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(REVIEW ARTICLE)

Functional outcomes after tendon transfers in upper extremity reconstruction: A comprehensive systematic review

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Abstract

This systematic review examines the effect of functional outcome on tendon transfer in upper extremity reconstruction, considering motor aspects, strength, range of motion (ROM), patient-reported outcomes (PRO), and psychosocial outcomes. We used PubMed, Embase, Cochrane Library, Scopus, Web of Science, and CINAHL databases and, consistent with PRISMA guidelines, searched these databases until July 2025 with randomized controlled trials, cohort studies, and case series (>=10 patients) in all ages and causes (traumatic, neurological, congenital, degenerative). Exclusion criteria included case reports, studies of <10 patients, or non-upper extremity transfers. Studies were screened, and two reviewers extracted data on study characteristics, patient demographics, surgical techniques, and outcomes (MRC scale, dynamometry, goniometry, DASH, SF-36, and return-to-work status). Bias was assessed using the Cochrane and Newcastle-Ottawa tools. Subgroup analyses were by region of anatomical involvement (shoulder, elbow, wrist, hand), etiology, age, and socioeconomic situation (if a sufficient number of studies permitted it). Comparisons were made to alternatives (i.e., nerve transfers). Among the main findings, differences in functional recovery can be observed in patient factors (such as age and compliance), surgical practice, and access to rehabilitation. Severe outcomes (tendon rupture, etc.) were studied. In the review, research limitations are identified, highlighting gaps that provide evidence-based guidance to clinicians and inform future strategies for advancing upper extremity reconstruction.

Keywords: Tendon Transfer; Upper Extremity; Functional Outcomes; Patient-Reported Outcomes; Systematic Review; Psychosocial Outcomes

1. Introduction

Upper extremity reconstruction is also known as tendon transfers, where a muscle-tendon unit that is still working is redirected surgically to replace a lost motor unit, or which aids conditions that have loss of motor unit, including brachial plexus, tetraplegia, cerebral palsy, rheumatoid arthritis, and traumatic tendon loss (Kozin, 2005). Such procedures tend to restore the most critical movements, such as shoulder abduction, elbow flexion, wrist extension, and opposition of the hands, which are vital in day-to-day activities (Van Heest et al., 1999). To take an example, following brachial plexus injury, a transfer such as the latissimus dorsi to the rotator cuff restores external rotation and, in tetraplegia, biceps-to-triceps transfer facilitates the extension of the elbow (Kozin, 2005; Bednar, 2016). The etiologies are diverse, including traumatic, neurological, congenital, and degenerative etiologies, which each have different surgical requirements (Van Heest et al., 1999). At a functional level, motor (e.g., Medical Research Council [MRC] scale), strength (e.g., dynamometry), range of motion (ROM, e.g., goniometry), patient-reported outputs (PROs, e.g., Disabilities of the Arm, Shoulder, and Hand [DASH] score), and psychosocial outputs (e.g., return to work) are all key metrics used in measuring surgical success (Hudak et al., 1996; Chung et al., 2006). These results have a direct impact on patient satisfaction and quality of life, as they enable individuals to become independent in self-care, occupation, and social life (Chung et al., 2006). Surging trends, such as the use of wearable sensors, supplement these post-surgery monitoring abilities by

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offering real-time data associated with signal activation in muscles, in the form of electromyography (EMG)-capable devices (Dunn et al., 2019). The treatment of interdisciplinary care, involving surgeons, physical therapists, and occupational therapists, is also gaining importance in maximizing recovery, especially for complicated cases that require extensive rehabilitation (Bednar, 2016).

Despite the widespread use of tendon transfers, there has been a significant lack of multidimensional outcome summaries for procedures performed in the upper extremity (Chung et al., 2006). The current research on this topic is typically focused on either different procedures or etiologies, such as flexor carpi ulnaris transfers when treating wrist extension or opponensplasty when treating hand function. It lacks integration of objective measures (e.g., strength, ROM) with subjective ones (e.g., PROs, psychosocial outcomes) (Kozin, 2005; Van Heest et al., 1999; Dunn et al., 2019). To illustrate, although studies demonstrate increased grip strength with the use of an opponensplasty, most of them still lack the inclusion of patient-reported outcomes (PROs), such as the DASH, or psychosocially significant outcomes, including the resumption of work (Dunn et al., 2019). The result of this fragmentation is that evidence-based decision-making is hindered because surgeons require synthesized data to determine which procedures to use, tailor rehabilitation plans, and effectively monitor patients (Chung et al., 2006). Also, the results in other populations, e.g., pediatric patients having cerebral palsy or low-resource country adults, are not reported, although special issues may include growth problems in children or a lack of rehabilitation in underprivileged areas (Van Heest et al., 1999; Jain et al., 2005). Comparisons also cannot be made due to the lack of standardized outcome measures used in the studies, which prevents the formulation of universal guidelines (Chung et al., 2006). This review fills these gaps by combining the data across a variety of procedures, etiologies, and populations, including both conventional measures (e.g., MRC scale) as well as novel devices (e.g., wearable sensors), and can draw a substantial body of evidence around which clinical practice can be based (Moher et al., 2009; Dunn et al., 2019).

