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Influence of Mechanical Choices on Development and Persistence of Osteoarthritis: How Alexander Technique Can Promote Prevention and Management

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Influence of Mechanical Choices on Development and Persistence of Osteoarthritis: How Alexander Technique Can Promote Prevention and Management

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Introduction

Philosophical circles have long been acquainted with Locke's concept of tabula rasa, or "blank slate," which has sparked an endless debate over whether nature or nurture makes us who we are. It is of particularly great interest to know the causation of continually burdening experiences; people who have developed osteoarthritis, for example, are reminded daily of their disease, and yet years of research have been unable to track a consistent, predictable causation. Does osteoarthritis occur by default, or is it designed into being along the way? Is the fate to deal with this condition vested in genetic makeup, or do individuals aggravate their joints into inflammation by the way they treat them? As many a seasoned philosopher would tell, people are not fully the "tabula rasa" but a complicated conglomeration of experiences, decisions, and inheritance. It seems plausible that such is the case for the development of osteoarthritis.

In light of this multi-dimensional perspective, this research studies the relevance of Alexander Technique to one of those dimensions. Alexander Technique is classified as a movement therapy, but this does not quite encompass the mindset of it—that it is indeed largely a mindset about movement. Alexander Technique emphasizes self-awareness about how a person moves, or uses, his or her body. It is physical minimalism, and involves continual recognition of muscle tension along with the ability to let go of any tension that is burdensome and unnecessary. This technique has diminished pain and increased the ease of movement for those who have experienced it—even people with osteoarthritis. But for it to be effective for the general population of people with osteoarthritis, it must first be generally known. What will be argued in the following pages is that the prevention and hindrance of osteoarthritis can be accomplished through a heightened consideration of how joints are treated.

Research Design

A large component of this research will be an investigation of osteoarthritis itself and the vast amount of study that has been exerted to understand its pathogenesis. The fields of physiology, genetics, immunology, and clinical practice already have much to share, and an understanding of the disease would be impossible without those areas of expertise. Information will be gleaned from those sources and combined with studies about the benefits and goals of Alexander Technique to discover the common ground of osteoarthritis treatment.

Hypothesis

Alexander Technique improves the experience of and pain management for people with osteoarthritis.

Methods

A cross-sectional study will be conducted assessing the association of Alexander Technique to the minimization of pain from osteoarthritis. This will be achieved by inviting participants who have osteoarthritis and have or have not taken Alexander Technique lessons to complete a uniform, online questionnaire about their levels of physical activity and pain.

Results

It was found that participants who had received Alexander Technique lessons reported an average of one more pain-free day per week, and experienced diminished pain levels for daily physical activities such as walking. Management strategies also indicated the benefit of Alexander Technique; those who had taken lessons used pain and anti-inflammatory medications less frequently and were able to be more physically active than the unexposed group. No statistical significance was achieved from the data, largely contributable to small sample size (Alexander Technique exposure, n=12, no Alexander Technique exposure, n=25)

Conclusion

Alexander Technique is a promising option for improved management of osteoarthritis that addresses the contribution of mechanical stress in disease etiology. Osteoarthritis patients who are also students of the Alexander Technique experience better quality of life as evidenced by lower pain levels and more potential for physical activity. This assertion would benefit from larger and more prospective studies to better understand the trends observed.

Chapter 1: Epidemiology of Osteoarthritis

Osteoarthritis of the knee ranks among the five most disability-inducing diseases for adults in the United States (US)[22], indicating its comparable severity to conditions like chronic

obstructive pulmonary disease and congestive heart failure[11]. Four out of every ten adults with this condition classify their health as less than positive[22]. The painfulness of daily activities along with the decline in emotional health from avoiding those activities contribute to this trend. In fact, 25% of osteoarthritis sufferers report being simply unable to withstand certain activities of daily living (ADLs)[22]. It is likely that the decline in health represents both mental and physical consequences and their synergistic effects upon each other.

An epidemic can be defined as the existence of health events that exceeds expected counts for a particular community[19]. Though only statistics localized to the knee have been discussed above, a conservatively estimated 26.9 million US adults were diagnosed with nonspecific osteoarthritis in 2005[22]. This represents an addition of 5.9 million to the prevalence of osteoarthritis since 1990[22]. The community of US adults faces an epidemic—one that has resisted management over the decades during which its incidence continues to rise. Even so, the US community can achieve a sense of stability and direction by following an established series of protocol for outbreak investigation. With a few modifications, the following outline (Figure 1) provided by the Centers for Disease Control and Prevention (CDC) is a useful tool to understand where osteoarthritis stands in the US population today[14]. By beginning with a description of the disease and its occurrence, the existence of an outbreak of osteoarthritis is evident. By moving toward identification of risk factors and development of treatment options, a reasonable and beneficial strategy toward osteoarthritis can be achieved.

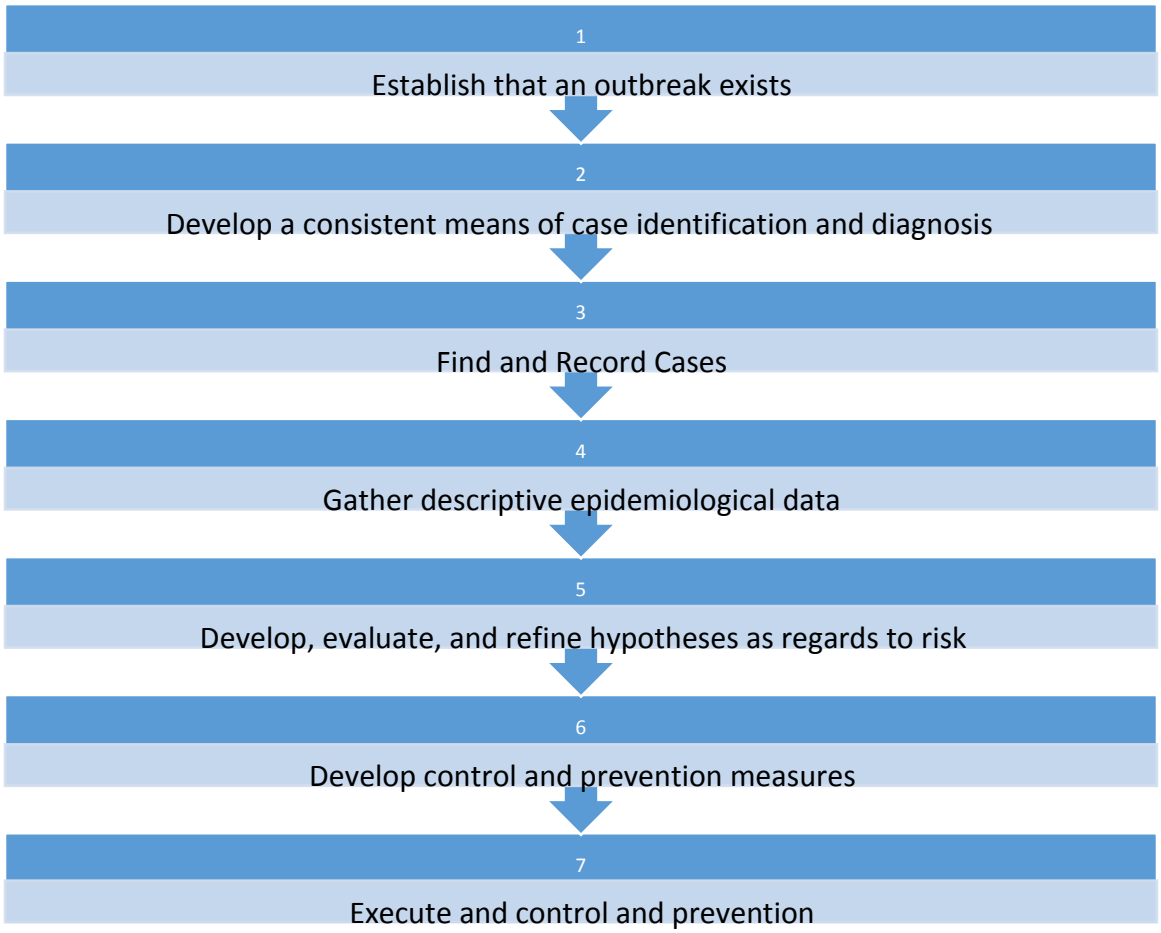

Figure 1: CDC Steps in Outbreak Investigation[14]

Diagnosis Confirmation and Case Identification

Osteoarthritis is not a disease for which proactive screenings are in place. Instead, its diagnosis is reliant on emergence of painful symptoms, and the only incentive for seeking medical intervention comes with the desire to reduce those symptoms[10]. Unfortunately, though, intervention has less potential for success in the comparatively advanced pathogenesis that prompts diagnosis[16]. Several techniques aim at filling this deficit for earlier detection, mainly relying on morphological changes at the joint to recognize a disease state. Although osteoarthritis is defined by cartilage loss, it is clinically diagnosable by the observance of osteophytes, subchondral sclerosis, and subchondral cysts, along with diminishment of the joint space[6] as seen

via plain film radiography[101] The search to provide earlier diagnosis is not solved well by this radiography, though, because reduction in joint space is still a relatively progressive event[10].

