Cerebral Cooling Effectively Achieves Mild Therapeutic Hypothermia In Healthy Volunteers

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Abstract

Introduction:
Hypothermia has been proven to prevent cell and tissue damage caused by ischemia. This study will determine the effectiveness of a new device to induce cerebral cooling and reach a plane of neuroprotective hypothermia.

Objective:
Determine if the Excel Cryo Cooling System® achieves rapid reduction of cerebral temperature into mild hypothermia.

Methods:
The Excel Cryo consists of a unique cervical collar and cooling element, which cools the blood as it travels through the carotid arteries. Healthy volunteer baseline tympanic temperatures were recorded with additional readings every 5 minutes over an 80 minute period. The cooling element was replaced every 20 minutes.

Results:
15 subjects reached an average temperature drop of 1.73°C in 31.7 minutes. 13 dropped 0.9–2.5°C and 2 dropped 3.0° and 3.6°C respectively.

Conclusion:
The Excel Cryo reduced temperature into mild hypothermia necessary for neuroprotection.

Keywords: Mild-Hypothermia, Ischemia, Neuroprotection, Excel Cryo

Introduction

Induced hypothermia has been demonstrated as a useful therapy for treating conditions that lead to cell and tissue damage caused by ischemia, including cardiac arrest, stroke, and traumatic brain injury. It has been shown that for every 1 degree Celsius temperature drop, cerebral metabolism drops up to 10% which is necessary for neuroprotection. Hypothermia provides the following benefits:

- Reduces the risk of ischemic injury to brain tissue following a period of insufficient blood flow
- Encourages cell membrane stability during periods of oxygen deprivation
- Helps to reduce reperfusion injury caused by oxidative stress when blood flow is restored
- Reduces intracranial pressure
- Reduces or eliminates free radical production

For cardiac arrest, recent studies show an association between time to cooling and mortality with a 1-hour delay in time to cooling increasing the risk of death by 20%[1], and positive outcomes when therapeutic hypothermia was combined with return of spontaneous circulation within 25 minutes of cardiac arrest.[2] Additionally, supporting the initiation of cooling as early as possible, or pre-hospital, another study found that in assessment upon discharge, for every five minute delay in initiating hypothermia treatment, there was a 6% percent greater odds of the patient having a poor outcome compared to a good outcome.[3]

In a study evaluating the long-term benefits of hypothermia in patients with severe traumatic head injury, it was found that mortality decreased by 40%, and the rate of favorable outcome increased by 70% one year after the head injury.[4] A previous study also compared selective brain cooling (SBC) to mild systemic hypothermia (MSH) in a TBI study of 66 patients randomized into 3 groups including SBC, MSH and control group. It was shown that the percentage of patients with a good neurological outcome after two years after injury was 72.7%, 57.1% and 34.8% in the SBC, MSH and control groups' respectively.[5]

Statistical Analysis

Statistically, the temperature improvement for the 15 patients was analyzed in two ways:

1. The temperature improvement for each patient was compared to a random improvement between 0.1° and 0.4°, which is the normal temperature range over the course of several hours. An unpaired t-test was used to compare the p-value between the test group and a randomized group. Results are given in Table 1 below.

2. The temperature improvement for each patient was analyzed looking at the change from the start of the treatment to the lowest temperature observed during the treatment, and compared to the temperature change from the start of the treatment to the end of the study. A paired t-test was used to compare the p-value between the test group change in temperature during treatment and the change in temperature after treatment. Results are given in Table 2 below.

TABLE 1

	Treatment Group	Control Group
Mean	1.727	0.26
Std Deviation	0.766	0.099
Std Error Mean	0.198	0.025
N	15	15
Difference of Means	1.467	
95% Confidence Interval	1.058 - 1.875	
t-value	7.3573	
Degrees Freedom	28	
p-value	<0.0001	

TABLE 2

	Temp Change Due To Treatment	Temp Change Start To Completion
Mean	1.727	1.113
Std Deviation	0.766	0.59
Std Error Mean	0.198	0.152
N	15	15
Difference of Means	0.613	
95% Confidence Interval	0.401 - 0.826	
t-value	6.1966	
Degrees Freedom	14	
p-value	<0.0001	

Objective

To determine the ability of the Excel Cryo Cooling System® to achieve a rapid reduction of cerebral temperature into mild therapeutic hypothermia in healthy adult volunteer subjects.

Materials & Methods

The Excel Cryo Cooling System is a non-invasive product consisting of a uniquely designed cervical immobilization collar with an anterior opening and door which holds the replaceable cooling element. The collar is fitted around the patient's neck and the cooling element is activated and applied to the front of the neck over the carotid arteries and secured in place by the collar. Cooling the blood as it travels through the carotid arteries is achieved through counter-current heat exchange. Baseline tympanic temperatures were recorded, and additional temperature readings were recorded every 5 minutes over a period of 80 minutes. The cooling element was replaced every 20 minutes per manufacturer recommendation.

Results

Fifteen subjects enrolled for data analysis reached an average temperature drop of 1.73°C, with the average time to reach Mild TH of 31.7 minutes. Observations were as follows:

- 5 quickest to cool subjects dropped temperature between 0.90°C and 1.7°C in 20 minutes
- 53% (8 of 15) of subjects reached Mild TH within 25 minutes
- 7 subjects dropped from .9 – 1.5°C
- 6 subjects dropped from 1.6 – 2.5°C
- 2 subjects dropped temperature 3.0°C and 3.6°C, respectively

Conclusion

We concluded that the Excel Cryo Cooling System is a safe and effective method for cerebral cooling and reaching mild therapeutic hypothermia, necessary for neuroprotection.

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