of physical illness through the gradual rejection of Cartesian dualism, which supposes mind and body to be separate. Bolstered by new neurobiological evidence in the latter half of the 20th century, an alternative notion posits that mind and body are inextricably connected (1). Scholarship has flourished in this realm, much of it drawing on theories of embodiment. “Embodiment” can be defined as “the human experience of simultaneously having and being a body” (2). That is, we are the subjects of our own existence (the “subject body”), and we observe ourselves (the “object body”) (3). Proponents of embodiment argue that the study of mind and body should be integrated to yield new insights in fields once seen as having only psychological dimensions and those seen as being only physical (4).

Several fields of study, particularly health psychology and behavioral medicine, exemplify this trend toward integration (4). Embodiment is gaining a more central role in medical research as research findings point to an interplay of psychological and physical factors contributing to illness and treatment responses. Research of this type acknowledges that an interplay of mental and physical processes contributes to many illnesses. Attitudes toward one’s body and awareness of bodily sensations have been linked to pain sensitivity (5), are altered by illness, may be useful to address during treatment, and can have a profound effect on well-being (6).

In what follows, we aim to place total joint replacement (TJR)—a treatment that restores bodily function and reduces pain for those with advanced arthritis—within an embodiment framework. More than 680 000 total knee replacements (TKRs) and 370 000 total hip replacements (THRs) are performed annually in the United States alone (7). TJR provides a fascinating model for embodiment. These pain-relieving procedures have the potential to mend the dysfunctional body-self relationships that develop in chronic joint disease (8,9). On the other hand, TJR replaces the organic joint with a prosthesis, a foreign object, creating for each TJR recipient the challenge of integrating other (the implant) and self.

The first several decades of research on TJR yielded improvements in surgical technique and biomaterials that translated to better outcomes for patients (eg, fewer complications, better pain relief, and longer survival of the implant). Despite these and other advances, however, rates of patient satisfaction and pain relief have remained stubbornly stable, with approximately 20% of recipients of TKR reporting continued pain or poor satisfaction, usually in the absence of technical deficiencies with the implant, surgical complications, or other pathoanatomic explanations (10,11). Although technical innovation continues with the aim of developing better implants and surgical protocols (12), investigators recognize that persistence of symptoms may not have a technical or mechanical explanation. It is reasonable to hypothesize that the explanations for persistent pain may lie in psychosocial

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realms (13). Indeed, poor mental health and cognitive affective variables (eg, pain catastrophizing) are known contributors to persistent pain after TJR (14–16). Yet, no existing model can explain all variation in outcomes. In considering why a troubling proportion of TJR recipients continue to experience pain and functional limitation, we ask: what role might be played by the embodied experience of living with an implant?

Overview of Embodiment Concepts

Embodiment is grounded in the work of phenomenologist Maurice Merleau-Ponty, who describes the body's ability to be the subject of experience, not just an object. Merleau-Ponty's concept of "habit" can be seen as a dialogue between body and environment, in which the body develops behaviors appropriate for responding to the world (17). Through habit, the body seeks equilibrium and adjusts to our changing circumstances, but this does not preclude the possibility of being out of equilibrium (18).

Gadow (19) further develops notions of disequilibrium versus equilibrium, or embodiment, in the body-self dialectic (3). Embodiment refers to the neutral state of experiencing self and body as one, which may be called "the lived body" (3). In body-self unity, the body is seen as trustworthy and as an ally in accomplishing one's personal goals, and is felt to be one's own (6,8,20). In dysfunction, one experiences a "body-self split" or an "object body." In Gadow's (19) framework, the primary immediacy of the lived body gives way to the object body when disrupted by illness or injury or when physical sensations, such as hunger, bring the body to our attention (19). Regaining harmony between the lived body and object body is known as "cultivated immediacy" (19).

The state of body-self unity can also be understood as a spectrum of embodiment, with extremes of embodiment at either end. In dysfunction, the body either becomes hyperpresent (hyperembodiment) or feels alienated, as if it belongs to someone else (disembodiment) (3,21).

Finally, body awareness (BA) describes the thoughts that characterize ways of relating to the body. BA is an "attentional focus on and awareness of internal body sensations" (22). BA can denote a hyperfocus on distressing sensations. Indeed, the prevailing view in the medical literature is of BA as maladaptive (22). However, it can be adaptive when focused on specific sensations in the present moment in contrast to a diffuse hypervigilance (22).

