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Review Article

Psychosocial Implications of Limb Lengthening and Reconstruction Orthopedic Surgery: A Literature Review

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Introduction

A fervent interest in improving patient care, quality of life, and outcomes in adolescent patients undergoing limb Lengthening/Reconstruction Surgeries (LLRS) has guided the exploration of how psychosocial markers in adolescence may be viewed as crucial to achieving enhanced healthcare delivery. This systematic literature review stems from a retrospective pilot study which investigated the importance of psychosocial aspects in the care of children, adolescents, and young adults who have undergone multiple LLRS. It was determined that such patients value psychosocial support given by their surgeons and caregivers, further promoting psychosocial maturation [1]. Currently, prospective investigation is in the process of being explored as yet another outgrowth of this seminal pilot study.

Specifically, the current review seeks to explore the literature relevant to aspects of psychosocial development fundamental to enhancing outcomes of a chronic, orthopedic medical condition. The dearth of studies applying a biosocial lens to this subspecialized field of orthopedic surgery and care supports the need for such expanded investigation.

Aim

The aim of the current literature review was to survey published research and theoretical studies related to the influence that psychosocial factors have in the treatment and outcome of adolescents undergoing treatment for chronic limb lengthening/reconstruction and deformity correction. To this end, the interplay of psychosocial developmental within the context of chronic orthopedic intervention was examined. It is expected that the findings will inform current best practice and clinical work with adolescents and pave the way for further studies into this scantily researched area.

Methods

This review spanned studies and writings published between 1950 and 2021 in the English language. Database search included PubMed. Manual search strategies were employed, specifically utilizing author and subject tracing.

Background

The term, psychosocial, first was articulated by Erikson to discuss human development with regard to the concepts of psychological (the mind) and social (relationships). Conceptualizing psychosocial development as a lifelong continuum, Erikson advanced the term psychosocial identity, reshaping his concept of ego identity to include the social function of the ego. Erikson later refined his epigenetic theory of eight stages of psychosocial development throughout the life cycle, from infancy through old age and death, detailing specific conflicts, or developmental turning points, with favorable or unfavorable resolutions inherent at each stage. Thus, successful completion of each stage establishes the foundation for later stage resolution. The psychosocial challenge in adolescence occurs during Erikson's fifth stage of development, where the conflict is centered around identity versus role confusion. Whereas the process of identity formation continues throughout the lifespan, adolescence is noted to be the developmental period most critical to the resolution of these identity polarities as well as for individuation. Experiences during this stage contribute to the maturation of sense of self that persists throughout one's lifetime [2-4].

An adolescent requiring LLRS due to deformity, traumatic injury, illness, or genetics often is subjected to surgical treatment that necessitates multiple surgeries, long hospital stays, being fitted with hardware that may be painful and unsightly, long recuperations at home with adjunct therapies, missed schooling, separation from peers, family financial burden, and a myriad of other challenges [1]. Such medical intervention takes place against a backdrop of the normal tasks of adolescent development. It is vital to consider the role that psychosocial development and needs have in the care and well-being of these young patients [5,6].

Limb Lengthening/Reconstruction and Deformity Correction

Limb lengthening is a subspecialty within orthopedics that employs innovative surgical techniques to correct limb deformity and length discrepancy [7]. In his historical review, Birch et al. deftly describe the developments spanning more than one hundred years from Alessandro Codivilla's seminal work in 1905 to the revolutionary work currently built upon the Ilizarov method and apparatus, revised and used by orthopedic surgeons today. As an outgrowth of the 2018 annual meeting of The Limb Lengthening and Reconstruction Society, Hamdy et al. offer a comprehensive summary of up to date surgical advances in the subspecialty, reviewing significant papers published in the previous year [8,9].

Hardware, such as external fixation, often is used in LLRS. External fixation is a technique by which a surgeon inserts wires and pins into the bone to stabilize it using an external frame [10]. The experience of external fixation for adolescents differs significantly from that of

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adults. For adolescents, external fixation can be a constant visual representation of their orthopedic problem. This may foster social isolation and negatively impact self-esteem, as many adolescents tend to experience uncomfortable feelings when publicly exposing their fixators. In addition, pin site infection is a common complication, especially in younger individuals whose increased levels of physical activity place them at greater risk [11]. Furthermore, the fixator may interfere with activities of daily living and require the augmentation of clothing to fit over the device [12]. Patients report having trouble dressing themselves, showering, and getting around independently. It also may affect sleep, which is necessary for proper cognitive and psychological functioning, emotional processing, and stress-related coping, especially in adolescents [13].

Recent advances in the field have introduced alternative techniques to external fixation that mitigate a number of its disadvantages. Lengthening over a nail is one technique that concurrently utilizes internal and external fixation. This integrated fixation approach involves insertion of an intramedullary nail and subsequent addition of pins and an external fixator. The pins and external fixator may be removed once the bone is consolidated, which limits the amount of time spent with an external device. Advances with fully implantable internal lengthening nails established a new standard for LLRS for upper and lower extremities. Internal lengthening nails achieve exceptional accuracy and control of distraction, result in few complications, and limit unattractive scarring. They have replaced external fixation in many cases and made the process safer and less stressful for patients [12,14,15].