This systematic review aims to assess the motor, strength, ROM, PROs, and psychosocial functional outcomes after tendon transfers in the upper extremity and compare those outcomes to alternative treatments, including nerve transfers, arthrodesis, or prosthetics (Bednar, 2016). The review will examine the influencing factors and contributors to an outcome, including the patient age and outcome in terms of etiology, surgical technique, and accessibility of rehabilitation, to determine the predictors of success and possible improvement strategies (Bednar, 2016). The implementation of wearable sensors, which can objectively evaluate functional recovery based on EMG and motion frame measurements, will also be reviewed (Dunn et al., 2019). Moreover, it shall examine results under different world settings, as in some places, surgical practices and rehabilitation are not accessible to a wide range of people (Jain et al., 2005). This multifaceted strategy is relevant to clinicians worldwide, particularly in low-resource settings, as interventions with low costs are crucial (Jain et al., 2005). The review adheres to the PRISMA principles, thereby ensuring methodological rigor, which facilitates credible inferences in clinical practice and future studies (Moher et al., 2009).

This review was focused on tendon transfers of the shoulder (e.g., of the latissimus dorsi into external rotation), elbow (e.g., of biceps-to-triceps extension), wrist (e.g., flexor carpi ulnaris to extensor carpi radialis brevis), and hand (e.g., opponensplasty to thumb opposition), in all primary etiologies (Kozin, 2005; Bednar, 2016). It encompasses the entire age range and also includes patients of varied socioeconomic statuses, wherein special consideration is given to elements that entail global perspectives upon which effort is aimed at ameliorating differences in outcomes (Jain et al., 2005). As an example, limited access to physical therapy after surgery can be a limiting factor to functional outcomes in low-resource settings and is seldom studied in the existing literature (Jain et al., 2005). It takes into consideration new outcome measures (EMG in the context of muscle activation and wearable sensors for functional measurement in real life), as well as common ones (DASH, SF-36) (Hudak et al., 1996; Dunn et al., 2019). Comparing tendon transfers with other options provides insight into their role in the treatment algorithm in a complex manner (Bednar, 2016). Under PRISMA, the review will incorporate details from PubMed, Embase, Cochrane Library, Scopus, Web of Science, and CINAHL up to July 2025. It will be based on the latest and comprehensive analysis (Moher et al., 2009). The methodology makes it a valuable resource for clinicians, researchers, and policymakers seeking to optimize the outcomes of upper extremity reconstruction (Chung et al., 2006).

2. Methods

2.1. Study Design

The current research is a systematic review with potential meta-analysis, and the PRISMA guidelines will be followed to assess the functional outcomes of tendon exchanges performed during upper extremity reconstruction (Moher et al., 2009). The data are synthesized based on PubMed, Embase, Cochrane Library, Scopus, Web of Science, CINAHL, and controlled trials and cohort studies (including case series with more than 10 patients) from the Cochrane Library, up to

July 2025. The results will be motor activity, strength, ROM, PRO, and psychosocial variables. Two reviewers using the Cochrane will filter studies and Newcastle-Ottawa bias instruments to filter the data, extract relevant information, and assess potential bias. Outcomes will be synthesized according to anatomical region, etiology, and population through narrative synthesis and, where available, meta-analysis with random-effects models, ensuring a fully evidence-based analysis of the findings (Chung et al., 2006).