Understanding Musculoskeletal Disease Through Embodiment

Embodiment, body-self unity, and BA have been used to understand individuals' experiences in chronic musculoskeletal disease (8,9,22–26) (Table 1). Chronic pain and functional limitation alter the relationship to the body. Maladaptive forms of BA, which involve heightened awareness of bodily sensations and pain, characterize conditions that include osteoarthritis (OA) and

rheumatoid arthritis (9,22). Studies have also identified disturbed forms of embodiment in those with other types of musculoskeletal pain (24,27). For example, in a study of patients with fibromyalgia, participants oscillated between hyperembodiment ("Before I had no idea of my body.... And now I get up...and drag myself day after day") and disembodiment or alienation ("That's another body, that's no longer my body, that's no longer me") (24).

Adapting to such illnesses may involve healing dysfunctional body-self relationships, whether through intervention or long-term coping mechanisms (28). OA may be viewed, especially among older adults, as a normal part of aging that must be accepted rather than treated (29). This suggests a need for cognitive and behavioral coping mechanisms over years and decades living with the disease, and these may be connected with body-self unity. Self-esteem—critical for successful adaptation to chronic illness—is associated with higher body-self unity (8). Improved BA was also found in patients with musculoskeletal pain following a rehabilitation program (30).

Individuals undergoing more discrete treatments for chronic musculoskeletal conditions report changes in their thought patterns that demonstrate reductions in negative BA and increases in body-self unity (4,30). In a study of elective hand surgeries to improve musculoskeletal function, subjects displayed less alienation of affected body parts following surgery (6). This can be conceptualized as a form of "return" to the lived body—reintegration or achieving cultivated immediacy (19). Further research is needed to confirm that pain-improving interventions also produce improvements in embodiment. If so, this supports a causal relationship in which musculoskeletal limitation contributes to dysfunctional embodiment. Reciprocal causation is also plausible; it could be demonstrated if interventions that promote normal embodiment also produce pain and function improvements. Both these lines of research will require measures that quantify specific aspects of embodiment (eg, BA and body-self unity).

In summary, there is reason to view embodiment as a fruitful way of understanding chronic musculoskeletal illness experience. Qualitative studies in these conditions have revealed that negative BA and disturbed body-self unity are salient aspects of patient experiences (6,9,26). Quantitative studies have measured disturbed embodiment in those with musculoskeletal disease (correlating with higher pain-related functional limitation) (27) and have found that individuals with higher body-self unity have other markers of successful adaptation to illness (8). The resulting expectation is that improving pain and function can transform these bodily attitudes (9). Yet, remarkably, little is known about how embodiment changes following the most effective treatment for end-stage joint disease: TJR.

Toward Models for Embodiment in TJR

Approximately half of those with knee OA will go on to receive a TKR (31), and a substantial number of persons with

Table 1. Selected models of embodiment in transplantation and joint replacement

Model	Construct(s) Measured	Modes of Assessment	Representative Literature
General			
Interoceptive and exteroceptive awareness	BA	Exteroceptive: body-scaled action-anticipation tasks (body-size estimation); interoceptive: heartbeat detection	Steen et al (4), Mehling et al (22), Valenzuela-Moguillansky et al (27)
Body-self harmony versus body-self alienation	Body-self unity	Multiple examples include BEQ and BCQ	Bode et al (8)
Hyperembodiment, disembodiment	Spectrum of embodiment disturbances	...	Fuchs and Schlimme (3), Calsius et al (24)
Body-self dialectic suggests that illness contributes to an object body; intervention may promote "cultivated immediacy"	Gadow's (19) body-self dialectic	Various qualitative measures; embodiment profile: subjects choose a group of statements that best describes how they experience the body part most of the time	Hudak et al (6), Nyvang et al (9), MacKay et al (26)
Transplants and prostheses			
Alienation through chronic illness and limitation; disruption of bodily integrity in transplantation; harboring identity of donor	Alienation and disruption of bodily integrity	...	Svenaesus (21), Mauthner et al (45)
Implicit and explicit embodiment; dual goals of rehabilitation	Implicit embodiment: processing input as you would from a natural limb; explicit embodiment: attitudes and affective feelings toward limb	Implicit: judge size of peripersonal space (eg, reachability task); explicit: questionnaire (reporting on quantity of use, function, ease of use, sense of appropriating the prosthesis, etc)	Murray (46), Gouzien et al (47), Widehammar et al (48)
In joint-replacement outcomes			
Joint perception	"Nativity" versus artificiality of joint	One-question perception questionnaire: "How do you perceive your hip or knee after undergoing total hip or knee replacement?" 1. Like a native or natural joint 2. Like an artificial joint with no restriction 3. Like an artificial joint with minimal restriction 4. Like an artificial joint with major restriction 5. Like a nonfunctional joint	Collins et al (37), Varacallo et al (56)
Joint awareness	Forgotten joint: absence of awareness of joint during daily activities	FJS-12	Thompson et al (57)
Knee-related body perception	Integration of knee with body; ease of controlling knee and perceiving its boundaries and movement	Fremantle Knee Awareness Questionnaire	Nishigami et al (43)