Magnetic resonance imaging (MRI) has great potential in this respect, although suiting it to the needs of viewing osteoarthritis is an ongoing challenge. MRI is preferable to plain film radiography because it produces vastly better resolution, giving more holistic insight into the joint such that the earliest morphological changes in cartilage may be detectable[10]. Even more experimental is the use of a Joint Acoustic Analysis System[25]. This system, adapted from the acoustic emission technology of structural engineering, provides an active, auditory interpretation of joint health[25] in contrast to the static, visual image of MRI. When further developed, this system may provide an alternative means of diagnosis and a way to prescribe treatment measures and movement therapies.

Descriptive Epidemiology

Descriptive epidemiology is the initial collection of information through means such as cross-sectional surveys and ecological studies, and provides useful statistics about a condition or other health event[19]. It does not assume causation or analysis, but is a necessary precursor; before discovering associations and tendencies, it is important to organize data into the categories of person, place, and time[19]. One example derived from data organization according to persons is that women are 45% more likely to develop knee osteoarthritis and 36% more likely to suffer from hip osteoarthritis as compared to their male contemporaries[22]. Descriptive epidemiology is hypothesis-generating because it notifies the researcher of trends toward disease[19]. These statistics may prompt research into how bone's density and size affects its ability to support

[1] A more thorough discussion of bone morphology is included in chapter 3.

loads, especially since incidence is markedly increased in women after the age of 50[22] and so may correlate to the onset of menopause.

Describing the extent of osteoarthritis would be incomplete without the acknowledgment of age, a factor combining the elements of person and time. Incidence of new cases increases up until the age of 80[22]. Prevalence of knee osteoarthritis, which combines incidental and all other existing cases of the disease[19], is remarkably increased as the US population ages: from an adult's mid-20s to mid-40s, the risk is a mere 4.9% in comparison to the 37.4% risk by the age of 60[22]. Because statistics like these lend themselves so readily toward determining the risk factors of osteoarthritis, identifying causative elements is a logical next step.

Risk Factors

Osteoarthritis is an eclectic disease arising from such a variety of sources that causation can be difficult to sort out. However, continuing research is supporting genetics as a source in many cases. The Arthritis Research UK Osteoarthritis Genetics Consortium, along with other genome-wide association studies, has so far isolated eleven loci on chromosomes that yield osteoarthritis tendencies[10]. Twin studies show that genetic makeup contributes especially to osteoarthritis of the hip and spine[20]. The increased prevalence of hand and knee osteoarthritis in women also has a solid genetic basis, with 65% of these cases being genetically derived[20]. Specific genes linked to osteoarthritis include transforming growth factor β, cartilage matrix protein, cartilage link protein, and several genes coding for types of collagen[20]. Genetic anomalies can also contribute to the development of osteoarthritis by an indirect route; single nucleotide polymorphisms for hip shape and bone density can inadvertently cause osteoarthritis because the resulting anatomic morphologies are risk factors hindering joint stability[10]. For example, hip dysplasia interferes with a correct articulation of the hip with the femur and can

lead to unequal leg lengths, and this misalignment contributes to adverse biomechanics from which osteoarthritis generally arises[10]. A multiplicity of factors contributes to and reinforces osteoarthritis, and it is often the case that these factors occur in layers—that there are risk factors for risk factors.

This layered effect is exemplified by the process of aging, which is itself a risk factor. Osteoarthritis of the knee especially becomes more of a risk as person ages, as cartilage degeneration is one of many changes encouraged by the passing of years[24]. Other changes include increased rigidity of ligaments, decreased amount and quality of synovial fluid, and roughness of the articular surface of the knee[24]. This decline can be seen on a cellular level, as glycation end-products are found in increasing amounts in aged joints[10]. These glycation end-products receive the attention of toll-like receptors, which are important mediators in innate immunity and thus contribute to inflammation[10]. Toll-like receptors are embedded in the membranes of chondrocytes, activating these immune cells of the cartilage and triggering the catabolic pathways toward osteoarthritis[10]. The strata of risk factors continue to mound. The symptoms of inflammation that alert many people of their osteoarthritis are directly caused by this immune response[10]. It would seem that the very mechanism designed to protect the body poses a risk toward its degradation at the climax of a long series of events.

Control and Prevention

Control of an epidemic through treatment and prevention is the aim of all the preceding steps in an outbreak investigation. Considering the suffering dealt with by those with osteoarthritis, health providers feel obligated to safely alleviate pain as a first step in treatment. However, it has proven difficult to tailor treatments that move beyond this basic address of symptoms. To make matters more complicated, even the safety of satisfying pain relief is

questionable. Acetaminophen is recommended as a first line of defense, but is often not strong enough and especially ineffective in patients already receiving the more powerful non-steroidal anti-inflammatory drugs (NSAIDs) [17]. NSAID pain relievers are powerful but dangerous to the gastrointestinal system, and even the COX-2 inhibitors taken as a substitute for more harmful NSAIDs[21] are posing threats to the cardiovascular system[21]. Clearly a new kind of safe pain relief is in order, but that is a tall order.

Non-pharmalogical treatments are gaining attention and use, but are still relatively unnoticed. Specifically recommended are exercises that incorporate daily tasks of the person with osteoarthritis into a routine that strengthen muscles around the affected joints[17]. Unlike common conceptions of exercise, it is especially important not to aggravate osteoarthritis by continuing an exercise that causes pain. Instead, a physical therapist should be involved in the planning of low-impact, aerobic exercises[17]. The prospect of learning how to continue movement with minimal pain and joint aggravation is an ideal that can be accomplished via Alexander Technique, which will be extensively discussed in the following chapters. Other treatments in common use are those intended to correct misalignment by wearing neoprene sleeves, valgus braces, or wedged insoles[17]. Though these are effective in correcting misalignment of diseased joints, only the first two have shown significant pain reduction[17].

Osteoarthritis has long been a disease characterized by painful limitations with little inclination toward healing. The Arthritis Foundation made a bold statement with their 2014 report, calling it "The Story of Yes[23]." Their goal is for a refocused perspective on arthritis that is more positive. They hope to accomplish this by making their organization more outwardly focused on meeting the needs of the average person with arthritis through advocacy, support, and enriched scientific research goals[23]. As a part of their vision they state: "We'll become their

[arthritis patients'] partner – and empower them to solve problems and meet their ever-changing daily challenges. With a chronic disease, treatment is a lifelong commitment. The goal is for people not to feel like victims and to help them solve their own problems[23]." The Alexander Technique, the topic of the following chapter, is indeed a commitment to solving one's own problems and to choosing a joint-friendly lifestyle.

Chapter 2: Principles of Alexander Technique

Alexander Technique is, out of necessity, distinct from more traditional trajectories toward health. When the vocal rest prescribed by his physicians proved scantily effective, Frederick Matthias Alexander's laryngitis[2] seemed determined to ruin his blossoming career in oratory. Alexander was more determined, though. He reasoned that a lack of any physical defects in his vocal mechanism must mean that his symptoms were the result of using a perfectly functional mechanism incorrectly[2]. He took it upon himself to discover his misuse and fix it[8]. The process by which he accomplished his own curing is now known as Alexander Technique[8], and his stubborn experimentation has been to the benefit of scores after him.

Alexander found that this "misuse," a term he had adapted for the purpose of his technique, was more specifically described as unnecessary muscle tension[8]. In other words, he was choosing to use his body poorly. Glenna Batson, using her unique perspective as both physical therapist and Alexander Technique teacher, analyzes his poor movement patterns as a modified startle reflex[2] (Figure 2). As his head tugged forward and down, his spinal extensor muscles contracted and his chest wall, needing to expand with breath, became unsustainably depressed instead. Exaggerated cervical lordosis (Figure 3) was the result of a combination of unnecessary preparations every time he began to speak[2].