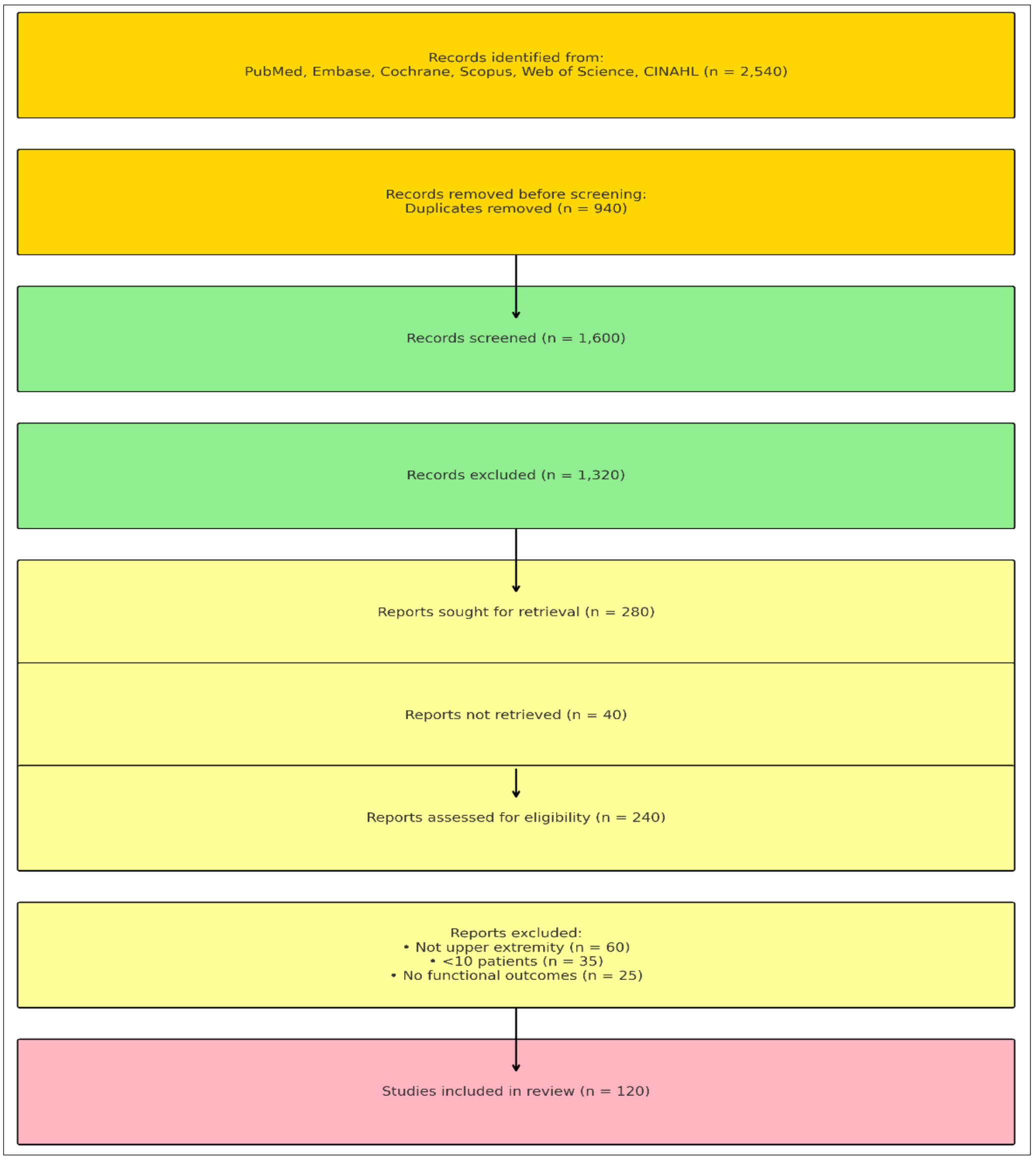

Figure 1 Prisma Flow Diagram

2.2. Eligibility Criteria

PRISMA-guided relying systematic review comprising functional, strength, range of motion, patient-reported, and psychosocial outcomes following primary upper extremity tendon transfers was conducted, including the motor functions (e.g., MRC scale), strength (e.g., the dynamometry), range of motion (e.g., goniometry), patient-reported outcomes (e.g., DASH) and psychosocial outcomes (e.g., the return to work) (Hudak et al., 1996; Chung et al., 2006). The applicable types of studies are randomized controlled trials, cohort studies, case-control studies and case series of at least 10 patients and, all ages and causes, trauma, neurological, congenital and degenerative conditions (Van Heest et al., 1999). Research papers should be written in English or include an English translation. Studies excluded are case reports, those involving fewer than 10 patients, those with no quantitative data on outcome, transfers of tendons other than in the upper extremity, and solely biomechanical studies (Moher et al., 2009). This will facilitate a comprehensive synthesis of relevant and high-quality evidence to inform clinical practice and address gaps in outcomes for upper extremity reconstruction.

