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Cerebral Fat Microembolism and Cognitive Decline After Hip and Knee Replacement

Sebastian Koch, MD; Alejandro Forteza, MD; Carlos Lavernia, MD; Jose G. Romano, MD; Iszet Campo-Bustillo, MD; Nelly Campo, MD; Stuart Gold, PhD

***Background and Purpose*—**Intra-operative cerebral microembolism may be a factor in the etiology of cognitive decline after orthopedic surgery. We here examine the impact of intra-operative microembolism on cognitive dysfunction after hip and knee replacement surgery.

***Methods*—**We enrolled 24 patients, at least 65 years old, requiring elective knee or hip replacement surgery. A transcranial Doppler shunt study was done to determine study eligibility so that the final study population consisted of 12 consecutive patients with and 12 consecutive patients without a venous-arterial shunt. A standard neuropsychological test battery was administered before surgery, at hospital discharge and 3 months after surgery. All patients were monitored intra-operatively for microemboli. Quality of life data were assessed at 1 year.

***Results*—**The mean age of patients was 74 years. All patients had intra-operative microemboli. The mean number of emboli was 9.9±18. Cognitive decline was present in 18/22 (75%) at discharge and in 10/22 (45%) at 3 months, despite improved quality of life measures. There was no correlation between cognitive decline and intra-operative microembolism.

***Conclusion*—**Cognitive decline was seen frequently after hip and knee surgery. Intra-operative microembolism occurred universally but did not significantly influence postoperative cognition. Quality of life and functional outcome demonstrated improvement in all cases in spite of cognitive dysfunction. **(*Stroke*. 2007;38:1079-1081.)**

Key Words: fat embolism ■ postoperative cognitive decline

Cognitive decline occurs in 5% to 29% of patients after orthopedic surgery.[1–4] The etiology of this decline is unknown. Recently intra-operative microemboli have been detected with transcranial Doppler (TCD) during skeletal surgery.[4–7] These microemboli are presumed to be lipid emboli. We here examine the hypothesis that cerebral microembolism during hip and knee replacement causes postoperative cognitive dysfunction. We further postulate that a venous-arterial shunt increases cerebral microembolism and adversely affects cognitive function.

Materials and Methods

Subjects

We enrolled 24 patients, at least 65 years old, who required elective primary hip or knee replacement after study approval by the local institutional review board. Patients were screened for a venous-arterial shunt so that the final study population included 12 consecutive patients with and 12 consecutive patients without a shunt. The following investigations were obtained:

Venous-Arterial Shunt Study

Pre-operatively a TCD shunt study was performed according to previously described protocol.[8] The shunt was characterized by the number of bubbles detected during Valsalva maneuver: 1 to 20 bubbles, >20 bubbles but no shower sign, and presence of a shower sign.[8]

Neuropsychological Testing

Neuropsychological testing was performed in accordance with the Statement of Consensus on Assessment of Neurobehavioral Outcomes after Cardiac Surgery[9] and consisted of 11 examinations: Symbol Search, Digit Span, Rey's Complex Figure, COWA (controlled word association), RAVLT (Rey Auditory Verbal Learning Test), Trails A, Trails B, Grooved Pegboard, Finger Tapping. The battery was administered 72 hours before surgery, at discharge and 3 months after surgery. Cognitive decline was defined as a decrease in an individual's performance of at least 20% from baseline in 2 or more tests at hospital discharge or 3 months.[3,10–12]

Quality of Life Assessment

Quality of life was measured with the Quality of Well being Scale (QWB), Short Form 36 and Western Ontario and McMaster University Osteoarthritis Index (WOMAC) at baseline and 1 year after surgery.[13] Pain frequency and intensity were assessed with the Visual Analog Scale (VAS).

Intra-Operative Monitoring

All patients were monitored intra-operatively with TCD. Studies were performed with a Nicolet Pioneer TC 4040 using a 2-MHz Doppler probe. Either the right or left middle cerebral artery was insonated unilaterally at a depth of 5 to 6 cm. Microembolic signals were defined in accordance with consensus criteria.[14] A higher intensity threshold of 6 dB was used.

Surgical Procedure

Knee and hip replacements were performed according to standard surgical practice. During knee replacement surgery a lower extremity

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From the Department of Neurology (S.K., A.F., J.G.R., I.C.-B., N.C., S.G.), Department of Neurology and Psychiatry, University of Miami, Miller School of Medicine; and the Orthopaedic Institute at Mercy Hospital (C.L.), Miami, Fla.