Figure 2[29]: Startle reflex in the left skeleton showing depressed chest wall

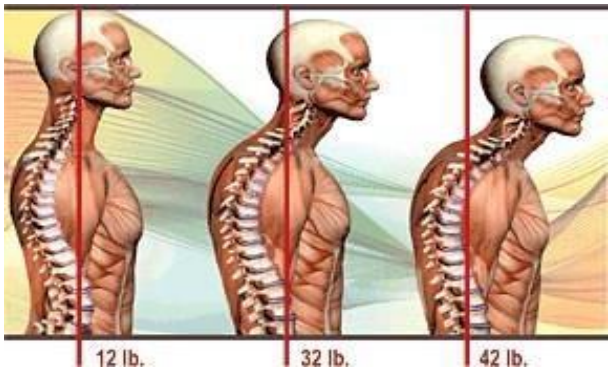

Figure 3[30]: Muscular impact from increased cervical lordosis, indicating increased tension in the spinal extensor muscles in the upper back

When he surrounded himself with mirrors to conduct his observation, the problem became clear, but fixing his misuse proved less simple than he anticipated. To do so, he would have to break a habit he had never previously known existed[8]. Trial and error swiftly taught his first lesson: he could not produce an effect of correct use that was completely unknown to him by relying on his previous notions of how to use himself. In effect, he was treating his mind and body as two separate entities, with their only relationship being that the former controlled the latter. Alexander describes his recognition of "psychophysical unity"[8] that pervades his technique:

> "I must admit that when I began my investigation, I, in common with most people, conceived of 'body' and 'mind' as separate parts of the same organism, and consequently believed that human ills, difficulties and shortcomings could be classified as either 'mental or 'physical' and dealt with on specifically 'mental' or 'physical' lines. My practical experiences, however, led me to abandon this point of view. It is *impossible* to separate 'mental' and 'physical' processes in any form of human activity"[1]

Not only is the brain informing the body about what mechanical choices to make, but the body is also sending feedback on those mechanical choices. Habitual misuse feeds misinterpretation, or as Alexander describes it, "unreliable sensory appreciation," of the communication between brain and body, hindering proprioception[8].

The Alexander Technique lesson combats this unreliable sensory appreciation by reeducating the student's movement to account for interconnected nervous and muscular systems[2]. In the lesson, the teacher uses touch to guide the student in realizing how habits of misuse result in unnecessary and harmful movement and holding patterns[12], and with this the

first hurdle is crossed. Once the problem is identified, the student must first unlearn his or her everyday habits of tension before discovering the freedom of correct use. These principles are respectively called inhibition and direction, in Alexander-speak[8]. By first inhibiting the instinct to jerk themselves out of their misuse, students avoid the co-contraction strategy[2], which involves contracting the muscle groups antagonistic to the ones participating in the misuse. Such a reaction merely replaces one tense muscle for another[2]. Through inhibition, relaxation of the originally tensed muscles is achieved instead, and can be followed by a more accurately informed direction of movement[1].

Studied benefits of Alexander Technique

Although the broad terminology used in Alexander Technique can seem quite abstract and difficult to explain, the individual who receives lessons experiences these concepts concretely. Testimonials boasting of better pain management and greater freedom of movement travel as would most anecdotal evidence[2], by word of mouth and recommendation. This has been vital to the spread of Alexander Technique among colleagues and cohorts, but it remains unknown to the majority of the population. A recent trend of research into the technique's efficacy, however, may exponentially increase the potential for Alexander Technique to be more accessible.

Work-related musculoskeletal disorders (WRMSD) have become heavily diagnosed amongst sonographers, and this prompted the creation of a workshop for these individuals at the University of the West of England[9]. At this workshop, sonographers gave an account of the contributing sources to their pain: repetitive precise movements of upper limbs, the pressure for speed and accuracy, and long work hours with few breaks[9]. These individuals were instructed in several techniques to relieve their pain symptoms, and were subsequently surveyed regarding the

benefit of each technique[9]. Alexander Technique made a positive impression amongst these workers; almost every participant indicated that he or she "strongly agreed" and "agreed" that it was a helpful, relevant, and practical way to make better use of their upper bodies as they completed the tasks of their career[9].

Taking a more quantitative approach, MacPherson et al. conducted a randomized trial to compare the effect of Alexander Technique, acupuncture, and usual care on the persistence of already chronic neck pain[16]. This is a decisive examination into the claims made by Alexander Technique, as the relationship of the head to the neck is a primary and continuous focus. Indeed, this relationship at the atlanto-occipital joint is called the Primary Control, and mastering the release of tension here is critical to successful reduction of tension elsewhere[8]. Thus, chronic neck pain is indicative of a malfunction in Primary Control. Participants designated for Alexander Technique received 20 individualized lessons, taught weekly in addition to the participants' usual care regimens[16]. The participants, all of whom scored at least a 28% on the Northwick Park Questionnaire (NPQ) for pain and related disability upon entry into the study, were evaluated through the same survey at 3, 6, and 12 months following the trial[16]. Even after a year, participants who received Alexander Technique retained an average 31% reduction in NPQ scores. Even for students like these, who had experienced neck pain for a median duration of six years[16], Primary Control was finally established.

Applications toward Medicine

The consensus from these and a handful of other studies is that Alexander Technique provides the educational tools to improve one's overall health through effective use. It is of note that there are indeed only a handful of studies devoted to the scientific analysis of Alexander Technique; its history with medical practice doesn't give the impression of a flourishing

relationship. For the greater part of the last century, there has been an inequality in implied credibility between F.M. Alexander's discovery and other medically relevant findings. This disconnect does not appear to have ever been Alexander's intent[1], however, and perhaps these two disciplines are more capable than ever to work together.

Many doctors in the early twentieth century considered Alexander to be a unique colleague, and they accepted his knowledge as valuable[1]. In his book, "The Use of the Self," Alexander recounts that it was not uncommon for doctors, whom he referred to as "medical men," to send patients with persistent or seemingly unfounded conditions his way[1]. Some of these conditions included angina pectoris, asthma, sciatica, stuttering, and even the very thing that prompted the technique's formation—issues of the voice and throat[1]. Recalling these conditions in his book, he proceeds to make a bold statement, especially in the light of the great diversity of his students' troubles[1]. Alexander claims that for all patients referred to him, they always presented unrecognized poor use that disabled their recovery and their maintenance of good health[1].

Bolstered by his continual experience of simple explanations solving perplexing conditions, Alexander advocated for the holistic training of medical practitioners[1]. He argued that medical training would be incomplete if the physician lacked an understanding of his own mechanical choices, because this would stunt his awareness of the patient's mechanical choices and his ability to make a fully informed diagnosis[1]. Because Alexander Technique educates the individual on how to treat one's body well, it is logical that those individuals specializing in treatment of the human body should be likewise educated.

Considering Alexander's experience with conditions that result from a system-wide error, it follows naturally that he would plead with doctors to consider in their diagnoses the effects of

movement choices on the human body matrix. However, the majority and most influential doctors of his time did not consider his plethora of experience to be of scientific merit. To them, Alexander was unlicensed and unreliable—an outsider trying to tell them how to better practice medicine[1]. Perhaps he gave up promoting his technique as being medically therapeutic after continuous rejection by those established in the field to whom he had presented his work[13]. So, because most physician contemporaries didn't take him seriously, he focused instead on branding his technique as one for the benefit of health and functioning, rather than for specific medical treatment[13]. Though this focus is in good faith with his convictions for treating the body as one unit, it has also contributed to its invisibility within the medical community.

Changes within the ideology of medicine are creating a great potential for Alexander Technique to be reintroduced and embraced as a proponent of maintaining health. Mayo Clinic acknowledges this transition with the new term "integrative medicine," an approach combining traditional medicine with complementary and alternative medicine (CAM) [5]. As the doors are being opened for CAM, testing these new treatments and therapies is an assumed preliminary step. As such, this environment must be content with turbulence as different kinds of CAM prove themselves valuable enough to become mainstream[5]. Among these ranks, Alexander Technique is classified as a movement therapy and more generally as a mind and body practice by the National Center for Complementary and Integrative Health[4]. This means that it will be undergoing evaluation for acceptance as a viable treatment option along with a mosaic of other CAMs[4]. Perhaps, in this current setting, the rejection that Alexander received can be replaced by acceptance, allowing many more people to realize the wholeness of their functioning.

Chapter 3: Development of Osteoarthritis: Prevention and Alexander Technique

The joint mechanism is one of the most defining and liberating features of the vertebrate body. The musculoskeletal system must have some sustainable way to move in relation to itself, and the joint system meets that need. Therefore, the degradation of the joint toward a disease state renders lifestyles to be unsustainable. Can the problem be that individuals utilize these crucial movement mechanisms—that they move? Surely the human body works best when activity is a regular occurrence, and joints should keep up. At what point can the distinction be made between designed function and damage—between use and misuse? Analysis of the etiology of osteoarthritis is formative in understanding this paradox. Alexander Technique creates an awareness of both tendencies, and as students recognize dysfunction and appreciate function, they can discover sustainable habits of use[2].

When osteoarthritis reaches a clinical stage, affected joints have already taken on a massive collective impact. The Center for Disease Control and Prevention asserts that in 2005, 33.6% of US citizens aged 65 or older had osteoarthritis[22]. For a large portion of the years before the 65th, it is likely that these osteoarthritic joints withstood an outstanding amount of use and did so agreeably. It is also logical that most of the cohorts to these osteoarthritis sufferers—the other 66.4%--possess joints that are still agreeable to impact after at least 65 years of it. Though it may go unappreciated until it falters, the anatomy of the healthy joint has a robust capacity.