The ultimate goal for most patients pursuing this procedure is to improve functionality and quality of life. The World Health Organization (WHO) describes quality of life as a measure of health that includes physical, social, and psychological factors [16]. These measurements should be assessed in an age-appropriate manner with consideration given to pre-existing conditions and comorbidities. LLRS surgeons are inquiring more about the quality of life of their adolescent patients for clinical and research purposes. This information allows them to improve the quality of care they provide, determine the efficacy of their treatments, and take into account potential mental health risks [1,17].

Psychosocial Implications of Limb Lengthening/Reconstruction and Deformity Correction

Adolescence occurs between the ages of approximately 12 and 18. During this stage of ego development, known as identity vs. role confusion, adolescents consciously search for their identity and intentionally develop relationships [4]. Successful transition from this stage to the next involves the extent to which children explore potential roles and the degree to which they commit to them. Role confusion will result if adolescents are unable to make deliberate decisions, experiment with personal limitations, and invest in interpersonal relationships as they see fit [18,19]. In general, adolescents are particularly susceptible to mental illness during this stage of development, as this period of considerable growth and psychological maturation is especially impressionable [20]. In an observational study of 215 participants, Bhandari et al. studied psychological distress and quality of life following orthopedic trauma in patients 16 years old or older, finding that 1 in 5 experienced psychological distress [21].

Life-changing physical and emotional events may decelerate psychosocial maturation when they occur in conjunction with the development of coping skills during adolescence. These events disrupt transition between stages, which can result in an "identity crisis" [4,22,23]. Taken further, one can consider the effects that LLRS has on the psychosocial development of adolescent patients as they navigate the challenging waters of identity formation. Ghoneem et al. found that the Ilizarov method did not cause long-term psychological distress nor functional disturbances in the forty-five children studied [24]. While acknowledging the demands of the Ilizarov treatment on the fifteen adolescents studied, Martin et al. and Niemelä et al. discovered that there was no prolonged adverse effect on psychological and psychosocial well-being [25,26]. Other studies determine that limb deformity and length discrepancy result in social and psychological problems that stem from diminished self-esteem [27].

Emotions, thoughts, and behaviors are difficult to quantify. Therefore, considerable work is required to understand the psyche of adolescents when trying to optimize their healthcare. Studies of brain development show that morphological, neurobehavioral, and neurochemical changes occur during adolescence that govern emotions and decision-making [28] Strengthening of this neurocircuitry notably results in the ability to adapt and process information. Anxiety, stress, and physical and emotional trauma can blunt these processes. Considering the lasting impact orthopedic surgery can have on adolescents during such a critical stage of development, it is in the best interest of orthopedic surgeons to remain aware of psychosocial factors in all stages of pre, peri and post care.

In a 2017 study conducted by Vranceanu et al. orthopedic surgeons were found to be indifferent to screening for psychological factors and to referring their patients for psychological treatment. This is a result of the stigma attached to seeking counseling, as well as orthopedic surgeons' discomfort with discussing mental health with their patients and the surgeons' lack of time [29]. Orthopedic surgeons are generally underqualified to assess preexisting psychosocial conditions according to Richard et al. [30].

A review of the literature shows extensive research investigating the psychosocial needs of adolescents in mostly rheumatologic and oncologic settings. These studies investigate special accommodations for adolescent patients and acknowledge that adolescence is a developmental transition period during which identity, body image, and relationship concerns arise and are complicated by health concerns [31]. These findings offer valuable implications for the care of chronically ill patients. Yet, such literature is scarce within the context of orthopedic surgery.

The age by which adolescents are capable of clearly communicating their physical condition is ill-defined. Studies show that adolescents want to discuss health-related concerns with their physician, but they are reluctant to do so. Their comprehension, verbal expression, emotional maturity, and cognitive capacity are still lacking so there is debate about whether adolescents can accurately and independently describe their physical condition. Hence, some quality of life

assessments are administered to adolescents themselves, while others are given to parents or guardians [32-34].

LLRS necessitates resilience, maturity, and self-motivation, as patients are required to engage in post-operative self-care and rehabilitation [35]. A lack of coping strategies or cognitive maturity can complicate the rehabilitation process [30]. Though correcting an orthopedic problem will result in significant improvement in the health condition, adolescents can be negatively impacted psychologically by multiple operations and hospital stays. The persistence of an underlying health problem and the possibility that orthopedic surgery will not completely resolve their orthopedic concern also can have negative effects. There is potential for these mental impairments to persist and intensify [17]. Furthermore, orthopedic surgery can cause other issues related to body image and self-esteem. For example, limb lengthening using the Ilizarov procedure results in multiple scars on the affected limb. How often patients seek cosmetic surgery to have these scars removed has not yet been investigated [36].