Correspondence to Sebastian Koch, 1150 NW 14th St, Ste #609, Professional Arts Center, Miami, FL 33136. E-mail skoch@med.miami.edu

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Baseline Clinical and Surgical Characteristics of the Study Population and Patients With and Without Cognitive Deficits at Discharge and 3 Months

		Discharge Cognitive Assessment		3-Month Cognitive Assessment	
	All Patients	Deficit Absent n=6	Deficit Present n=18	Deficit Absent n=12	Deficit Present n=10
Age	74±6	71±3	75±7	72±6	76±6
Male, n (%)	10 (41)	3 (50)	7 (39)	3 (33)	4 (40)
Hypertension	15 (62)	3 (50)	12 (67)	6 (50)	8 (80)
Diabetes	5 (21)	1 (17)	4 (22)	1 (8)	3 (30)
Knee replacement	18 (75)	5 (83)	13 (72)	6 (50)	9 (90)
Hip replacement	6 (25)	1 (17)	5 (28)	6 (50)	1 (10)
Anesthesia general	5 (20)	1 (17)	4 (22)	4 (33)	1 (10)
Anesthesia spinal	19 (80)	5 (83)	14 (78)	8 (67)	9 (90)
Duration of surgery, min	91±25	87±24	92±26	93±32	90±18
No. of emboli	9.9±18	4.7±2.9	12±20	12±23	6.2±7.6
Size of emboli, dB	12±5	8.9±1.7	13±5.7	10±3.8	13±6.3
Venous-arterial shunt	12 (50)	4 (67)	8 (45)	8 (67)	3 (30)

Values are shown as means±SD or No. (%). None of the group differences were statistically significant.

tourniquet was inflated before skin incision. Cemented knee prosthesis was routinely used for knee surgeries.

Hip replacement was performed uncemented. Pain was initially managed with opiate-based patient-controlled analgesia and femoral nerve block in patients with knee replacement. Subsequently, patients were changed to oral analgesia, including in-hospital opiate therapy according to standard practice.

Data Analysis

Baseline characteristics between patients with and without postoperative cognitive decline were compared using Student *t* test for continuous variables. Categorical variables were compared with χ^2 test and Fischer exact *t* test when indicated. Two-sided *P* value <0.05 was considered significant.

Results

Baseline characteristics of the study population are depicted in the Table. A total of 34 patients underwent a TCD venous-arterial shunt study to yield the final study population of 12 consecutive patients with and 12 without a venous-arterial shunt. The prevalence of a shunt was 35%. A spontaneous shunt was found in 6 patients. The shunt was classified as follows: <20 bubbles in 10, >20 bubbles in 1 and a shower sign in 1 patient.

There were no significant differences in the sizes of emboli in patients with and without a shunt. Patients with a shunt had more emboli, but this did not reach statistical significance (4.4±3.5 versus 15.4±23.7; $P=0.14$).

Cognitive decline was present in 18/24 (75%) at discharge and in 10/22 (45%) at 3 months. Two patients did not complete the 3-month testing. Characteristics of patients with and without cognitive decline are shown in the Table. There were no significant differences in microemboli in patients with and without cognitive deficit at any time.

Quality of Life

After surgery, significant improvements were noted in functional and pain scores (WOMAC, SF-36) and overall well-being (QWB).

Discussion

Only 2 prior studies have assessed the relationship between intra-operative microembolism and cognitive outcome in orthopedic surgery. Neither study was able to establish a causal relationship between the two.[3,4] Similar to our study, intra-operative embolic counts were low, significantly less than those seen during cardiac surgery.

We did not find that a venous arterial shunt influenced the number and size of microemboli. Prior TCD studies have detected larger numbers of emboli in patients with a venous-arterial shunt during joint surgery.[7] It is possible that the majority of patients in our study had a small shunt. In 10/12 patients the shunt study detected <20 microbubbles. Larger shunts have previously been correlated with more intra-operative emboli during hip and knee surgery.[7]

Our findings are limited by the small number of patients and our results may be inconclusive. However, a strong relationship between cognitive decline and microemboli does not seem readily apparent. There remains some uncertainty about the definition of cognitive decline used in this study, which may overestimate cognitive decline.[15] An effect of microemboli on cognition may thereby have been diluted by incorrectly classifying individuals as impaired. Additionally, the clinical significance of postoperative cognitive decline after hip and knee surgery is unclear. Our patients quality of life, pain, and overall well-being improved after surgery, as is well described in joint replacement.[13] It is difficult to understand the full clinical implications of neuropsychological decline, as determined by objective cognitive testing, on patient's everyday function after joint replacement.

Even though we did not find intra-operative microembolism to contribute to postoperative cognitive decline we feel that given the importance of cerebral microembolism on cognitive outcome in other fields, such as cardiac surgery, the role of microembolism during orthopedic surgery deserves further study.

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Disclosures

None.

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