The Healthy Joint Mechanism

Synovial joints occur at the articulation of any two bones between which considerable movement is necessary, and their resilience results from several features working together to provide shock absorption and stabilization (Figure 4). A layer of hyaline cartilage enveloping the articular surface of synovial joints cushions against the impact of carrying weight on the

joint[6]. This cartilage, together with the lubricating capacity of synovial fluid in the joint capsule, prevents bony surfaces from touching as they move relative to each other. The outer layer of the

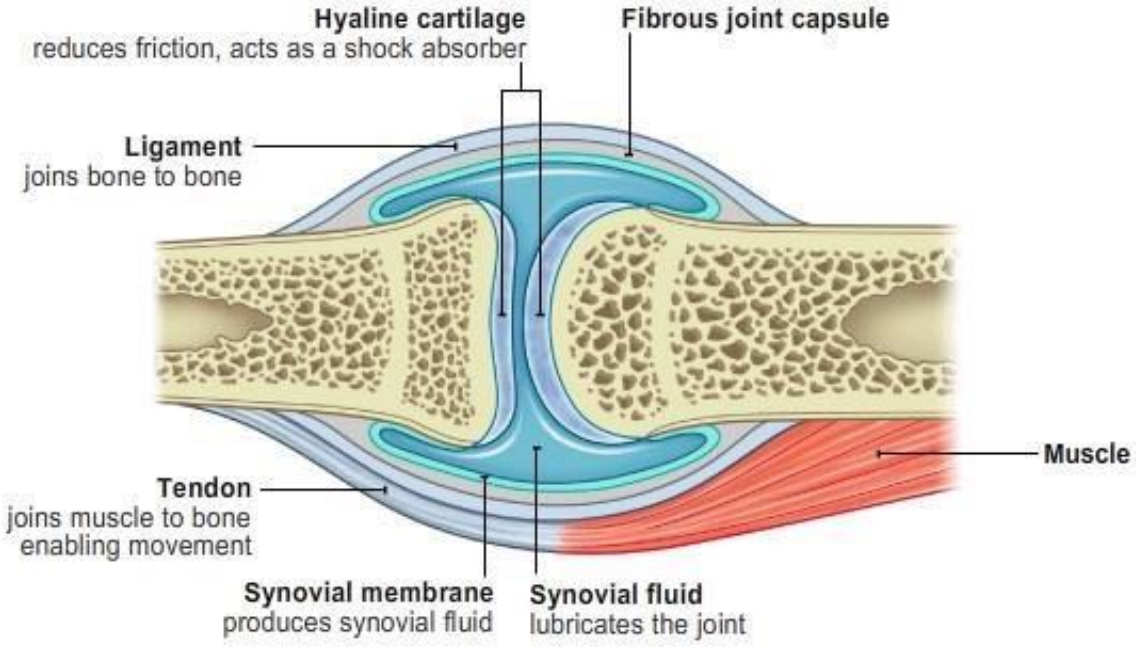

Figure 4[31]: Healthy Synovial Joint

joint capsule is described as the fibrous membrane, designed from thick connective tissue that thickens further to create ligaments in its goal of joint stabilization[6]. Though the joint capsule encloses hyaline cartilage and synovial fluid in all cases, some joints have an extra layer of defense. Articular discs, like those between vertebrae and in the wrist, absorb shock and allow for greater flexibility[6]. Even more specialized are menisci, which are C-shaped fibrocartilaginous pads that create tracks for the condyles of the femur to rest in as they move relative to the tibia, securing the knee joint further[6]. To understand how a healthy joint is maintained, though, it is helpful to consider joints at the cellular level. Several types of proteoglycans are embedded within the collagenous matrix of the cartilage, and their retention of water affords the cartilage its quality of shock absorption[10]. Chondrocytes, or cartilage cells, work as members of the immune system to regulate joint cartilage, reacting to threats toward its

physical and chemical integrity by producing a host of inflammatory proteins. Some of these, like aggrecan-degrading enzymes and collagenases, have reductive implications, while other proteins appear to aid in cartilage repair[10]. Up to a reasonable amount of biomechanical stress, these mechanisms work as a proverbial well-oiled machine. Osteoarthritis develops as a good system's unfortunate response to overload.

Structural Changes during Osteoarthritis

When components of the extracellular matrix in joint tissues are mechanically disrupted through blunt trauma or other stress, this disruption initiates the pathogenic process toward osteoarthritis. In this destructive process, cross-links within the collagenous matrix are broken by the impact of shear stress[24]. The reformation of these cross-links does not entail a complete restoration: instead of being somewhat randomly arranged as in healthy cartilage, cross-links realign in a parallel or radial fashion[24]. This creates a visibly distinct texture from smooth cartilage before trauma[24]. A large loss of proteoglycans from the extra-cellular matrix occurs after these bonds are torn, and the resultant decline in cartilage hydration contributes to the narrowing of the joint cavity space indicative of osteoarthritis[24].

Structural changes are not confined to cartilage, however. Subchondral bone, which lies between trabecular bone and the cartilage calcified below the tidemark (Figure 5), undergoes endochondral ossification in which the tidemark of calcification advances and penetrates the blood supply[10].

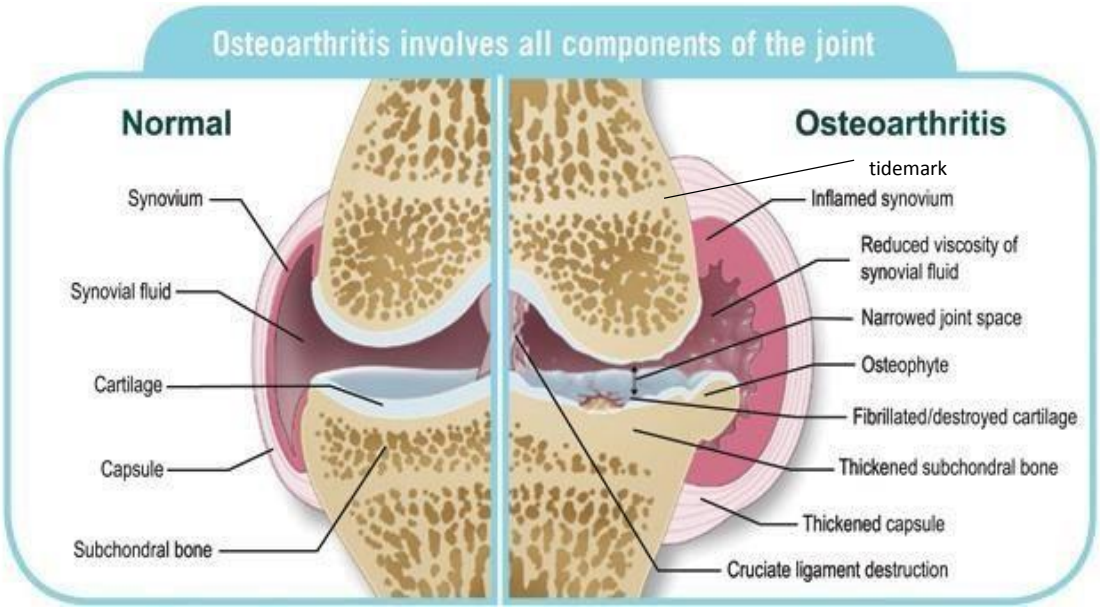

Figure 5[32]: Structural Changes in Osteoarthritis

The earliest physiologically detectable advancement of osteoarthritis, however, is the condition of synovitis[10]. This is inflammation of the synovial membrane, when synoviocytes accumulate and initiate release of inflammatory mediators that exacerbate degeneration through positive feedback[10]. As with chondrocytes and their positive process of immune function in small-scale matrix remodeling, inflammation of the synovial membrane occurs through continued stimulation of the innate immune system[10]. Because synovitis is one of the initial clues that a joint is inclined to develop osteoarthritis, its detection is significant for early treatment.

Efforts toward Early Detection

Is early treatment the best defense against osteoarthritis, and must people wait until they develop a clinically diagnosable case before they realize the need to address an issue? In a review of occupational hazards toward osteoarthritis development, one study analyzed the effect of operating jackhammers on the joints of the upper extremity. Pneumatic tools of this nature vibrate at frequencies of 2000 to 3000 oscillations per minute, and thereby stun the protective mechanism of muscles, tendons, and cartilage that absorb shock[7]. The muscle spindles that

receive feedback from loading become overwhelmed by the stimulation, and the high impact can create microfractures in the subchondral bone. The development of osteoarthritis in elbow or acromioclavicular joints in such cases can easily be accredited to damage taken on the job[7]. But when osteoarthritis becomes diagnosable, it has moved past the potential for healthy immune repair[10]. In the ethos of standard osteoarthritis care, a gap exists between being at risk and being diagnosable. A person either has osteoarthritis or they do not, and a definitive line divides each camp from the other in regards to the treatment received. The preceding analysis, however, suggests that osteoarthritis develops in continuum, with the "at risk" steps being potentially just as serious for what they enable. Indeed, this imagined gap can be a chasm of many years between initial damage and diagnosis, and all the while the continuum proceeds.

