Cardiac

Neurologic and cognitive outcomes after aortic arch operation with hypothermic circulatory arrest

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Background. *Neurologic injury is still a frequent cause of mortality, morbidity, and long-lasting disability in patients undergoing an aortic arch operation with hypothermic circulatory arrest. The aim of this analysis was to evaluate short- and long-term outcomes in neurologic and cognitive functions in this group of high-risk patients.*

Methods. *A total of 333 patients undergoing an aortic arch operation between February 2004 and June 2010 were retrospectively reviewed. Cerebral protection was obtained with deep hypothermic circulatory arrest in 220 patients (66%) or with moderate hypothermic circulatory arrest in 113 cases (34%). Straight deep hypothermic circulatory arrest was adopted in 35 cases (11%), while the association with antegrade cerebral perfusion was adopted in 271 cases (81%) and with retrograde cerebral perfusion in 27 cases (8%). Seventy-eight patients were enrolled in a case control prospective study (mean follow-up time = 42 months) and underwent neuropsychologic evaluations; data were compared with those of a matched-control group of hypertensive patients without history of cardiac operations.*

Results. *Forty-one out of 333 patients experienced permanent neurologic dysfunction (12%) and 83 experienced temporary neurologic dysfunctions (25%). Acute aortic dissection and deep hypothermic circulatory arrest were significant predictors of mortality and permanent neurologic dysfunction. Acute aortic dissection and hypothermic circulatory arrest duration >30 minutes were significant predictors of temporary neurologic dysfunction, while antegrade cerebral perfusion was protective on mortality. Neuropsychologic evaluations showed no significant differences between the groups. The operative group showed worse verbal and working memory (*P = .003*), worse semantic fluency (*P = .036*), higher degree of alexithymia (*P = .004*), and a lower quality of life (*P = .007*).*

Conclusion. *Although moderate hypothermic circulatory arrest with antegrade cerebral perfusion demonstrated a lower mortality compared with deep hypothermic arrest, neurocognitive testing demonstrated no difference between the groups. Additionally, patients undergoing an aortic arch operation demonstrated long-term cognitive deficits and psychological dysfunction when compared to a matched cohort of nonoperative patients. (Surgery 2016;160:796-804.)*

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Accepted for publication February 4, 2016.

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0039-6060/$ - see front matter

http://dx.doi.org/10.1016/j.surg.2016.02.008

AORTIC ARCH OPERATION WITH HYPOTHERMIC CIRCULATORY ARREST (HCA) represents, to date, a challenging task and high-risk cardiovascular procedure. Particularly, neurologic injury is still a frequent cause of perioperative mortality and morbidity after this kind of operation. The incidence of permanent neurologic dysfunction (PND), as reported by various studies

and registries, is between 2–5% for elective cases and 9–16% for urgent and emergency cases.[1]

Moreover, it is known that neurologic injury can also occur as temporary neurologic dysfunction (TND), which is a functional expression of fine and presumably transient brain injury, theoretically capable of determining long-term deficits of cognitive and intellectual functions and alterations of the neuropsychologic profile of the patients.[2]

Until now, there has been no general agreement on the safest technique to adopt to reach the best cerebral protection. Concerns remain about the temperature to reach during circulatory arrest, the employment of selective cerebral perfusion (SCP), and the site of arterial cannulation.

The aim of this report is to evaluate postoperative short-term outcome in patients undergoing cardiac operations with HCA and different modes of cerebral perfusion, and to assess long-term deficits in neurologic and cognitive function with a case-control, prospective study.

MATERIALS AND METHODS

Patients. A total of 333 consecutive patients, who underwent an aortic arch operation with HCA at the University Hospital of Turin from February 2004 to June 2010, were retrospectively reviewed. The mean age was 64 years (range, 21–80), and 90 patients (27%) were female. Table I shows overall preoperative characteristics, intraoperative data, and early outcome. A total of 124 patients (37%) with chronic lesions underwent an elective operation, and 209 patients (63%) with acute aortic syndrome underwent an emergency operation; the reason for an emergency operation was acute type A aortic dissection in 190 cases (91%) and intramural hematoma in 12 cases (6%). Seven patients had miscellaneous etiologies (3%).

Definitions. According to a recent consensus of thoracic aortic experts from all over the world, HCA was considered deep between 14.1–20°C, moderate between 20.1–28°C, and mild between 28.1–34.0°C.[3,4] The short-term outcome variables were early mortality (EM) and neurologic event (NE), divided in PND and TND. EM was defined as death within the hospital or within 30 days from the operative procedure. PND was defined as clinical signs persisting at the time of discharge from the hospital and/or in the presence of localized ischemic infarcts detectable by conventional neuroimaging techniques. TND was defined as temporary clinical signs by means of confusion, agitation, delirium, prolonged obtundation, or transient stroke with negative cranial computed tomography (CT) scan and complete resolution before discharge.[2]

Table I. Overall preoperative characteristics, intraoperative data and early outcomes

Variable (n = *333*)	*Value*
Age, y (mean, SD)	64 ± 12
Female (*n*, %)	90 (27)
Hypertension (*n*, %)	151 (45)
COPD (*n*, %)	18 (5)
Peripheral vasculopaty (*n*, %)	21 (6)
Previous cardiac surgery (*n*, %)	50 (15)
Emergent surgery (*n*, %)	209 (63)
Preoperative neurological deficit (*n*, %)	51 (15)
Preoperative neurological deficit not evaluable (*n*, %)	37 (11)
Type of aortic disease (*n*, %)	
Acute type A aortic dissection	190 (57)
Degenerative aneurysm ± aortic regurgitation	81 (24)
Intra-mural hematoma	12 (4)
Other*	50 (15)
Surgical procedures (*n*, %)	
Ascending aorta + hemiarch replacement	169 (51)
Ascending aorta + hemiarch replacement + aortic valve surgery	80 (24)
Total arch replacement	40 (12)
Total arch replacement + Elephant Trunk	21 (6)
Other	23 (7)
Total surgery time, min (mean, SD)	368 ± 165
Cardiopulmonary bypass time, min (mean, SD)	193 ± 70
Crossclamp time, min (mean, SD)	105 ± 45
Arterial cannulation (*n*, %)	
Central	15 (5)
Femoral	143 (43)
Axillary	175 (52)
Hypothermic circulatory arrest time, min (mean, SD)	39 ± 24
Hypothermic circulatory arrest temperature (*n*, %)	
Deep hypothermic circulatory arrest	220 (66)
Moderate hypothermic circulatory arrest	113 (34)
Cooling time, min (mean, SD)	55 ± 26
Rewarming time, min (mean, SD)	66 ± 23
Selective cerebral perfusion (*n*, %)	
Antegrade	271 (81)
Retrograde	27 (8)
No perfusion	35 (11)
Early Mortality (*n*, %)	73 (22)
Neurological Event (*n*, %)	124 (37)
Permanent Neurological Dysfunction (*n*, %)	41 (12)
Transitory Neurological Dysfunction (*n*, %)	83 (25)
Reoperation for bleeding (*n*, %)	39 (12)
Renal dysfunction	18 (5)
Pulmonary complication	58 (17)

*Other: congenital diseases; cronic aortic arch dissections; aortic arch penetrating atherosclerotic ulcers; endocavitary masses.
SD, Standard deviation; *COPD*, Chronic Obstructive Pulmonary Disease.