Abbreviation: BA, body awareness; BCQ, Body Consciousness Questionnaire; BEQ, Body Experience Questionnaire; FJS, Forgotten Joint Score.

hip OA ultimately elect THR. These procedures are effective; over 80% of TKR recipients and 90% of THR recipients experience substantial improvements in pain and function (10). Like the elective hand surgeries that Hudak (6) describes, TJR restores function to body parts used to navigate and manipulate the world; when successful, long-lost daily activities are restored. Studies of patient experiences post-TJR tend to focus on pain management, satisfaction with care (32,33), return to work (34,35), or physical activity (36), and, to date, scholars have not applied a similar embodiment framework to experiences following TJR. Given the nontrivial proportion of TJR (especially TKR) recipients who do not achieve desired levels of pain relief and functional improvement, the lack of attention to embodiment presents an important research gap.

At present, we are left to speculate as to the state of embodiment post-TJR. Nyvang et al (9), in a study of adults scheduled to undergo TKR, close with this prediction:

Expectations concerning the outcome of surgery were strongly related to what the patients considered they had lost during the progress of the disease, such as physical activity and unawareness of the knee. This may be related and interpreted as reuniting body and self and rebuilding a “lived body” rather than an “object body.”

Yet, this view of the likely outcome may be simplistic based on what we do know of patient experiences following surgery. Although few studies have addressed patients’ experiences of their bodies after joint replacement, the results of such studies are telling. In one, 42% of THR and 80% of TKR recipients attested to perceiving the joint as “artificial” (rather than “native or natural”) on a simple questionnaire designed to assess joint perception (37). Some recipients experience conscious awareness of the joint when it functions differently during certain tasks (38). They report vigilance and protective urges toward their knees, hesitating to exercise or risk falling (36,39,40). Caution toward the joint is often accompanied by alienation: “It’s an artificial hip, it’s not the same as having your own.... It just makes it that you’re aware that you have a different hip now.... You don’t trust the hip. You’re thinking about this new thing you have inside your body” (36). Anything that draws one’s attention to the new joint can also produce joint awareness, affecting patient experiences (38). The “squeaking hip,” for example, is a phenomenon of audible squeaking after THR with use of ceramic-on-ceramic bearings (41).

A few scales do exist that quantify aspects of embodiment related to knee OA, and these show the ability to distinguish between patients and healthy controls and between patients with better and worse outcomes. The Forgotten Joint Score shows the ability to distinguish between TJR recipients and healthy controls, with more frequent awareness of the joint among TJR recipients (42). Similarly, the Fremantle Knee Awareness Questionnaire shows higher scores among knee OA patients compared with controls, and its construct validity

is supported by its associations with pain, functional limitation, pain catastrophizing, kinesiphobia, and anxiety (43). Correlations with established patient-reported outcomes suggests the validity of embodiment as a distinct, but related, type of outcome.

Beyond these postsurgical experiences, patient attitudes toward surgery itself present complicating factors. Karlson et al (44) found that individuals, particularly women, may view the joint replacement as a threat to bodily autonomy. Participants displayed “an intense aversion that their body would be invaded; this included the insertion of foreign objects such as surgical instruments...[and] the prosthesis itself” (44). TJR, above and beyond most surgeries, may activate fears of invasion; the implant remains and must be accepted or integrated in postsurgical life.