If prevention is to enhance proactivity against osteoarthritis, the pathogenesis that creates disease out of damage must be seen at work. Shark et. al. have manipulated technology designed for structural engineering for this very purpose[25]. If acoustic emissions (AE) sensors can detect and measure crack initiation in buildings[25], could they not detect crack initiation within the human structure? It was proposed that AE technology, with the sensitivity to measure within the range of 20 to 200 kHz, could measure whether a knee was well-lubricated and gliding silently or emitting sound indicative of degeneration[25]. To adapt this technology to measure acoustic emission based on joint angle, the AE sensor was placed on the surface of the knee closest to the femur's articulation with cartilage and coupled with an electronic angle measurement. This was dubbed the Joint Acoustic Analysis System (JAAS) [25]. The experiment specified the following movement pattern: participants folded their arms across their chests and ascended from a seated to an upright standing position, then reversed the movement to sit again[25]. This created four movement phases: ascending acceleration, ascending deceleration, descending acceleration, and descending deceleration. The last three of those phases produced the highest peak magnitudes of

AE in the groups of participants who had knee osteoarthritis, with descending deceleration producing especially stark elevations[25]. Because the collection of AE data is only possible as the knee is moving, it is set apart from other methods of joint analysis. Unlike MRI or other common techniques, AE allow for a more descriptive picture of the joint as it moves—an auditory video of how a joint is fairing under loading and moving patterns. This ability to listen to the knee presents the potential to observe osteoarthritis before it is diagnosed and quantifiably determine the efficacy of preventative measures[25].

Alexander Technique: Reducing Muscle Tension and Joint Loading

With the Joint Acoustic Analysis System comes the possibility to observe osteoarthritis through the prospective vantage point of prevention instead of the retrospective situation of damage control[25]. Unfortunately, osteoarthritis prevention is once again, minimally existent. It is to this previously mentioned gap that Alexander Technique holds promising evidence. One of the central concepts of Alexander Technique is what Gelb refers to as "economy of effort," in which the minimization of all but the necessary work to accomplish an action allows for greater ease of movement[8]. Research on the biomechanics of walking has come to a similar conclusion. In a discussion of modeling human gait patterns, the optimization of human motion is represented by a mathematical equation in which muscle tension as well as joint torque and angle profiles were calculated to minimize the function of human performance[27]. In other words, walking is optimal when human performance is minimal. This refers not to a minimal quality of performance, but instead to minimal quantity of performance as measured by mechanical energy, jerk, and dynamic effort[27].

How can humans proactively minimize their performance to optimize it? Xiang et. al. acknowledge the complexity of the mechanism behind ideal human gait, attributing it to the intricacies of neural control to create a fluid, consistent, and sustainable walking pattern[27]. Likewise, Alexander Technique's efficacy relies on reeducation of the neuromuscular system, treating the mind and body as one unit that must work cohesively. Through the processes of inhibition and direction discussed earlier, neural awareness informs muscular learning, enabling release of tension and greater ease[2].

The model of tensegrity is often employed for further explanation of these phenomena. In this structural engineering concept, there is a fluid mosaic of tension, and the hard compressed components float within soft components that expand and contract[2]. Alexander Technique strives to recreate this ideal within the human structure; bones should be allowed to suspend in a muscular network that is dynamic and organic, adopting tension and releasing it as needed to perform work (Figure 5). This is in contrast to the idea of an axial compression structure

Figure 5[33]: Human Tensegrity Models: full skeleton, bony spine, knee

vulnerable to the wear and tear imposed by joint loading[2]. Radin et. al. agree that the body structure should not be treated merely as a system to bear weight, asserting that osteoarthritis is primarily the result of mechanical choices that abuse the intended purpose of joints[24]. Joints such as that of the knee allow for movement at a small friction relative to large loads, but forcing them to move larger loads than are needed departs from design[24].

Denial of all activities of daily living that require lifting or carrying or any extra loading, however, would be impractical and not focused on the main physical contributor toward osteoarthritis development. Stress experienced by the articular cartilage is most destructive when the joint is bearing a higher rate of strain[24]. This assertion contains an important distinction: the frequency of strain carries more negative significance than the amount of strain. Radin et. al. subjected one group of rabbits to carrying heavy loads infrequently and a second group to carrying lighter loads frequently[24]. They discovered that repetitive impulsive loading, as experienced by the second group, caused more severe cartilage damage[24]. Within nine weeks, cartilage loss became evident in the joints of the rabbits that carried light loads daily[24]. Even though the experiment ended at this point and these rabbits experienced normal stress henceforth, osteoarthritis developed six weeks later[24]. The data suggests that frequent and small joint overload is more detrimental than rare, gross overload[24]. Thus, poor mechanical choices during daily standing, walking, climbing stairs, and the like are the greater criminals in joint degeneration. Alexander Technique teaches students how to undo these seemingly trivial daily misuses[2], preventing repetitive impulsive loading and the ever chronic continuum toward osteoarthritis.

Chapter 4: Living with Osteoarthritis: How Alexander Technique Can Help

Though efforts toward early detection and prevention of osteoarthritis are beginning to take on speed, the majority of those actually bearing the disease are not yet seeing any movement. Methods like the Joint Acoustic Analysis System[25] remain in experimental stages, and Alexander Technique tends to be a well-kept secret among performers[1]. Meanwhile, the diagnosis of osteoarthritis is largely symptom-based and its treatment largely relief-based[10]. The experimental shift in methodology is gaining momentum toward reform, though, fueled by increased insight into etiology and pathogenesis[10].

Accumulating research cites unfavorable movement patterns as major vectors toward osteoarthritis development, acknowledging that these physical choices may sometimes stand alone as causative factors for a disease known for its multifactorial etiology. These unfavorable movement patterns are described more simply by Alexander Technique practitioners as "misuse[1]." Especially for an aging US population, osteoarthritis is a daily, literal grind on the joints[22], and emerging trends toward prevention anticipate a welcome revolution from misuse to good use.

Established perspectives on osteoarthritis outcomes and treatment

Though osteoarthritis can develop from an array of sources, adverse biomechanics tend to be a main contributor. Anatomical issues, such as unequal leg lengths[10], are obvious culprits to this end. Even when anomalies in musculoskeletal design are not present, a high level of physical activity and sports participation, injuries to bone or cartilage, and excessive weight are all major risk factors[10]. This assertion falls on listening ears, and experience warrants little room for disagreement. Perhaps, however, it is heard too well and too easily accepted as unequivocal.

Adverse biomechanics are a fact of life and even a tribute to hard work and the passage of years, so goes one prevailing justification. Age is indeed the strongest risk factor, not only for the years of loading implied, but also for the decrease in regenerative capacity at the joint[10]. In a survey of osteoarthritis sufferers in the United Kingdom (UK), a significant subset of participants indicated a lack of initiative to seek preventative medical treatment[26]. When asked for their reasoning, several participants found their resignation logical because arthritis was a packaged deal with aging and just as irreversible[26]. Twenty-nine percent even admitted to being unsurprised by their diagnosis[26]. They accepted aches and pains in the joint as an inescapable aging milestone, an unenthusiastic rite of passage indicative of the wear and tear from years of living[26]. This response likely underestimates the average climate of negative outlooks for those who have this condition, because interviewed participants had just completed an arthritis self-management program and were thus comparatively motivated[26]. Lack of motivation to seek preventative treatment on the part of those most likely to be motivated illustrates the disheartening insignificance placed on both treatment and prevention.

Another destructive perspective on treatment is that managing osteoarthritis is equivalent to managing pain. The treatment-seeking deficiency seen in many of the UK survey participants was spawned, in part, by the deficiency of the treatments themselves. Several of the participant's physicians had indicated that their disease was untreatable[26]. Worse yet, these osteoarthritis patients perceived a lack of sympathy towards their "easier" condition[26]. Ninety percent of participants claimed that pain-relieving and anti-inflammatory medications were the only treatments offered by their general practitioners[26]. If these medications were avoided in favor of self-management strategies, it was often at the emotional and psychological expense of avoiding those social activities requiring any significant mobility[26].

In recent guidelines for knee osteoarthritis management published by Osteoarthritis Research Society International (OARSI)[17], several non-surgical approaches are discussed and recommended based on the ability of the treatments' benefits to supersede their risks. In an analysis of pharmaceutical interventions, use of acetaminophen is deemed appropriate only for short-term use[17]. Not only does acetaminophen pose risks to multiple organs during prolonged use, but its usefulness as a pain reliever is also diminished with continued exposure[17]. Drug dependence is a painful irony for those with osteoarthritis, because as their condition becomes more serious, their resource for relief becomes both less capable and more harmful. This destructive cycle is due for an overhaul, but this can only be accomplished by dispelling the assumptions about osteoarthritis that only exacerbate the lack of treatment.

