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Postoperative Cognitive Dysfunction after Total Joint Arthroplasty in the Elderly: A Meta-Analysis

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ABSTRACT

This meta-analysis consolidated the research on postoperative cognitive dysfunction (POCD) following total joint arthroplasty (TJA). Data from 17 studies that assessed cognition pre- and post-surgery in TJA patients alone (15 studies) or matched TJA and control groups (2 studies) were analysed. Results were grouped by cognitive domain (memory, attention, language, speed, general cognition) and follow-up interval (pre-discharge, 3-6 months post-surgery). The TJA data revealed small declines in reaction time and general cognition pre-discharge, but no evidence of decline 3–6 months post-surgery. Very limited TJA and Control data indicated no group differences in the changes to performance over time; however, the TJA group was cognitively compromised pre- and post-surgery compared to Controls. Further appropriately controlled research is required to clarify whether POCD commonly occurs after TJA.

Total joint arthroplasty (TJA) of the hip and knee is among the most common major surgeries performed on older adults [1]. The number of TJAs performed each year has increased substantially over the last decade [2] and this trend is predicted to continue as our population ages. TJAs are usually performed to treat damage caused by osteoarthritis [2], which is common among older adults, and typically yield good surgical outcomes as they markedly improve pain, physical function, and have few medical complications [3]. Although surgically successful, patients may still experience short- or long-term post-operative cognitive dysfunction (POCD) [4–6], which is a subtle form of cognitive decline that can develop after surgery and affect multiple cognitive domains, particularly in the elderly [7].

There are multiple theories regarding the cause of POCD. One is that it results from intra-operative microemboli that travel to the brain. These emboli are thought to be released when the artificial prosthesis is inserted or the tourniquet that is used during surgery is removed [8]. Other potential causes of POCD include general anaesthesia and/or postoperative analgesia [9]; although research has consistently failed to find a relationship between general anaesthesia and POCD after TJA [5,10,11]. Furthermore, a systematic review that investigated the potential role of analgesia in post-operative cognitive problems confirmed that POCD was not related to either the type of analgesia or its method of administration [9]. Thus, the underlying cause of POCD has yet to be established.

The actual incidence of POCD after TJA is presently unclear, with some studies reporting substantial rates [4,5,12–14] and others failing to find evidence of cognitive dysfunction [11,15]. Moreover, the incidence rates reported by those studies that did find evidence of POCD following TJA are highly variable, ranging from 16% to 45% [5,13], with both rapid recovery [16] and chronic dysfunction [4] also noted.

Some of the variability in these research findings may result from between-study methodological differences. For example, the existing POCD studies differ in terms of their mean age, sample sizes, sample composition (i.e. TJA patients only versus partial/revision procedures plus TJA), research design (i.e. TJA group only versus TJA and Control groups), follow-up interval, and the definition of clinically significant change (i.e. use of reliable change indices versus cut-off scores). There are also differences in how cognition is measured, as both detailed cognitive batteries [4,5,14] and basic screening tools, such as the Mini Mental Status Examination (MMSE) [17,18], have been used. Moreover, differences in the ability of individual tests to detect subtle cognitive dysfunction may impact on the reported incidence, severity, and duration of POCD.

Importantly, research suggests that POCD may negatively impact on the post-surgical quality of life of patients and their families. While this area remains under-researched in TJA patients, there is comparable evidence in cardiac and general hospital inpatients suggesting that POCD is associated with enduring negative effects, even after controlling for potential confounding factors, such as age

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and comorbid medical conditions [19,20]. For example, cardiac patients who developed cognitive problems within six weeks of their surgery also experienced a range of other problems one year later [19]. Specifically, they had reduced functional capacity, were more limited by their symptoms (e.g. shortness of breath interfered more with their daily activities), and reported more cognitive difficulties [19]. Based on research conducted with general surgery patients, POCD may also have significant financial implications for both TJA patients and the wider community [21,22]. For instance, patients who developed POCD are reportedly more likely to leave the labor market prematurely and to spend more time on welfare [21], and require more assistance with their activities of daily living [22]. While research of this type has yet to be conducted with TJA patients, it might be expected that TJA patients with POCD would be similarly affected.

Despite the high incidence of TJA in the older population and the potential burden associated with the development of POCD, the nature and extent of POCD after TJA remains poorly understood. There is little consistency in the research findings, and the literature specifically relating to POCD after TJA has not been reviewed, either qualitatively or quantitatively. Rather, current reviews of post-surgical cognitive outcomes have either focused on cardiac surgery [23,24] or have combined data from patients that have undergone different forms of surgery [25,26]. The absence of an over-arching analysis of existing research on POCD following TJA represents a major obstacle to our understanding of the incidence and severity of these problems. The current meta-analysis synthesised the available research data in order to provide this information.