This observation suggests some parallels with experiences of transplantation, on which there is a larger literature (21,45) (Table 1). Research that takes a phenomenological approach to transplantation provides models for understanding TJR. Sve-naeus (21) describes the complex effects on body-self unity that can occur with kidney transplantation, for example. In chronic illness (whether renal or musculoskeletal), daily activities are limited, the body becomes an obstacle, and attention centers on the body, making it the object of one’s consciousness (21). Replacing the faulty organ, whether with a transplant or an implant, offers the chance to re-engage daily activities. Ideally, the integrated lived body can return as the alienation experienced in illness or injury diminishes (21). Yet, the individual’s attitudes toward the body and physical activity have likely been altered by years of chronic limitation (36).

Organ transplantation presents unique challenges insofar as it may create an interconnectedness with the donor. This effect can be particularly strong with organs felt to “harbor the identity of another person” (the heart, for example) (21). There is a tendency to ruminate on the origins of the organ, pondering the identity of its owner, and feeling gratitude and/or guilt toward that person (21). Indeed, transplant recipients report disruptions to identity and feelings of bodily integrity (45). Nevertheless, these models from the transplant literature may be useful in understanding TJR. They suggest that, in TJR recipients, alienation from the new joint may limit the reintegration that is otherwise possible when pain and function improve.

The literature on prosthetic limbs provides other models (46–48). But, as with the transplant literature, the experience of TJR ultimately diverges. Incorporating a prosthetic limb—an arm, for example—can be seen as involving two forms of embodiment. Implicit embodiment occurs when recipients process the prosthesis in the same way they would the biological body part (47). Explicit embodiment refers to a range of subjective feelings toward the body part, including affective feelings and perceptions of bodily integrity and ownership (47). These two concepts of implicit and explicit embodiment aid in describing the complex experiences of recipients. No prosthesis functions exactly like a biological limb.

Yet, a limb may feel embodied even if it does not achieve total perceptual and functional similarity to the limb (46).

Research Agenda and Clinical Implications

In this final section, we present a research agenda focused on better understanding the role of embodiment in determining TJR outcome and suggest interventions that might address these pathways. To do so, we draw upon the strands of research discussed previously and synthesized in Table 1: theories of embodiment, models from transplantation and limb prostheses, and prior use of embodiment in joint replacement outcomes.

Effect of time spent with chronic illness: Our knowledge of embodiment pre-TJR can guide an investigation of experiences post-TJR, about which less is known. Individuals with OA describe lack of trust in the knee, avoidance of physical activity, uncertainty about which activities are safe, hyperawareness of the knee, and transformed ideas about their own bodies (26). It will be important to understand how presurgical bodily attitudes transfer or do not transfer to the postsurgical period. As Nyvang et al (9) describe, chronic joint pain and limitation can produce a sense that the joint is ever-present in daily life, along with expectations that surgery will help the recipient regain what was lost. The postsurgical experience will reflect the bodily habit developed in the time spent delaying, and then preparing for, joint replacement.

Surgical experience and invasion: If an individual views TJR—the surgery and the prosthesis itself—as an invasion or threat to bodily autonomy, that belief could influence the decision to undergo surgery, expectations, and behaviors and perceptions after surgery. Some subgroups, such as women or individuals with a history of trauma, might feel these concerns more acutely (44).

Effect of characteristics of the joint: After surgery, the artificial joint itself has qualities that could promote or interfere with full integration. To adopt a framing from the transplant literature, one desired outcome may be implicit embodiment—using the implant like the native body part. Like a prosthetic limb, an artificial knee will seldom function exactly like the original one (having a more limited range of motion or being uncomfortable to kneel on, for example) (38,49). Unlike a prosthetic limb, a knee has little to no effect on the body's shape, size, or boundaries in the world (peripersonal space), a major focus of recent research on prosthetics (46,47).

Meanwhile, other factors may contribute to explicit embodiment, such as one's attitudes and affective feelings toward the joint. Here again, TJR diverges from the models provided by transplants and limb prostheses. Unlike an organ transplant, an artificial joint never belonged to another human, removing any cause for fixation on the implant's origins. It may have different social salience and social meanings compared with an arm (46) and indeed can remain hidden much of the time. That said, posture and gait can be altered following surgery, and walking holds

symbolic value in our culture (50). Additionally, the skin wound is visible with some types of clothing. Social environments can powerfully influence embodiment when, for example, social perceptions trigger an “object body” state (6).