The evidence for Alexander Technique

The Alexander Technique concept of inhibition can be applied to understand the futility of treating osteoarthritis through pain alleviation alone. In his experimental self-treatment, Alexander was challenged by his inability to simply discontinue habitually poor use by moving his neck where it ought to be and holding it there[2]. Muscles cannot be relaxed by moving them out of a tense position, because this attempt only invokes more muscle tension[13]. Glenna Batson[2], a physical therapist and Alexander Technique teacher, refers to this conundrum as the "co-contraction strategy," in which one tries to undo extensor muscle tension by contracting the antagonistic flexor muscles[2]. Thus, the problem is reinvented rather than resolved. Inhibition is the process by which the instinctive co-contraction strategy is inhibited and replaced by a new direction of movement that is free from the old tension[1]. Inhibition is analogous to ideal osteoarthritis management in this way: just as co-contracting to fix an unnatural posture

temporarily removes the overt symptoms of misuse but cannot amend underlying tension, masking the painful symptoms of osteoarthritis cannot amend the underlying disease process.

The methodology through which Alexander Technique teaches undoing and redirecting is in stark contrast to common therapies for osteoarthritis. The perspective is so different that terminology is called into question; practitioners of the Technique are unlikely to even describe it as a therapy[13]. The method of improvement here is primarily educational, and this tends to come with a far different goal than does treatment. Those seeking treatment, as a general rule, desire for their problem to be fixed more than to be taught how to fix their problem. Alexander Technique lessons are ineffective if the student is not active and engaged, and expects only treatment[13]. For those who learn how to dispel the risk factor of misuse rather than transiently treat symptoms, the potential to rein in the disease process is far greater.

Several studies have already exhibited the efficacy of managing pain's causes through Alexander education. As mentioned in the chapter focusing on Alexander Technique, MacPherson et al. conducted a randomized, controlled trial to compare the ability of this method to relieve chronic neck pain to the effects of acupuncture and normal care regimes[16]. Participants had experienced a median of six years of unyielding neck pain[16], indicating that their usual treatment's insufficiency was already understood. Alexander Technique's effect on neck pain stands alone both in quantity of pain relief and quality of relief duration. A year after the study, participants assigned Alexander Technique lessons reported a continual 31% reduction in their pain according to the Northwick Park Questionnaire[16] measuring pain and related disability.

Similarly, Little et. al. measured the effects of Alexander Technique lessons, massage therapy, and prescribed exercise for those with chronic and recurrent back pain[15]. Participants were chosen very selectively, and those considered eligible had long-standing struggles with

back pain despite seeking primary care remediation. Seventy-nine percent of participants had experienced pain for more than ninety days[15]. Though not necessarily inflicted with osteoarthritis, the participants described here have struggled with the same inability of commonly available treatments to minimize the sources of their pain.

In the results of this trial, Alexander Technique takes the leading position in relieving this chronically unyielding pain. Outcome measures included the disability survey scores as well as a report on the number of painful days within a time period, among other measures[15]. Even a year after the trial was completed, a follow-up survey revealed with high levels of confidence the following results: those who received 6 lessons of Alexander Technique along with exercise experienced a 17% reduction on the Roland Disability Score, while for those enrolled in 24 lessons the reduction was 42%[15]. Painful days were reduced by 48% in the former group and 86% in the latter[15]. To put it another way, participants who had received 24 lessons with or without exercise experienced 20 fewer painful days within the course of a month[15]. This data was polarized against the effect of exercise, which was far less helpful, and the effect of massage, which was short lived and nonexistent after a year[15].

One of the most hopeful results of this study is perhaps unexpected in the midst of a strict assessment in pain reduction. Alexander Technique lessons proved most effective at reducing fear that led to activity avoidance[15]. In the interviews of those who had just attended the arthritis self-management program[26], as cited previously, fear of physical activity was the trade-off for bearing pain unmediated. After a service evaluation of Alexander Technique at a pain clinic in the UK, fifty-one percent of service users were able to reduce or stop their intake of pain medication[18]. In contrast to previous comments about their fear of movement and ultimate negativity toward various degenerative pain, participants described experiencing Alexander Technique with words like “invigorating,” “relaxing,” and that it was like “walking on air” [18].

Alexander Technique lesson certainly reduced pain for these individuals, but it also increased various aspects of well-being on which pain interferes; all categories of general activity, walking ability, normal work, relationships, mood, sleep, and enjoyment of life improved over the course of three months, but the greatest benefit was seen in the latter three[18]. Those attending this pain clinic had been given the ability to enjoy life better. This evidence suggests that managing osteoarthritis well does not involve minimizing movement, but reconstructing the method of movement. Alexander Technique gives people with chronic pain, like that from osteoarthritis, the possibility of not living by such a trade-off.

Chapter 5: How does Alexander Technique exposure affect management of osteoarthritis?

Observations and Hypothesis

A small, yet powerful force of research has been indicating the therapeutic nature of Alexander Technique for chronic pain sufferers[15,16, 18]. The contrast between this source of pain management and the more readily accessed resource of pain medication is pronounced. Rather than treating pain, Alexander Technique addresses the culprit misuse responsible for pain[2]. Though no studies were found to specifically address the relationship of Alexander Technique lessons to diminishment of osteoarthritis, a potential trend may be inferred from the results of the chronic neck pain and chronic back pain studies mentioned previously[15,16]. Being one of the five most debilitating diseases amongst US adults, osteoarthritis nourishes chronic pain with each movement[22]. This disease qualifies for a resolution of the biomechanical exhaustion that manifests as pain.

Pain associated with the disease may be alleviated as an end in itself, but the pathology of osteoarthritis specifically lends itself toward a remedy in Alexander Technique. Chondrocytes remodel and revitalize cartilage as it is used for movement, but overstimulation of this immune function leads to synovitis, or inflammation of the synovial membrane[10]. Repair of the cartilage can also rearrange the cartilaginous cross-links in such a way that the amount of proteoglycans, along with their ability to hydrate and absorb shock, is lessened[10].

When an individual has poor use by the standards of Alexander Technique, the joints relating to the muscles being misused experienced added friction. If a person stands with his or her knees locked, or holds a hunched spinal curvature, he or she creates knee or intervertebral joint friction that is constant. According to Radin et. al. this pattern of frequent mechanical strain

on the articular cartilage is the most destructive pathway to osteoarthritis[24]. When an individual exhibits good use, he or she should experience fewer complications associated with biomechanical stress. Individuals with osteoarthritis, even if at a more advanced age or with genetic predisposition toward joint degeneration, should be less burdened by this disease than they would if their joints had been further burdened by poor use. Therefore, it was hypothesized that among patients with osteoarthritis, students of Alexander Technique experience less frequent and less severe pain associated with activities of daily living and report quality of life that is less diminished by this condition.

Methods

To test this hypothesis, a cross-sectional study was implemented. A survey examined the quality of life, activities of daily living, pain, and pain management of a cohort of individuals with diagnosed osteoarthritis, comparing the responses of those with and without exposure to Alexander Technique. To limit bias, eligibility ensured that survey respondents were over the age of forty, and participants were also asked to list their age. Since age correlates strongly with onset of osteoarthritis and is the most significant risk factor[10], it was necessary that early disease and juvenile arthritis be excluded for the likelihood that genetics was more contributory than the slow wear of mechanical stress in those cases. It was also necessary to exclude individuals whose osteoarthritis had been managed via surgical repair or replacement. While it would be interesting as an indication of severe disease impact, the natural joint mechanism is no longer represented and responses to questions about pain would be tainted if the surgery was at all helpful.

Since individuals with osteoarthritis are dispersed throughout the community, and since students of Alexander Technique are difficult to find in this area, it was decided that an online survey would accommodate the largest possible sample size. Thus, a survey was created through

eSurv.org and dispersed via email and via Facebook interest groups for Alexander Technique and for osteoarthritis. Survey participants were asked the following questions:

1. Have you previously taken Alexander Technique lessons?
    - Yes
        - Were these lessons in a group or individual setting?
        - How long has it been since your last lesson?
            - 0 years
            - 1-2 years
            - 3-5 years
            - over 5 years
    - No
2. What is your age in years?
3. What is your gender?
    - Male
    - Female
4. What is/was your occupation?
5. Have you played any sport in the past?
    - No
    - Yes
        - If yes, please specify: _____
        - How many years did you play? _____
        - Any injuries from this activity? If yes, please specify_____
        - Are you still participating in the sport(s)?
            - No
            - Yes
6. What other activities, besides sports, do you undertake for exercise?
    - Please list. _____
    - What is your average pain level, with 1 being least severe, from these physical activities?
      1 2 3 4 5 6 7 8 9 10
7. Please rate your average daily pain from osteoarthritis on a scale of 1 to 10, with 1 being the least painful and 10 being the most painful.
      1 2 3 4 5 6 7 8 9 10
8. Do you have any pain free days in a normal week? How many days per week?
      0 1 2 3 4 5 6 7
9. In what ways do you relieve your pain from osteoarthritis? Please check all that apply.
    - Anti-inflammatory medications prescribed for arthritis
    - Prescribed or over-the-counter pain medication
    - Massaging the joint(s)
    - Icing and heating the joint(s)
    - Herbal supplements, vitamins, and minerals
    - Healthy diet
    - Smooth aerobic activities, such as water aerobics
    - Electrical stimulation of the joint
    - Reducing movement
    - Alexander Technique
10. Of the preceding answer choices, which one do you find MOST helpful in osteoarthritis pain management? _____
11. Do you feel that osteoarthritis negatively impacts your quality of life?
    - Yes
    - No
12. What do you feel has contributed to the development of your osteoarthritis?