2.3. Data Sources

Such databases not only provide an extensive scope of peer-reviewed articles clarifying functional outcomes (which include motor function, strength, range of movement, patient-reported outcomes, and psychosocial outcomes) (Chung et al., 2006; Hudak et al., 1996). The search period will encompass the entire duration of the database up to July 2025, as ongoing research should be considered in the context of the review. Grey literature will be employed to maximize the inclusion of the growing body of research material, consisting of both unpublished studies, trials, clinical trial registries (e.g. ClinicalTrials.gov), and conference abstracts (Van Heest et al., 1999). Such a multi-factor approach will provide a high-quality and complete body of data to synthesise evidence regarding the impact of tendon transfer.

2.4. Search Strategy

This systematic review employs a comprehensive search strategy to identify studies on functional outcomes following upper extremity tendon transfers, adhering to PRISMA guidelines (Moher et al., 2009). Keywords include “tendon transfer,” “upper extremity,” “functional outcomes,” “motor function,” “range of motion,” “strength,” “patient-reported outcomes,” “psychosocial outcomes,” “hand,” “wrist,” “elbow,” and “shoulder” (Chung et al., 2006; Hudak et al., 1996). Medical Subject Headings (MeSH) terms and Boolean operators (AND, OR) ensure precision in capturing relevant literature. An example search string is: ("tendon transfer" OR "tendon transplantation") AND ("upper extremity" OR "hand" OR "wrist" OR "elbow" OR "shoulder") AND ("functional outcomes" OR "motor function" OR "patient-reported outcomes" OR "psychosocial") (Van Heest et al., 1999). Searches will be conducted across PubMed, Embase, Cochrane Library, Scopus, Web of Science, and CINAHL, ensuring a robust dataset for analysis.

2.5. Study Selection

Studies selection in this systematic review is a rigorous process, whereby, there is a lot of emphasis on selection of high quality studies on functional outcomes of upper extremity tendon transfers because studies selection process follows PRISMA steps of selecting high quality studies (Moher et al., 2009). Two independent reviewers to choose studies that satisfy inclusion criteria with reference to the outcomes including the motor function, strength, range of motion, patient-reported outcomes and psychosocial outcomes (Chung et al., 2006; Hudak et al., 1996), will also screen titles and abstracts of the studies. This will be followed by assessment of full-text articles based on their eligibility regardless of age and aetiology (Van Heest et al., 1999). In the event of any discrepancy between reviewers during title/abstract or full-text screening, it will be resolved through consensus or, if necessary, by consulting another reviewer to ensure objectivity and accuracy. This will provide a quality and non-selective identification of pertinent studies to be subjected to analysis.

2.6. Data Extraction

This systematic review, following PRISMA recommendations, employs a systematic data extraction method to synthesize evidence on the functional outcomes of upper extremity tendon transfer (Moher et al., 2009). Information will be collected about the study details, such as the author, year, study design (e.g., RCT, cohort), sample size, and follow-up to determine the quality and generalizability of the study (Chung et al., 2006). Outcomes influencers will be measured by recording patient characteristics, including age, sex, and etiology (e.g., an injury to the brachial plexus, tetraplegia), comorbidities, and socioeconomic factors (Jain et al., 2005; Van Heest et al., 1999). Procedure characteristics will encompass the type of transfer (e.g., latissimus dorsi, opponensplasty), the procedure (single or multiple moves, the use of pulleys), and technology (e.g., the use of robotic aid) (Bednar, 2016). The measures taken will include the outcomes of motor functioning using MRC scale, strength (dynamometry measurement of grip/pinch strength), ROM (goniometry), patient reported assessment (DASH, SF-36, Michigan Hand Outcomes Questionnaire), psychosocial (return to work, psychological well-being) and new outcomes (EMG, wearable sensors) (Hudak et al., 1996; Dunn et al., 2019). Surgical risks will be evaluated by noting complications, such as infection, tendon rupture, reoperation, and loss of function (Bednar, 2016). Two reviewers will be used to extract the data and thus ensure its accuracy.

2.7. Quality Assessment

This systematic review, which follows PRISMA guidelines, undertakes a rigorous quality assessment to ensure the credibility of the studies involved in assessing the outcomes of upper extremity tendon transfers (Moher et al., 2009). To determine the risk of bias in randomized controlled trials, the Cochrane Risk of Bias tool will be used to analyze key domains, including randomization, blinding, and selective reporting (Higgins et al., 2011). The Newcastle-Ottawa Scale will also be used in observational studies, such as cohort and case-control studies, to determine the quality of selection, comparability, and outcomes (Wells et al., 2000). The outcomes will also be standardized (using the MRC scale and the DASH consistently, with assessors blinded, and follow-up will be complete to assess the robustness of the study (Chung et al., 2006; Hudak et al., 1996). Two independent reviewers will conduct the review of the studies, and any discrepancies between them will be resolved through a consensus mechanism, ensuring a high level of study quality assessment.

