Effect of Chin Tuck Against Resistance (CTAR) Exercise to Improve Swallowing Capacity among Stroke Patients with Dysphagia: A Randomized Controlled Trial

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Abstract

***Objective*:** Dysphagia after stroke affects more than 50% of stroke survivors. It can adversely impact the quality of life. Totally 41% of patients with dysphagia experience anxiety or panic during mealtimes and more than 33% of patients avoid eating with others because of dysphagia. Chin tuck against resistance (CTAR) exercise is one of the swallowing exercises, which will regenerate the neurons and improve the suprahyoid muscle activation. This study evaluate the effect of the CTAR exercise along with conventional therapy in comparison with only conventional therapy in improving swallowing capacity among stroke patients with dysphagia ***Material and Methods*:** A randomized controlled trial was conducted among 40 stroke patients with dysphagia in tertiary care hospital and they were selected by using a simple random sampling method. Using Gugging swallowing scale (GUSS) and Functional oral intake (FOIS) Scale pre and post swallowing assessment was done in both the groups. CTAR exercise along with conventional therapy was administered to the study group for 14 consecutive days and the control group received the only conventional therapy. ***Results*:** This study revealed that the mean± SD of GUSS pre-assessment in the study group was 7.15± 3.031 and 6.45± 3.692 in the control group and the post-assessment mean value had progressed to 15.45± 4.006 in the study group and 11.65 ± 3.660 in the control group with the p-value (p-0.003), which shows the study significantly improves the swallowing capacity among stroke patients with dysphagia. ***Conclusions*:** CTAR exercise along with the conventional therapy improves to swallowing capacity when compared to only the conventional therapy group.

Key words: chin tuck against resistance, conventional therapy, dysphagia, stroke

Key Messages

- Most of the stroke patients have dysphagia showed either unilateral or bilateral sensory loss and sensory deficit exists in pharynx and larynx.
- It has been concluded that the severity of laryngeal sensory deficit determines predisposition to aspiration.
- CTAR exercise is an alternative form of head-lift exercise and patients will have less rigorous activity, and enjoy more while performing exercise.
- So this study can help stroke patients with dysphagia to improve their swallowing capacity.

Introduction

A Stroke is a condition where the blood supply to the brain is disrupted, which results in oxygen starvation, brain damage, and loss of function. Globally 1 in 4 adults over the age of 25 will have a stroke

in their lifetime [1]. The worst complication after stroke is dysphagia which might even lead to aspiration pneumonia [2].

Dysphagia (Difficulty in swallowing) is extremely common following stroke as it affects those swallowing muscles, affecting 27% to 64% of stroke survivors. Although dysphagia improves spontaneously in many people with stroke, some will die and 15% of stroke survivors will still have swallowing problems after one month; many of these individuals require long-term feeding with major impairment of function, recovery, and quality of life. Complications of dysphagia include aspiration leading to chest infection and pneumonia, malnutrition, inability to rehabilitate, increased risk of infection, prolonged length of hospital stay, and increased risk of death [3,4]. Since most of the dysphagic patients showed either a unilateral or bilateral sensory loss in one study and a sensory deficit exists in the pharynx and larynx in stroke patients with dysphagia, it has been concluded that the severity of laryngeal sensory deficit determines a predisposition to aspiration [5].

Training the suprahyoid muscles is important for safe swallowing in patients with stroke who are susceptible to aspiration. CTAR exercise is a new modified exercise in swallowing therapy. In addition, it has the relative advantage of being convenience, simple, cost-efficient, and motivating dysphagia patients with stroke. Implementing CTAR exercise among stroke patients with dysphagia will improve the patient's swallowing capacity, minimize the incidence of aspiration, and will aid in the early removal of Ryles's tube. Therefore, it will initiate early oral intake in stroke patients. CTAR exercise is an alternative form of head-lift exercise and patients will have less rigorous activity, and enjoy more while performing the exercise. So this study can help stroke patients with dysphagia to improve their swallowing capacity.

Methods

This funded, single-center, parallel- group randomized controlled trial (RCT) was conducted at tertiary care hospital, Puducherry, after approval of the institute ethics committee (IEC. No-JIP/CON/IEC/M.Sc./2020/MSN/2)and written informed consent from their patients and the legal guardian. The trial was registered with Clinical Trial Registry ofIndia(CTRI: 2021/12/039029 on 29/12/2021).