Effect of Chronic Conditions in Adolescence on Psychosocial Development

Patients undergoing orthopedic surgery are considered to have a chronic health condition. A medical condition is considered chronic if it persists for three or more months [37]. In children and adolescents, specifically, chronic health conditions are defined as physical, emotional, or mental conditions that interrupt school, work, and regular activities. It requires frequent doctor visits, medication, or the assistance of medical equipment [38]. LLRS involves the diagnostic process, the surgery itself, recovery time, physical therapy, as well as additional surgery for removal of hardware. The amount of time spent with hardware on is a major drawback. Depending on the severity of the condition to be corrected, the process can take numerous months [39]. This can result in a significant amount of stress. Unaddressed, this stress can devolve into mental health disorders such as anxiety and depression [40].

When the adolescent concurrently is having to contend with medical chronicity and developmental tasks, the psychological challenges may increase markedly [5,6]. Mattson et al. explored psychosocial adaptation in children with long term physical disability, focusing on coping mechanisms in the context of utilization of such mechanisms and the nature of the parent-child relationship [41]. Studying adolescents with chronic disorders, Moos et al. investigated the relationship that coping skills and family environment have in the management of acute and chronic stressors [22]. Studying children who have undergone repeated surgeries for Early Onset Scoliosis (EOS), Flynn et al. investigated psychological sequelae and concluded that clinicians needed to increase their awareness of possible resultant psychological problems, particularly those patients with more total surgeries beginning at a younger age [42].

Among other factors, Suris et al. looked at the impact that chronic health conditions have on adolescent psychosocial development noting that one in ten patients have limits to their daily activities. It would seem that this number would increase with LLRS patients. The investigators determined that there was abundant evidence to support the fact that chronic conditions affect adolescent development and, conversely, that adolescent development affects the health condition as well. Nevertheless, they found that there were more commonalities than differences when compared with healthy peers [43].

LLRS has long-term effects on adolescents that can remain well into later stages of development. Although not specific to orthopedic patients, Yap found that approximately twenty percent of children admitted to the hospital withstand some emotional disturbance, nevertheless this generally subsides within six months following discharge. Of relevance to this investigation, Yap further noted that prolonged or repeated hospitalizations tend to make the young patients more vulnerable to psychological problems [44].

Early exposure to health-related trauma can predispose adolescents to psychiatric disorders with long-term sequelae. The chronic physical and emotional disability that accompanies limb deformity affects adolescents' social lives as well as physical and psychological well-being [45]. Substantial lower limb deformity and length discrepancy, for example, can cause dissatisfaction with appearance, back and knee pain, and irregular gait [46]. Coping with these complications may manifest as behavioral changes including aggression, isolation, and misconduct. This occurs as adolescents have limited cognitive development and emotional intelligence for adequate self-expression [47,48].

Conclusion

As demonstrated by Erik Erikson, psychosocial development is a life-long continuum. Erikson maintained there are eight stages of development. Successful completion of each stage establishes the foundation for the following stage, allowing for the healthy development of personal identity. The particular focus of this inquiry was on adolescent patients, as they are in a critical period for individuation and formation of personal identity. Experiences during this stage contribute to the maturation of sense of self that persists throughout life.

The adolescent mind goes through considerable change during the identity *vs* role confusion stage of development. Orthopedic surgery to correct limb length discrepancy or deformity has the potential to disrupt healthy maturation, the acquisition of developmental tasks, and prevent the strengthening of emotional intelligence. With limits to a cultivation of sense of self, adolescents may turbulently enter the next stage of development with resultant maturation gaps. Therefore, it is essential that orthopedic surgeons incorporate psychosocial assessment into their holistic care of adolescent patients. This can help prevent healthcare-related trauma and have a lasting impact on the psychological well-being of adolescents who undergo limb lengthening/reconstruction surgery.

Thus, the interface of medical chronicity in adolescent patients who have undergone multiple orthopedic surgeries for limb lengthening and psychosocial factors in view of developmental considerations formed the foundation for this review as well as for continuing inquiry. The pilot study's focus was to understand the insights, challenges, and opportunities inherent in caring for this population, which is intrinsically bound with the need to better identify and consider psychosocial aspects of patient care throughout the life cycle. Studies specific to multiple limb lengthening surgeries and psychosocial implications are scant, thereby further supporting the need for such investigation and review. This review sought to underscore the importance of further investigation into this little

researched topic with an eye toward lessening traumatization, promoting psychosocial development, and improving patient care and outcomes.

This knowledge will allow orthopedic surgeons to mindfully consider and address the psychosocial needs of patients not only during this critical period but through all stages of development.

Conflict of Interests

Dr. Rozbruch reports grants from I am not done yet foundation and personal fees from Nuvasive and Orthospin outside the submitted work. All other authors have no conflicts of interest to report.

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