Awareness of Neuropsychological Function In Coronary Artery Bypass Graft Surgery

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Abstract

Changes in brain function after Coronary Artery Bypass Graft Surgery have been documented in several studies from the late 1970's to the present. The present study attempts to further clarify neuropsychological changes that may occur as a result of bypass surgery. Previous investigations of neuropsychological alterations following bypass surgery were limited to only a few psychometric measures to detect such changes. This study incorporates a neuropsychological test battery that is sensitive to very subtle neurocognitive changes. Twenty-eight subjects, fourteen angioplasty subjects and fourteen bypass subjects, were tested on a computerized test battery. After completion of each test in the battery, subjects rated their performance on a likert scale. There were significant differences between the two groups on three of the six tasks. The bypass group was the only group to demonstrate a significant difference in perception of performance on any of the tasks. The present study concludes that bypass surgery can lead to neuropsychological changes that may originate in the hypothalamus.

Despite medical, scientific and technological advances that have reduced morbidity in Coronary Heart Disease (CHD), the disease remains a serious threat. CHD is the number one cause of death in the United States today. In a 1988 health survey, it was found that 650,000 people in the U.S. die annually from heart disease and there are approximately one million new and recurrent myocardial infarctions each year (Erikson, 1988). Many physicians choose Coronary Artery Bypass Graft Surgery (CABGS) to treat the most severe cases of CHD. In 1984, roughly 50,000 bypasses were performed and by 1987, that number had risen to an estimated 245,000 (Robinson, Blumenthal, Barker, & Reeves, 1990).

During CABGS, hypothermia is induced to decrease the myocardial oxygen demand. Cardioplegia, immobilization of the heart, is implemented to prevent arrhythmia complications. But perhaps the most crucial technique involved in bypass surgery is connecting the patient to the cardiopulmonary oxygenator (i.e. the "heart-lung machine") to meet the circulatory and oxygen demands of the body during surgery. Beginning in the late 1970's and continuing into the 1980's, several studies have examined neuropsychological changes after bypass surgery. In 1983, it was reported that 1.7% of 2,616 bypass patients exhibited neuropsychological change following the bypass surgery (Zapolanski, Loop, Estafanous, & Sheldon, 1983).

When examining the medical reasons for the resultant neuropsychological changes following bypass surgery, it appears that the effects of the cardiopulmonary oxygenator on the brain may be the most salient. Currently, brain alterations resulting from CABGS are attributed to either microemboli (microscopic air bubbles) or perfusion differences produced by the cardiopulmonary oxygenator (Taylor, 1982). Perfusion, forcing blood through the blood vessels, may lead to brain alterations during bypass surgery because of differing flow and pressure rates. Martzke, Murkin, Buchan, Sharma, and Campbell (1992) examined the effects of microemboli as a result of bypass surgery. They found the microemboli to be the source of long term neuropsychological alterations following bypass surgery. Alterations were detectable at seven days post-operatively and remained present at the six to eight week follow-up.

Until now, research in this area has centered around documentation of post-operative alterations without any regards to patient awareness of their level of functioning. However, it has been hypothesized that patient perception of neuropsychological changes may effect their performance on neuropsychological function tests. In testing the subjects in the present study, we attempted to assess the relationship between neuropsychological performance on the tasks as well as patient perception of their performance. Awareness of perceived neuropsychological alterations following bypass surgery has not previously been studied. The present study is designed to address more comprehensively the neuropsychological changes and awareness of those changes secondary to CABGS.

Method

Subjects

Twenty-eight subjects, aged 40-80, were divided into two groups of fourteen subjects each. A control group consisted of subjects who had undergone angioplasty and fourteen subjects comprised the bypass surgery group. Of the twenty-eight subjects tested, four were female. Three of the four female subjects were in the bypass group and only one was in the angioplasty group. Of the twenty-four males tested, thirteen were in the angioplasty group and eleven were in the bypass group. All subjects were administered the test battery individually after they read and signed an informed consent form.