Results

Respondent Demographics

After one month of recruitment and survey participation, a sample size of 40 participants resulted in 37 usable responses. Twelve of these respondents had previously taken Alexander Technique lessons, and the remaining 25 had no exposure to it. The average reported age of the former group's members was 56 years, and the latter group averaged at 59 years old. Because this represents only a three-year difference, it was determined that all survey data from respondents who provided their age (n=37) could be used. Gender represents another demographic difference of significance because women are at an increased risk of developing osteoarthritis, especially after the age of 50. Of those citing Alexander Technique exposure, 83.3% (n=10) were female, while 68% (n=17) of participants without Alexander Technique experience were female.

Physical Activity Affected by Osteoarthritis

Alexander Technique exposure		No Alexander Technique exposure	
average pain levels		average pain levels	
walking	2.17	walking	3.34
running	1	yoga or Pilates	2.8
cycling	2.5	hiking	2.75
strength training	1	weight lifting	5.5

Table 1

Table 1 cites some of the open responses to the questions "What other activities, besides sports, do you undertake for exercise?" followed by "What is your average pain level, with 1 being least severe and 10 being most severe, from these activities?" Walking was the most common form of exercise listed from both groups, and the average pain associated with this activity was slightly higher for those without Alexander Technique training. Also of note was the difference in pain from strength or weight training between groups, although only a few

responses contributed to these statistics. All scores greater than 7 were associated with weight lifting, working out, or gardening.

For specific sports, number of years played, and related injuries, responses yielded no consistent trend. For example, an individual who had not taken Alexander Technique boasted participation in basketball, baseball, football, tennis, golf, skiing, swimming, scuba diving, and jogging for about 50 years, attaining no further injuries than "a sprained ankle and a broken finger." Likewise, an individual incorporating Alexander Technique into downhill and cross-country skiing, bicycling, and hiking indicates no injuries from those sports even after 55 years of them.

Alexander Technique?	Pain-Free Days per week	No pain-free days?
Yes	2.5	25%
No	1.5	52%

Table 2

The statistics in Table 2 indicate that people who had not taken Alexander Technique were more likely to indicate fewer or no pain-free days in a typical week. Those using Alexander Technique experience gained, on average, one more day without pain per week, and were 27% more likely to have at least one pain-free day per week.

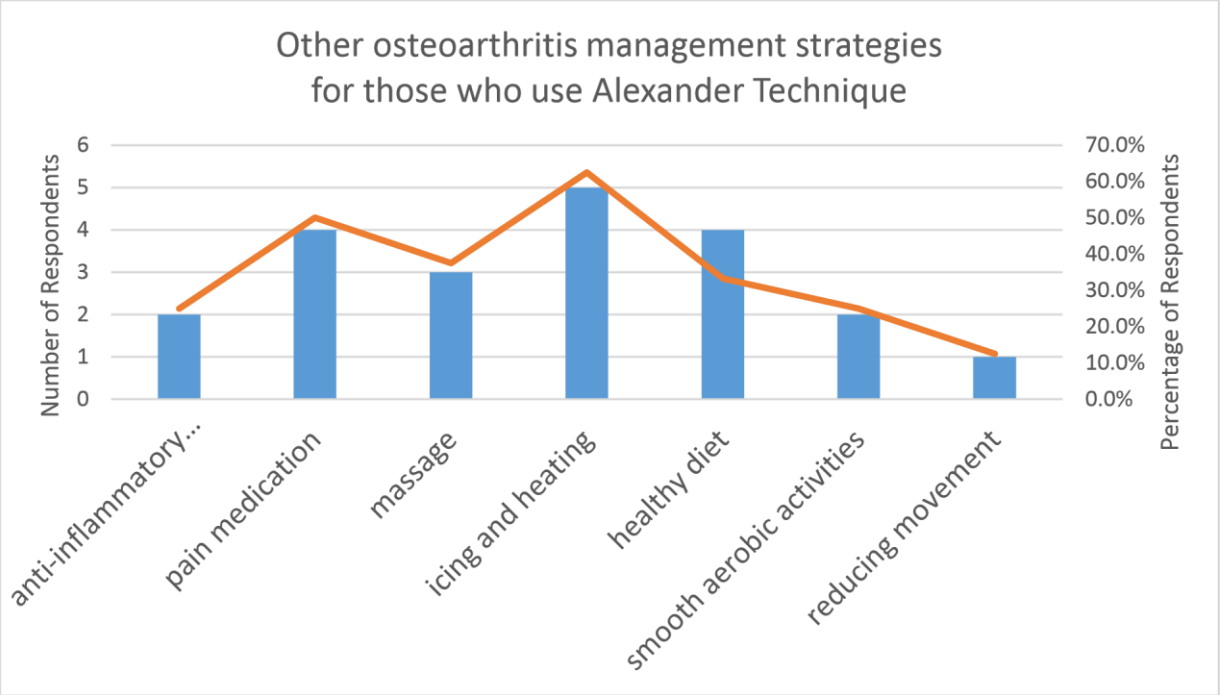

Figure 7

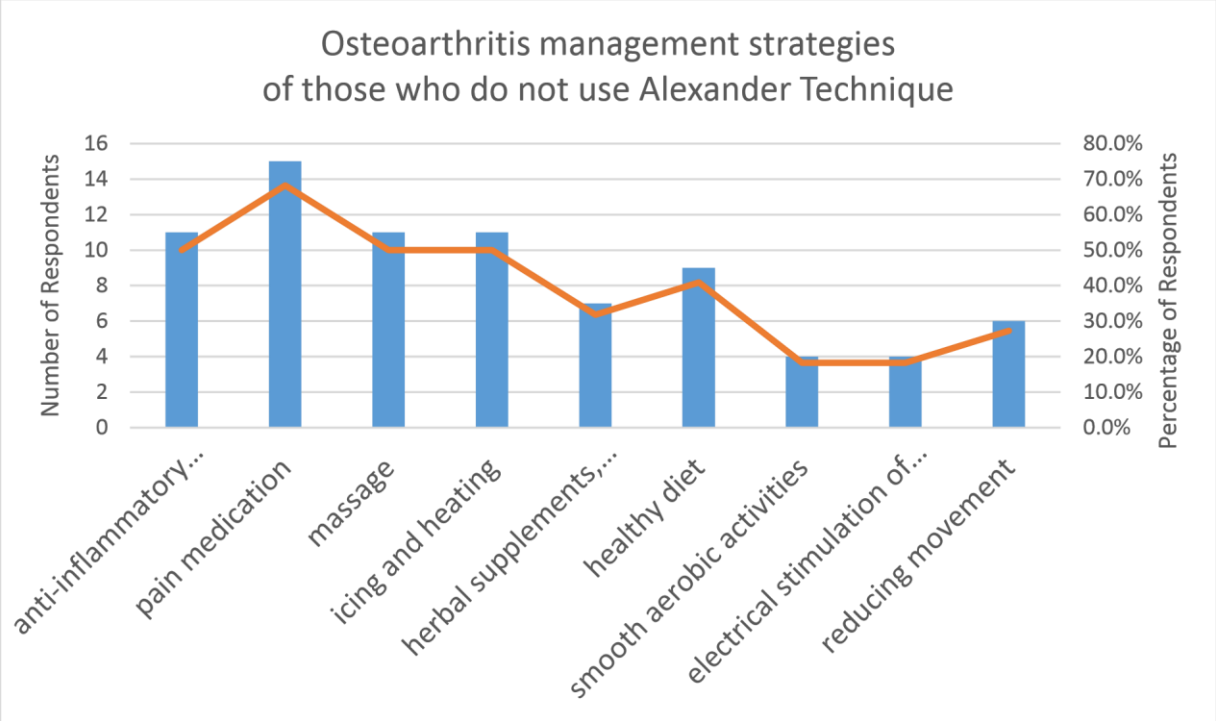

Figure 8

Figures 7 and 8 indicate several differences in management preferences between groups with or without Alexander Technique experience. Figure 7 shows that of the 8 people who responded to this question from the Alexander Technique group, 25% used anti-inflammatory

medications and 50% utilized pain medication to cope with their osteoarthritis. The prevalence of medication usage is increased among those without Alexander Technique as a management strategy, with 50% and 68.2% usage of anti-inflammatory and pain medication, respectively. Those without previous Alexander Technique lessons were 14.8% more likely to manage osteoarthritis symptoms and progress by rationing movement. It is also of interest that the group unexposed to Alexander Technique were more likely to have a greater diversity in management strategies, indicating that several have also implemented electrical stimulation and herbal supplements and vitamins as part of their strategy to minimize osteoarthritis.

A follow-up question from the one generating Figures 7 and 8 asked which one of the management strategies had proven the most beneficial in their experience of treating osteoarthritis. For the Alexander Technique group, 71% responded that this neuromuscular reeducation for which they are categorized was the most beneficial to them. In contrast, those without Alexander Technique exposure cited pain and anti-inflammatory medications 60% of the time.