Study population and period

All consecutive eligible stroke patients with dysphagia who were getting treatment in tertiary care hospital, Puducherry, India during January 2022 to March 2022 were recruited in the study. Patients were include Patient age >18 years, Stroke patients diagnosed within 6 months, dysphagia following stroke confirmed by gugging swallowing scale (GUSS), FOIS (functional oral intake scale) , who was able to sit without assistance, and who could to perform chin tuck using a CTAR device (rubber ball). We excluded patients with unstable condition, previous abnormality in mouth, throat and neck, multiple organ dysfunction syndromes, Uncooperative patients and global aphasia or sensory aphasia

Sample size estimation

Sample size was calculated using comparison of 2 independent mean formulas [6]. The power and alpha levels were set at 0.90 and 0.05 respectively with standard deviation of 1. According to a prior analysis, each group required at least 16 subjects. Therefore, a total of 32 subjects were required. However, we recruited 40 subjects considering the possibility of dropouts.

Control of bias and Study Interventions

Randomization was done using computer- generated random table with 1: 1 allocation ratio. Study group received CTAR exercise along with conventional therapy and the control group patients received only the conventional therapy for 2 weeks.

Data collection

The random sequences were concealed before allocation to both groups by the serially numbered opaque sealed envelope technique. The study was carried out in both Neuro-medicine and Medicine departments of tertiary care hospital after obtained the ethical clearance. The eligible participants were identified based on their inclusion and exclusion criteria, they were randomly grouped into intervention and control arms using block randomization.Informed consent were obtained from the participants in both the study group and control group, after explaining the study purpose and procedure in verbal communication and written forms.With the selected stroke patients their demographic data age, sex, marital history were collected through interview method and dysphagia level was assessed using the GUSS scale and FOIS scale on day one. Study group performed the CTAR exercise along with the conventional therapy using the rubber ball for two weeks. The control group performed only the conventional therapy, after performing this exercise on day 14, the post-test GUSS and FOIS was done.

Intervention for study group CTAR Exercises

There are many swallowing exercises such as head lift exercise, tough resistance, and electrical stimulation etc., shaker exercises (head lift exercises) was traditional swallowing exercise, that was very effective in improving the swallowing function. The withdrawal of patients was very high in shaker exercises and hence the modified shaker exercise called chin tuck against resistance was developed. The chin tuck against resistance exercise was a very simple concept. It was simply tucking the chin down or pressing or nodding the chin in a downward motion against resistance. Chin tuck against resistance - the training exercise where the participants were asked to sit straight and hold the rubber ball under their chin and tuck their chin as head flexion and neck flexion. It would strengthen the suprahyoid muscles of the neck and improve the swallowing ability. It had two types of exercises, isometric and isotonic exercises. In isometric CTAR, the patients were asked to sit upright and hold the ball under the chin. Sustain chin tuck against device (inflatable rubber ball) for as hard as possible; do it three times, each time sustained for 60s with no repetition, and provide rest for 1minute in between each set. In isotonic CTAR**,** the patients were asked to sit upright and hold the ball under the chin. Tuck the chin, as hard as possible against the ball; then lift the chin. Perform this exercise for 30 consecutive repetitions. These two exercises were performed twice a day for two weeks [6].

Intervention for Control group Conventional therapy

Conventional therapy was the normal exercises for the mouth and tongue. The participants had to do alternate lip movement, lip seal achievement, tongue –elevation up and down, protrusion and lateral movement of the tongue, and pharyngeal stimulation. Pronunciation of "BAA, TAA, and THAA" improved both the speech & mouth deviation, which helped in swallowing improvement. These exercises had to be done two times a day [7].

Outcome measures

This study used the gugging swallowing scale (GUSS) and functional oral intake scale (FOIS) to evaluate the dysphagia level and oral diet. GUSS scale has two divisions: The preliminary assessment (Part 1 - indirect swallowing test) and the direct swallowing test (part 2)which consists of three subtests namely semisolid diet swallowing test, liquid diet swallowing test, and solid diet swallowing test. Thus all these subsets must be performed sequentially from indirect swallowing test to solid diet swallowing test. It has four levels of scales, 20- No dysphagia, 15-19 - Mild Dysphagia, 10-14 - Moderate Dysphagia and 0-9 - Severe Dysphagia. This scale exhibits inter-rater reliability with the kappa statistics (α= 0.86- 0.91) [8].