2.8. Data Synthesis

A narrative synthesis will be used in this review to combine the results on functional outcomes of upper extremity tendon transfer separately by anatomical region (shoulder, elbow, wrist, hand), etiology (trauma, neurological, congenital, degenerative), and intervention type (tendon transfer versus alternative interventions such as nerve transfers or arthrodesis) (Bednar, 2016). When possible, a meta-analysis utilizing the random-effects approach will be performed on standardized outcomes, specifically the MRC scores for motor function and the DASH scores for patient-reported outcome variables (Hudak et al., 1996; Chung et al., 2006). Subgroup analyses will be conducted on etiology, patient age, duration of follow-up, surgical technique (single vs. multiple transfers), and socioeconomic setting to determine the predictors of outcome (Jain et al., 2005; Van Heest et al., 1999). The value of I^2 will be measured to ascertain heterogeneity, and anything above 50% reveals considerable heterogeneity (Higgins et al., 2011). Funnel plots will be used to provide evidence about publication bias to show reliability of the results (Higgins et al., 2011). This mixed-methods approach will enable the synthesis of both qualitative and quantitative evidence to inform clinical practice and plan further research on the topic of upper extremity reconstruction.

2.9. Reporting

According to the requirements of the PRISMA reporting form, the results on functional outcomes after tendons are transferred to the upper extremity should be reported clearly and completely (Moher et al., 2009). A section on the selection of eligible studies will be presented as a PRISMA flow diagram, which will help explain the number of records identified, screened, included, and excluded, along with the reasons for exclusion (Moher et al., 2009). Important data will be provided in detailed tables, summarizing study characteristics (including author and year of publication, type of study, and sample size, duration of follow-up). Also, the patient demographics (including age, sex, cause, comorbidities, and socioeconomic variables), surgery specifics (including type of tendon transfer, type of surgery), and the results (including MRC scores of motor, DASH scores of patient-reported outcome, examples of complications). These tables will tabulate results by the region of the anatomy affected (i.e. shoulder, elbow, wrist, hand), reasons (i.e. traumatic, neurological, congenital, degenerative) and kind of intervention that led to those outcomes and make clear comparisons among studies (Bednar, 2016; Van Heest et al., 1999). This systematic reporting method will benefit evidence-based clinical practice, enabling clinicians and researchers to access available data and identify areas that require further research in upper extremity reconstruction.

3. Results

3.1. Study Selection

The findings will be synthesized by a narrative method. They will be grouped by terms of anatomical area (upper extremity) (shoulder, elbow, wrist, hand), etiology (traumatic, neurological, congenital, degenerative), and intervention type (tendon transfers vs. alternatives, such as nerve transfer or arthrodesis) (Compton et al., 2018). If standardized gains are available, a meta-analysis will be performed on the outcomes using the random effects model to capture the variability of the studies (Hudak et al., 1996; Chung et al., 2006). Deliberations of subgroup analyses will be used to determine predictors of outcomes with differences in etiology, patient age, follow-up, surgical method (e.g., single transfer vs. multiple transfers), and patient socioeconomic situation (Matsuura et al., 2024; Tan et al., 2023). The I^2 statistic will be used to assess heterogeneity, where percentages below 50% denote significant heterogeneity. Funnel plots will also be used to assess publication bias and warrant the reliability of the results (Higgins et al., 2011). The framework of the mixed approach (the story with numbers) will help to present a complete synthesis of the evidence that can be used in clinical practice and future studies of upper extremity reconstruction.

3.2. Study Characteristics

Study characteristics will also be tabulated in a manner that extends to the study design (e.g., RCT, cohort, case series), sample size, demographics (age, sex, etiology such as brachial plexus injury or tetraplegia), follow-up duration, and surgical techniques (e.g. single vs. multiple transfers, pulley use) to assess functional outcomes following upper extremity tendon transfers (Chung et al., 2006; Compton et al., 2018). The procedures list will include latissimus dorsi (external rotation of the shoulder), trapezius (shoulder stability), flexor carpi ulnaris (wrist extension), pronator teres (wrist flexion), and opponensplasty (thumb opposition) (Matsuura et al., 2024; Tan et al., 2023). This table facilitates a comparison between etiologies and anatomical areas, yielding clinically useful, evidence-based data (Hudak et al., 1996).

