COGNITIVE DISFUNCTION IN ARTHROPLASTY SURGERY: CEREBRAL FAT EMBOLISM?

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INTRODUCTION:

More than 400,000 knee and hip replacements are performed annually nationwide. Over 20% of the patients get confused in the perioperative period. It has been shown that fat emboli occur following arthroplasty due to the intramedullary instrumentation of the bone. Fat released from the bone marrow enters the venous circulation and passes through the right side of the heart to enter the lung. In approximately 25% of adults a congenital communication exists between the right and left side of the heart. This communication, called a patent foramen ovale (PFO), is the most common venous to arterial (v-a) circulation shunt. Normally the foramen ovale is closed by the pressure gradient between the left and right atria. Nevertheless, flow from the right to the left atrium can occur as circulatory pressures on the right heart increase. Consequently, this shunt may allow more and larger fat particles to enter the arterial circulation and reach the brain, thereby causing cerebral ischemia and tissue damage.

The clinical significance of intra-operative microembolism during joint replacement remains uncertain. In this study we investigated the occurrence of intra-operative microembolism in patients undergoing elective hip or knee replacement and their effect on neuropsychological outcomes in groups with and without a v-a shunt.

METHODS:

The present study was approved by both the Investigational Review Board of Mercy Hospital and the University of Miami. All eligible patients provided informed consent. A total of 23 patients, 65 years or older, undergoing primary knee or hip replacement surgery were enrolled. A prior history of stroke, dementia, atrial fibrillation, carotid stenosis and inability to have MR imaging performed were exclusion criteria. All surgeries were performed by a single high volume surgeon. 83% received spinal anesthesia versus 17% who had general.

The following procedures were done pre-operatively: MR imaging with fluid attenuated recovery inversion (FLAIR) and Diffusion Weighted (DW) imaging 72 hours before surgery; intravenous administration of an air/saline agitated solution under TCD monitoring with and without Valsalva maneuver to determine the presence of a v-a shunt. Even though PFO can be demonstrated by transoesophageal echocardiography, transcranial Doppler ultrasound (TCD) is a special form of non-invasive ultrasound neuroimaging technique that has shown similar sensitivity. All patients were monitored intra-operatively with TCD for microemboli. Follow up MR imaging was performed 72 hours after surgery. A neuroradiologist, blinded to study protocol, reviewed all DW images for acute injury and compared post-operative FLAIR sequences with baseline studies for any acute changes.

TCD studies were examined blinded to study protocol, for the presence of microembolic signals, defined according to standard criteria. Additionally, various neuropsychological tests were performed pre- and postoperatively by a clinical psychologist. Cognitive decline was defined as more than 20% change in two different tests.

Intergroup comparison of mean values was performed using Mann-Whitney rank-sum test. Spearman's rank correlations coefficient were calculated to assess association between intraoperative measurements. The SPSS® software (Chicago, IL) was used for the statistical analyses. A p value <0.05 was considered statistically significant.

RESULTS:

We enrolled 23 patients with a mean age of 74.3 ± 1.5 years. 57% were female. All patients except one (rheumatoid arthritis) were diagnosed with end-staged osteoarthritis. Eighteen unilateral TKA, five THA and 1 bilateral TKA were performed. A v-a shunt was detected in 11 of the 23 patients (3 hip and 8 knee replacements).

We found intra-operative microembolism in every patient. Both shunt groups had similar intraoperative monitoring time. The overall mean number of emboli was 10.1 ± 3.7 SE and mean size of the embolic signal was 11.4 ± 1.1SE dB. Patients with a v-a shunt had microemboli which were twice as large as patients without a shunt; the v-a shunt group also had about twice as many microemboli relative to the group with no v-a shunt group (Figures 1 and 2). However, these differences were not statistically significant.

One patient had a DVT episode and another had transient blurry vision associated with dysarthria in the postoperative period. Both were in the v-a shunt group.

Of all patients, 73.9% showed cognitive decline at discharge and 47.6% at 3 months follow up. These findings were not statistically different between the v-a shunt and no shunt groups (p=0.2).

Cognitive decline was not associated with age, gender, type of surgery, presence of hypertension, diabetes, cholesterol, or type of anesthesia.

No acute DW imaging abnormalities were detected. Only one patient with a v-a shunt was found to have an increased subcortical FLAIR hyperintense signal abnormalities post-operatively.

Figure 1

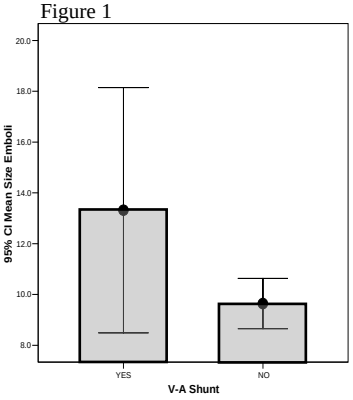
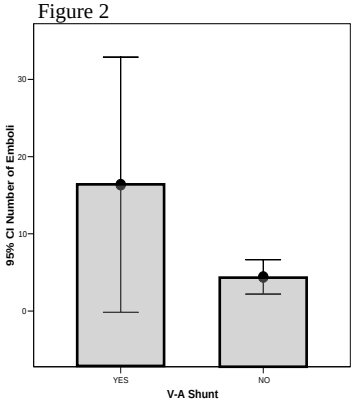


Figure 2



DISCUSSION:

Almost 80% of then patients showed cognitive decline at discharge. This was extremely surprising and has not been reported before. At three months almost 50% of the patients continue to score at significantly lower levels of cognitive function. We detected cerebral emboli in all patients undergoing hip or knee replacement. Previous reports have shown MRI to be sensitive in identification of cerebral fat embolism, with abnormalities appearing as hyperintense lesions on T2-weighted, proton density and FLAIR sequences. In our study we found that DW imaging and FLAIR abnormalities are rare post-operatively.

The role of fat microembolism in postoperative cognitive decline is still elusive. We found no significant associations with v-a shunt status with respect to microemboli size and number and with neuro-psychological outcomes. However, all associations were in the hypothesized direction and two patients with v-a shunt experienced adverse postoperative outcomes. We are following this cohort of patients and suspect that a significant number of them will return to normal at the one year mark.

The clinical significance of this decline is probably of increase significance now that a lot of the patients are going home. Clearly more follow up and additional studies in larger patient series are needed.

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