Methods

Search Strategy and Selection Criteria

Comprehensive searches of the PubMed, PsycINFO, Embase and Scopus electronic databases were undertaken to locate all studies that assessed cognition among older adults after TJA that were published between January 1980 and August 2012. A complete list of the search terms is provided in Appendix.

To be eligible for inclusion, studies had to have: (1) included a surgical group who underwent TJA of the hip or knee; (2) examined participants who were over 50 years of age (or mean age minus 1 SD ≥50 years); (3) assessed cognition using standardised neuropsychological tests (excludes self-report measures and clinician ratings); (4) performed pre- and post-surgical cognitive assessments of either one (TJA) or two (TJA, Control) samples; (5) completed at least one post-surgical assessment 24 hours or more after surgery; (6) provided data that would allow for the computation of an effect size (e.g. proportions, means and SDs, or exact *t*-values); (7) assessed participants who were not reported to have had a neurological (e.g. dementia) or medical condition that may have impacted on cognition; (8) a sample size that was greater than one (excludes case studies); and (9) been published in a journal in English.

Studies were deemed eligible for inclusion if they included patients who had 'elective' hip and knee surgery. Although this term can be used to refer to partial and revision procedures (in addition to TJA), these procedures usually only constitute a small number of elective surgery patients [2]. Therefore, where TJA data were not reported separately, studies that assessed samples of elective surgery patients were assumed to consist primarily of TJA patients.

If a study that was published within the previous decade did not provide the necessary data, but was otherwise eligible, the corresponding author was contacted by email to request these data. The authors of eleven studies were contacted for this purpose [4,5,12–14,27–31], five of whom provided the requisite data [12–14,27,29].

The original literature search was kept broad in order to capture the maximum number of potentially relevant papers and identified 1,312 studies (excluding duplicates). An examination of the titles and abstracts of these papers revealed that approximately 65% were not relevant to either TJA or POCD. A further 25% were relevant to TJA only, while approximately 5% addressed POCD, but not in a TJA sample. The full-texts of the remaining 5% were screened using the inclusion criteria to determine their eligibility, with 19 studies being eligible for inclusion. The most common reasons for the exclusion of studies were a failure either to provide the data for TJA patients separately from that of other surgical patients or to conduct a post-surgical cognitive assessment (i.e. only pre-surgical assessments completed). Meta-analyses assume that the data from different studies are independent and, therefore, that each sample only contributes once to the calculation of a mean effect-size [32]. If sample independence could not be established through the information provided in the publication, the corresponding authors were contacted by email for confirmation. When samples overlapped, the respective studies were combined and treated as one. To this end, the data from two studies by Evered et al [5,33] were combined, as were the data from two studies by Dupplis and Wikblad [34,35]. Therefore, the data from a total of 17 independent studies were analysed in this study.

Research Design and Data Preparation

Four of the 17 studies used an experimental design to examine whether different types of anaesthesia resulted in different cognitive outcomes following TJA [6,10,11,36]. Only the 'standard care' patients (the control group) from Cheng et al. [36] could be included in the current meta-analysis, as the experimental group received non-standard treatment. In contrast, both the experimental and surgical control groups from Jones et al. [11], Nielson et al. [10] and Williams-Russo et al. [6] received standard care TJA; consequently these groups were combined for current purposes, and means and SDs for the total TJA sample calculated. In addition, two studies provided mean (and SDs) cognitive scores for specific subgroups; namely the presence/absence of POCD [37] or post-surgical delirium [27]. As these subgroups were not required for the current meta-analysis, their data were combined to provide an overall mean and SD for the entire sample. Thus, the data that was extracted from these six studies equated to that of a single-sample pre- and post-surgery design, and hereafter will be referred to as such.

Of the 17 studies that assessed cognition after TJA, 15 used a single-sample pre- and post-surgery design [6,10–13,15–18,27,29,35–38] and only two used a two-sample (TJA and Controls) pre- and post-surgery design [5,14]. Given that very few studies used the latter design, the TJA data from these two studies were additionally treated as if they came from a single-sample pre- and post-surgery design (i.e. TJA data analysed, control group data excluded) and tabled with the other studies that used this design for comparative purposes.

Cognition was assessed using a wide variety of different tests, and many studies used either the same test or a close variant (e.g. Grooved Pegboard Task and the Purdue Pegboard Task). When tests were deemed to measure the same construct, they were analysed together and given a more generic label (e.g. motor speed). For reporting purposes, all tests were grouped into five broad cognitive domains, based on those identified by Lezak et al. [39]: memory, attention, language, motor and processing speed, and general cognition.

Studies also varied considerably with regard to the interval that elapsed between the TJA surgery and the follow-up cognitive assessment; ranging from one day to 12 months. For current purposes, all assessments were combined into one of two follow-up intervals: pre-discharge (within one week of surgery) and longer follow-up (3 to 6 months post-surgery). With two exceptions, these