Quality of Life

The majority of respondents admitted the negative impact their osteoarthritis had on quality of life. The percentage of this response indicated that it was slightly more prevalent in the group who had previously taken Alexander Technique lessons. Of the 8 who answered, 6 (75%) claimed their osteoarthritis worsened quality of life. The 21 participants who responded and had not taken Alexander Technique were 71.4% likely to agree that osteoarthritis hindered quality of life.

Contributions to Osteoarthritis

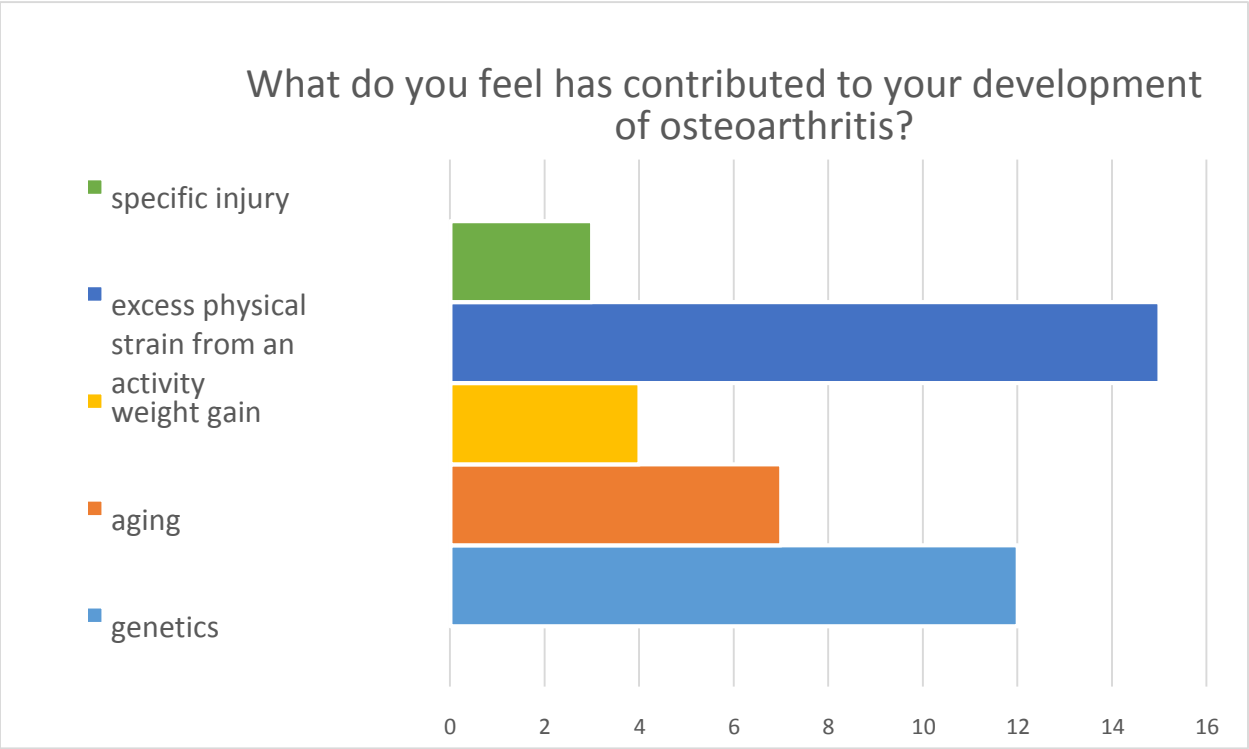

Figure 9

The question referred to in Figure 9, even though it was left open to textual responses, yielded results consistent with the three major risk factors for osteoarthritis: age, genetics, and adverse biomechanics[10]. Also consistent with multifactorial causation, many individual responses indicated several elements characterizing the development of these cases of osteoarthritis. Many cited age and genetic predispositions, but almost every respondent claimed that some type of mechanical stressor contributed to joint degeneration, as shown by the categories of specific injury, excess physical strain from an activity, and weight gain. There is little to note in the difference of this response between the two groups, except that those without Alexander

Technique often wrote that they "overused" their joints in some way, while none of the students of Alexander Technique claimed this in their disease history.

Discussion

Although consistency in trends would have been bolstered by a larger sample size and a higher rate of survey completion, the data yields informative results nonetheless. In support of the hypothesis, a negative correlation was observed between the habit of good use as taught by Alexander Technique and pain experienced because of joint degeneration. This is evident by the less frequent use of anti-inflammatory or pain medication, such as NSAID drugs, despite the relative lack of movement avoidance on the part of Alexander Technique students. These respondents had indicated that they had greater freedom of movement because their physical activity was less of a burden on the musculoskeletal system.

As hinted previously, some of the data trends were nonexistent or inconsistent with the hypothesis and previous research about Alexander Technique. Those who had taken lessons reported a negative effect of osteoarthritis on quality of life slightly more often than did their counterparts. Averages of pain scores from sport and other physical activities, not considering the particular strenuousness of the activities, was no different between groups. Accounting for the degree of activity strain, the more painful activities like gardening and weight lifting lend themselves toward long periods hunched over ground or to extra loading at the joint, respectively, even in conditions of good use. For milder activities, like walking, the pain scores of those with Alexander Technique exposure indicate that these activities can be achievable with minimal mechanical stress, even to joints lacking healthy cartilage.

Some individuals in the group with no previous Alexander Technique lessons may exhibit naturally good use, and this may be confounding. Alexander Technique is described as neuromuscular reeducation not just because one must relearn how to move in a different, freer manner. Alexander studied the postural patterns of infants and observed that free, economical

motion is the natural state often lost in the anxiety of modern society, and this must be relearned[8]. If an individual does develop osteoarthritis but has maintained an understanding of how to use his or her body well, pain will no doubt be less severe.

Being a cross-sectional study, the experimental design was not strong enough to determine temporal association. Such questions arise unanswered: "How long have these individuals had osteoarthritis? Did their participation in the physical activities mentioned begin before their diagnosis? Did the Alexander Technique students know how to practice good use before the progression of a diseased state, or did osteoarthritis prompt them to seek out alternative therapeutics?"

Small sample size also hindered the strength of associations. Among the 37 usable surveys, several were incomplete, causing many survey statistics to be based on a smaller sample size still. For example, 71% of those who had taken Alexander Technique claimed it as the most beneficial resource to the management of their osteoarthritis. It is reasonable that this statistic would remain as high or increase given a greater number of responses. In the reality of this data set, however, it represents five out of seven responses, and so the statistic remains promising but fails to be powerful.

This trend, along with the ones previously discussed, were not statistically significant. For example, the association of receiving Alexander Technique lessons to usage of anti-inflammatory medication achieved an odds ratio[19] of 0.33. This indicates that Alexander Technique is protective against this medication; in other words, those who have taken lessons are 33% as likely as those who have not taken lessons to require this form of management. The significance of this statistic is measured with a p-value of 0.2217 and therefore is not substantial proof, however. As is the case with many data trends, the culprit hindering significance is sample size. If for the above data on anti-inflammatory usage, the sample size was increased to 40 in

each group and the percentage of responses remained the same (odds ratio=0.33), the result would be statistically significant ($p \leq 0.05$).

Effect sizes are another means of statistical analysis that demonstrated significant developments despite the small sample[3]. In brief, effect size is a means of analyzing the size of the differences between groups with less emphasis on sample size[3]. Several participants listed walking as a form of physical activity. The effect size for associated pain level in reference to the exposure of Alexander Technique was -0.542. This negative effect size indicates a protective exposure once again. More specifically, an effect size of -0.5 indicated that 69% of the Alexander Technique-exposed group would have pain levels below the average pain level within the unexposed group[3]. Though this statistic may be confounded by participants who listed walking in combination with several other physical activities, the effect size still provides evidence for the protective mechanism of Alexander Technique.

Conclusion

A preliminary study has been undertaken to assess the ability of Alexander Technique to improve individuals' management of osteoarthritis. It follows from a small pool of research heralding the ability of neuromuscular reeducation to revamp harmful movement patterns that can contribute to chronic pain. Osteoarthritis is an ideal candidate to be stalled by such reeducation, as the foremost symptom it generates is chronic pain[10]. Results from this study demonstrate that chronic pain is indeed a less burdensome symptom in the presence of a body and brain reeducated into habits of good use. A more ideal study to determine the efficacy of Alexander Technique would be prospective, and would analyze the effect of lessons on development of osteoarthritis. For example, a cohort study involving large sample sizes of

controls and of individuals taking Alexander Technique could use the aforementioned Joint Acoustic Analysis System[25] to precisely detect the initiating pathogenesis of osteoarthritis. In this case, a series of acoustic emissions examinations over the course of approximately three decades could yield insightful results. There is great hope that this study prompts research that can carry greater scientific and statistical weight, so that more people may learn how to free their joint mechanisms to carry less weight.

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