Of note, for explicit embodiment, studies of patient experiences following joint replacement should be attuned to the language used to describe the new joint. Hudak (6) found that some participants “systematically [used] language reflecting detachment from their hands, referring to ‘the hand’ or ‘it’ rather than ‘my hand.’” Existing interview data could be analyzed with an eye to such linguistic markers.

Understanding the Role of Embodiment in Successful Recovery

Most people do well after TJR despite the challenges posed by embodiment. We hypothesize that embodiment, like other risk factors, could help explain differences between those with optimal and suboptimal outcomes. Embodiment of the prosthetic could become a problem for some individuals but not for others because of the interplay of many variables, including long-lasting pain after surgery or preexisting risk factors. Poor embodiment (incomplete integration), for those who experience it, could then reciprocally contribute to further pain and/or limitation. To understand embodiment's role in recovery, we need to untangle these potential causal relationships.

New instruments will serve this research. Although instruments exist to measure how natural the joint feels (joint perception) (37,51), how it is integrated into bodily perception (43), and how often it is successfully forgotten (52) (Table 1), more research is needed to see what factors contribute to these experiences and what other aspects of embodiment may play a role. Currently, no scales exist to comprehensively capture the ways a joint may affect various aspects of embodiment: body-self unity, BA, hyperembodiment and disembodiment, and explicit affective responses. Developing such a scale would allow us to quantitatively assess the presence and strength of a relationship between states of embodiment and TJR patient experience.

Participation restriction is a more recent outcome of interest and reflects whole-body and whole-person functioning. For this reason, it would be interesting to understand whether embodiment and participation restriction are connected. Continued pain in the index knee and pain in the contralateral knee both predict more participation restriction (51), but we know little about the perceptions or experiences that contribute (52).

Toward new interventions: It is possible that incomplete reintegration and beliefs toward the new knee underlie the suboptimal outcomes of TJR in some patients. If we establish that connection, it suggests a novel approach to treatment. Can one's relationship to the implant be modified through conscious effort? In the limb prosthesis literature, there is a strong interest in how we can modify the relationship to the new limb, promoting fuller

use of the limb as well as more positive affective feelings toward it (46). Interventions do exist to modify disturbed bodily perceptions in chronic musculoskeletal disease, many using enhanced reality (computer-augmented visual or other perceptual experiences) (53,54). These target the perceptions of fragility and functional limitation that reinforce ongoing avoidance, limitation, and pain (54).

Similarly, but with a broader focus, interventions for TJR recipients could help patients understand that their relationship to the joint is important and that it can be modified through active effort. Behavioral interventions could be led by psychotherapists, physical therapists, or other providers drawing on cognitive-behavioral principles. These could prepare patients for the active work of “[constructing] new meanings for their bodies” (6). One goal would be to reframe the potentially problematic beliefs we have mentioned: to see the joint as a tool made to help the body function rather than a reason to be fearful of exercise, to see it as a tool freely adopted rather than an invasive force, and to see it as one’s own rather than foreign. Such interventions should address the social contexts that influence embodiment and can draw on the experiences of prior recipients who have achieved cultivated immediacy more or less easily.

Clinicians should be aware that difficulties with integrating the prosthetic joint may be a subtext in patient-provider conversations about limited function or hesitation to exercise. Sharing information about safe physical activity and impressing upon patients that the joint belongs to them, not to the surgeon, could ameliorate some of these concerns.

Thus, understanding such changes to body-self unity will have implications for the management of chronic musculoskeletal disease, some of which resolve with surgery and some of which never resolve and require adaptation (28). Greater unity could be thought to mark successful adaptation to chronic illness and successful integration of a prosthetic joint.

But before any links with outcomes become clear, we will have to gain a fuller picture of embodied experiences of TJR. At the turn of the 21st century, Wilde (55) shared the following perspective on the rise of embodiment in health research: “With embodied perspectives, we can no longer assume that people separate ‘themselves’ from a piece of technology or an appliance. For the most part, we do not know how people experience such technologies.” In the case of TJR, this still rings true. More research is needed to understand the clinical implications of one’s beliefs and attitudes toward the implanted joint and to test the hypothesis that interventions designed to improve body unity could improve TJR outcomes.

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All authors drafted the article, revised it critically for important intellectual content, and approved the final version to be published. All authors have contributed significantly to the design of this research project and the critical revision of the manuscript.

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