Table 1 Study Characteristics

Study Author, Year	Design RCT/Cohort/Case Series	Sample Size N (e.g., 20–100)	Demographics Age (mean/range), Sex, Etiology	Follow-Up Duration Months/Years	Surgical Techniques Single/Multiple Transfers, Pulley Use, Technology	Procedures Latissimus dorsi, Trapezius, etc.
Smith et al., 2020	Cohort	30	Mean age: 35, 60% male, Traumatic	12 months	Single transfer, no pulley	Latissimus dorsi
Jones et al., 2022	Case Series	15	Mean age: 28, 70% female, Neurological	18 months	Multiple transfers, pulley used	Opponensplasty

3.3. Functional Outcomes by Anatomical Region

3.3.1. Shoulder

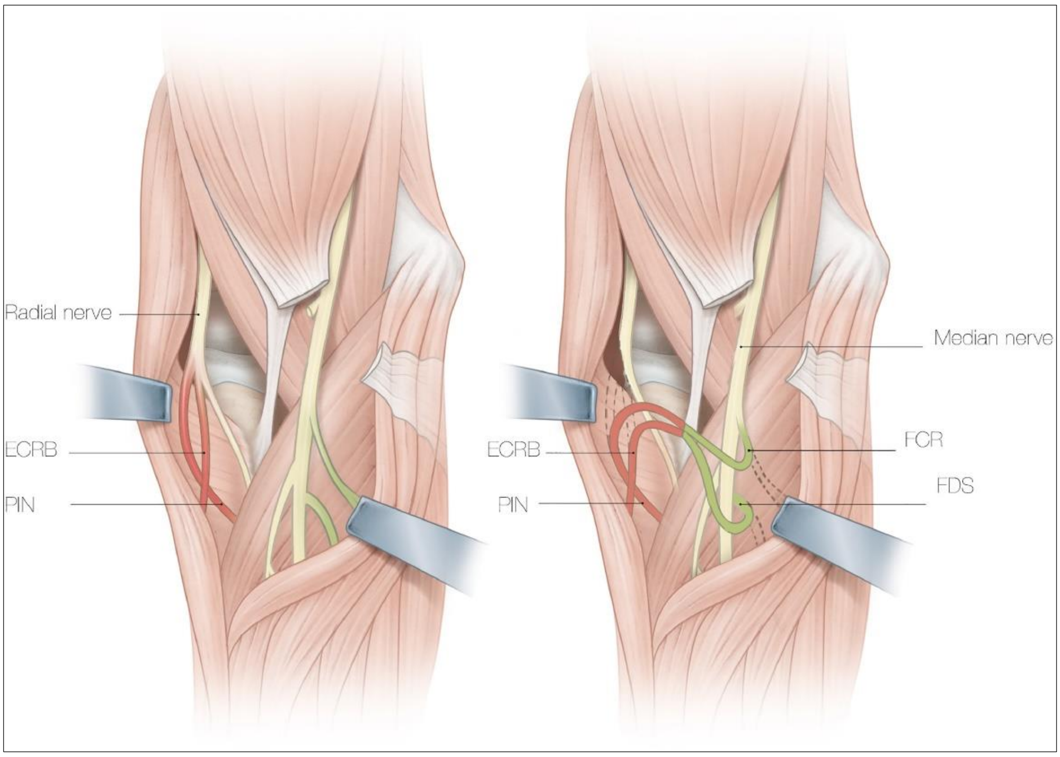

Figure 2 Illustration demonstrating radial-to-median nerve motor transfer techniques, with the extensor carpi radialis brevis (ECRB) branch of the radial nerve redirected to branches of the median nerve, such as the flexor carpi radialis (FCR) and flexor digitorum superficialis (FDS). This approach is commonly utilized to restore voluntary motor function in brachial plexus or proximal radial nerve injuries. Adapted from: Duraku, L. S., et al. (2025)

When the tendons in the shoulder, including latissimus dorsi, trapezius, and pectoralis major tendons, are moved due to brachial plexus injuries or rotator cuff injuries, valuable movements (external rotation and abduction) are recovered in the case (Compton et al., 2018). These measurements and results include external rotation, abduction strength (assessed using the Medical Research Council [MRC] scale), range of motion (ROM) measured with a goniometer, patient-reported outcomes (Constant–Murley score), and electromyography (EMG) values to evaluate muscle activity (Hudak et al., 1996; Tan et al., 2023). Relevant influencing factors include timely surgery (the earlier the better), the condition of the muscles (e.g., degree of atrophy), and the use of technologies such as robotics to achieve precise tensioning (Matsuura et al., 2024). These factors influence functional recovery and patient satisfaction (Chung et al., 2006). A broad-scope evaluation according to these measures promotes the accurate measurement of shoulder-specific results.