Procedure

A neuropsychological test battery was administered individually on a Macintosh Powerbook 160. The following tasks were administered to each subject: (1) Rotor Pursuit task that measured motor coordination, (2) Decision Time task that measured simple reaction time, (3) Digit Span that measured short-term verbal memory, (4) Problem Solving task that assessed the subject's problem solving capabilities, (5) Mental Rotations task that measured visual-spatial orientation, (6) Semantic Priming task that assessed the priming ability of the subject.

After subjects completed each of these tasks, they were asked to rate their performance on the task just completed. Subjects rated their performance on a traditional likert scale ranging from one to seven. Statistical analyses performed included fifteen one tailed t-tests calculated on a Macintosh statistics program. A priori .05 significance level was adopted in order for a difference to be considered significant.

Results

Three of the six tasks administered yielded significant differences between the two groups. The Reaction Time, Digit Span and Semantic Priming tasks were the most sensitive tasks in detecting subtle differences between the two groups. On the Reaction Time task, the bypass group had a significantly lower reaction time than the angioplasty group [$t(26)=2.38$, $p<.05$].

The Digit Span task yielded significant differences in the strand length of numbers correctly recalled between the two groups. The angioplasty group correctly recalled a longer strand of digits than the bypass group [$t(26)=1.79$, $p<.05$]. The Semantic Priming task yielded a significantly greater priming effect in the bypass group than in the angioplasty group [$t(26)=2.62$, $p<.05$].

When examining perceived subject performance, there were significant differences between the two groups on only one task. The Rotor Pursuit task demonstrated that the bypass group rated their performance significantly lower than the angioplasty group rated their performance [$t(26)=2.06$, $p<.05$].

Discussion

Three of the six neurocognitive tasks yielded significant performance differences between the two groups. The angioplasty group performed better than the bypass group on the Reaction Time and Digit Span tasks but not on the rotor pursuit, problem solving, mental rotations, or semantic priming tasks.

When comparing the findings of the present study to prior studies, significant differences had not previously been reported between bypass subjects and control subjects when measuring reaction time (Newman, Klinger, Venn, Smith, Harrison, & Treasure, 1987). In two other studies, bypass subjects were shown to demonstrate significant neuropsychological changes following surgery on the Digit Span task (Fish, Helms, Sarnquist, Tinklenberg, 1987, and Shaw, Bates, Cartlidge, French, Heavside, Julian, & Shaw, 1986). On the Semantic Priming task, the bypass group performed better than the angioplasty group. There are no previous studies that have examined the priming effect of bypass subjects after surgery.

When examining perceived performance on the tasks, the only task that yielded a significant difference was the Rotor Pursuit task. The bypass subjects rated their performance significantly lower than the angioplasty subjects rated their performance.

The tasks that yielded significant performance differences assessed functions controlled by the same region of the brain, the hippocampus. The hippocampus is located in the telencephalon and has been shown to be responsible for many brain functions, including memory. The Digit Span and Semantic Priming tasks are both assessments of memory, thus the processes that are responsible for these tasks are also governed by the hippocampus. The ReactionTime task requires the subject to utilize information processing techniques. The hippocampus is also responsible for such function (Shaver and Tarpy, 1993).

Since the bypass group performed more poorly than the angioplasty group on the Decision Time and Digit Span tasks, such differences could be attributed to alterations in brain function at the hippocampul level following bypass surgery. The Semantic Priming task indicated that the bypass subjects had a larger priming effect than the angioplasty group. This is not surprising because it has been shown that certain types of neurological damage can actually improve the priming effect (Shaver and Tarpy, 1993).

The perception of performance t-test scores were insignificant in all tasks but the Rotor Pursuit Task. From the performance predictions of the bypass group, it was shown that they were not aware of their performance deficits on the Reaction Time and Digit Span tasks but were aware of difficulties on the Rotor Pursuit task. Thus, bypass subjects do not appear to be aware of their deficits on certain neuropsychological tasks.

This study is unique in that it implemented a computerized neuropsychological test battery that is very sensitive to the most subtle deficits. In order to improve the present study, we are in the process of replication by adding more subjects, testing pre and post CABGS, and using a group of surgical subjects to serve as a control group.

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