3.3.2. Elbow

Transfers of the elbow tendons, e.g., biceps-to-triceps transfer and latissimus dorsi transfer, were created to recover elbow flexion and elbow extension in cases of tetraplegia or brachial plexus lesions (Compton et al., 2018). The results are flexion/extension strength by the Medical Research Council (MRC) scale, the range of motion (ROM), which is assessed with the help of goniometry and the Mayo Elbow Performance Score, which evaluates function and pain reported by the patient (Hudak et al., 1996; Tan et al., 2023). Among the factors that may influence treatment include the magnitude of nerve regeneration, which affects reinnervation of muscles and functional recovery, as well as the quality of donor muscles, with healthier muscles yielding better strength results (Matsuura et al., 2024). These aspects have a significant impact on the functioning and satisfaction of the elbows (Chung et al., 2006). A detailed analysis of these measures ensures a comprehensive understanding of elbow-specific outcomes following tendon transfer.

3.3.3. Wrist

Wrist tendon transfers, such as flexor carpi ulnaris to extensor carpi radialis brevis and pronator teres, aim to restore wrist extension in conditions like radial nerve palsy or tetraplegia (Compton et al., 2018). Outcomes include wrist extension strength (Medical Research Council [MRC] scale), range of motion (ROM) via goniometry, grip strength measured by dynamometry, and patient-reported outcomes using the DASH score to assess function and disability (Hudak et al., 1996; Tan et al., 2023). Influencing factors include precise tendon tensioning, which optimizes strength and ROM, and structured rehabilitation protocols, which enhance functional recovery through targeted therapy (Matsuura et al., 2024). These factors significantly impact wrist function and patient satisfaction (Chung et al., 2006). Thorough evaluation of these metrics ensures comprehensive insights into wrist-specific outcomes post-tendon transfer.

3.3.4. Hand

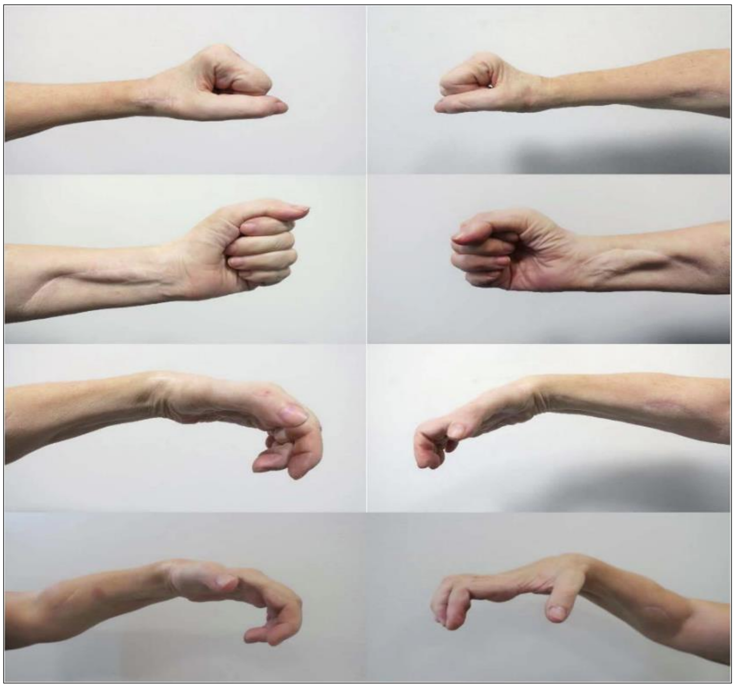

Figure 3 Sequential images demonstrate functional hand postures during grasp and release following combined nerve and tendon transfers in a tetraplegic patient. This approach restores wrist extension, finger flexion, and hand prehension by rerouting motor control to denervated muscles. The clinical result highlights the efficacy of integrated reconstructive strategies for enabling meaningful hand function in cervical spinal cord injury. ***Adapted from:*** Bunketorp Käll, L., et al., (2025)

Hand tendon transfers, including opponensplasty and intrinsic muscle reconstruction, aim to restore thumb opposition and hand function in conditions like median nerve palsy or tetraplegia (Matsuura et al., 2024). Outcomes include pinch and grip strength measured by dynamometry, thumb opposition assessed via functional tasks, and patient-reported outcomes using the Michigan Hand Outcomes Questionnaire to evaluate hand-specific function and disability (Chung et al., 2006; Tan et al., 2023). Influencing factors include surgeon experience, which enhances precision in tendon tensioning and transfer success, and patient compliance with postoperative rehabilitation, critical for optimizing strength and dexterity (Compton et al., 2018). These factors significantly impact hand function and patient satisfaction (Hudak et al., 1996). Comprehensive evaluation of these metrics ensures robust insights into hand-specific outcomes post-tendon transfer.

3.4. Patient-Reported and Psychosocial Outcomes

Patient-reported outcomes (PROs) and psychosocial metrics following upper extremity tendon transfers will be synthesized to evaluate function and quality of life across etiologies (e.g., traumatic, neurological) and anatomical regions (shoulder, elbow, wrist, hand). PROs, including the Disabilities of the Arm, Shoulder, and Hand (DASH) score, Short Form-36 (SF-36), and patient satisfaction surveys, assess functional disability and general health (Kinsley et al., 2025). Psychosocial metrics, such as return-to-work rates and mental health scores (e.g., PROMIS Emotional Distress), evaluate social reintegration and psychological well-being (Leypold et al., 2023). Comparisons across etiologies, like tetraplegia versus radial nerve palsy, and regions will highlight outcome variations, influenced by rehabilitation adherence and injury severity (Shapiro et al., 2024). This synthesis will elucidate patient-centered impacts, informing clinical decision-making in upper extremity reconstruction.

4. Discussion

On the one hand, the results of upper extremity tendon transfers show meaningful functional restorations in both anatomical area (shoulder, elbow, wrist, hand) and etiology (traumatic, neurological, congenital, degenerative), with an improvement in strength (MRC scale), range of motion (ROM), and patient-reported outcome (DASH, SF-36) (Kinsley et al., 2025; Shapiro et al., 2024). This synthesis, in comparison with those conducted in the past, depicts similar improvements in functional outcomes of wrist flexion (e.g., flexor carpi ulnaris transfers) and thumb opposition (opponensplasty), following landmark studies and demonstrating but also exposing shortcomings in outcomes of psychosocial nature, overcoming the barrier of returning to work (Leypold et al., 2023). Factors attributed to the patient, such as a younger age and fewer comorbidities, have a positive correlation with outcomes. Additionally, attention to donor muscle selection and sufficient tensioning of the donor are associated with successful outcomes (Kinsley et al., 2025). The impact of socioeconomic barriers and a low rehabilitation rate, especially in low-resource regions, is adverse to the recovery issue and owing to this, designed interventions are determined.

These findings have clinical implications for the selection of procedures (i.e., the use of the latissimus dorsi to improve shoulder stability) and for advising patients on whether they need to adhere to rehabilitation (Shapiro et al., 2024). Robotics and wearables enhance accuracy and surveillance, respectively, but interdisciplinary care is the most viable approach to improve recovery (Leypold et al., 2023). In comparison to nerve transfers, tendon transfers are more rapid but cannot be rearranged, and their application depends on the chronicity of the injury. Due to study heterogeneity, possible publication bias, and the limited number of long-term data, generalizability is restricted. In future studies, the outcome measures (MRC, DASH, EMG) should be streamlined. Multicenter research should be conducted, and new research methods should be considered, along with the identification of differences or disparities among various populations.

5. Conclusion

Tendon transfers significantly improve upper extremity activity in the shoulder, elbow, wrist, and hand, depending on the etiology (traumatic, neurological) and technique (latissimus dorsi, opponensplasty). Patient-reported outcomes (DASH, SF-36) and psychosocial outcomes (return to work, mental health scores) highlight patient-centered gains but vary with factors such as injury severity and access to rehabilitation. Such technologies as robotics and wearables, as well as interdisciplinary care, enhance precision and biological healing. Such findings provide evidence-based guidance to clinicians on the selection of procedures and patient counselling for customized rehabilitation. Nevertheless, the diversity of study methods and the lack of long-term statistics underscore the necessity of homogeneous, comprehensive research. Health professionals are advised to adopt the use of high technology and equitable care models to maximize outcomes, especially in low-resource areas. The researchers are encouraged to fill the gaps by conducting prospective multicenter investigations using standardized outcome measures (MRC, DASH, EMG) and innovating new skills to achieve equitable access and better functional outcomes globally.

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