FOIS assess the feeding performance of dysphagia patients. It consists of a 7- point scale with level 1 indicates no oral intake, and level 7 implies total oral intake with no restrictions. This scale exhibits inter-rater reliability method among two raters. It was found to be 0.9. Thus, the tool was found to be highly reliable for the study [9].The assessments were performed immediately before the start of the intervention (pre-assessment) and after the 2-weeks of intervention (post-assessment).

Statistical analysis

Statistical analysis was performed using the SPSS version 26.0 (IBM Corporation). Descriptive statistics are presented as mean with standard deviations. The Shapiro- Wilk test was used to check the normality of the collected data. To evaluate the effect of CTAR exercises used independent t-test to compare the post-intervention of both the group in GUSS scale, Mann-whitney test used to compare the FOIS intervention values of both the group. Wilcox sign U test was used to compare measures before and after the intervention in each group. The significance level was set at $p< 0.05$.

Results

Table-1: Demographic and clinical characteristics of the patients

variables		Study group (n=20) N (%)	Control group (n=20) N (%)	p value
Age (mean ± standard deviation)		46.25 ± 15.217	54.55 ± 10.313	**0.051***
Gender	Male	15 (75)	12(60)	0.311
	Female	5(25)	8(40)	
Co-morbidities	Diabetes mellitus	7(35)	5(25)	0.731
	Hypertension	10(50)	10(50)	>0.05
	Rheumatic heart disease	2(10)	2(10)	>0.05
	Coronary artery disease	1(5)	0(0)	>0.05
	Hypothyroidism	1(5)	0(0)	>0.05
Type of stroke	Ischemic	16(80)	14(70)	0.465
	Hemorrhagic	4(20)	6(30)	
Paretic side	Right	11(55)	9(45)	0.870
	Left	8(40)	10(50)	
	No paralysis	1(5)	1(5)	
Feeding tube type	Oral	0(0)	2(10)	0.487
	Tube feed	20(100)	18(90)	
Other deficit	Facial palsy	7(35)	7(35)	>0.05
	Dysarthria	13(65)	13(65)	
Tube removal	Yes	9(45)	3(15)	0.038
	No	11(55)	17(85)	

The table 1 shows that demographic and clinical characteristics of the patients in both groups.

Table-2: comparison of Gugging swallowing assessment independent mean between the groups

Comparison	Study group		Control group		Mean difference	df	p- value
	Mean	SD	Mean	SD			
Pre- assessment (Day-1)	7.15	3.031	6.45	3.692	0.700	38	0.516
Post-assessment (Day-14)	15.45	4.006	11.65	3.660	3.800	38	0.003*

The table 2 shows mean and standard deviation of swallowing assessment in first and 14th day assessment among the stroke patients in study and control groups. In GUSS assessment, showed significant improvements in swallowing function, however on comparing the study and control groups, after the intervention, it was found that the CTAR exercise with the conventional therapy group showed significantly (p-0.003)more improvement in swallowing, compared to the only conventional therapy in the control group (Table- 2). We compared the pre and post-assessment differences within the study and control groups. The data was checked for its homogeneity by the Shapiro-wilk test and it shows the data follows the non-normal distribution. So, the Wilcoxon test was used as statistical analysis. There was a significant difference in GUSS within the control group ($p<0.05$) (Table -4).

Table -3: comparison of two independent median of functional oral intake scale assessment between the study group and control group

Comparison	Study group	Control group	Statistical significant
	Median (IQR)	Median (IQR)	p-value
Pre-test (Day –1)	1(2,1)	1(1,1)	0.682
Post-test (Day-14)	5(4,6)	2.50 (2,4)	**0.006***

Table 3 reveals that comparison of two independent median of functional oral intake scale assessment between the study group and control group**.** In FOIS Assessment, the experiment group showed significant improvement in oral diet after the intervention was (p-0.006)**.**

Table -4: changes in parameters before and after intervention among the stroke patients

Comparison	Study group			Control group		
	Pre- test	Post-test	p-value	Pre –test	Post-test	P-value
	Median (IQR)	Median (IQR)		Median (IQR)	Median (IQR)	
GUSS	16(12, 18)	16(12,18)	1.000	5 (4,8.7)	11 (9,14)	**0.000***
FOIS	1 (1,2)	5 (4,6)	**0.000***	1(1,1)	2.5 (2,4)	**0.000***

Table 4 shows the changes in parameters before and after intervention in study and control groups. When comparing the data within the groups, Wilcoxon sign statistical analysis was used. The calculated p-value ($p< 0.05$) in the study and control groups indicates that FOIS scores in both the study and control groups were significant.

Discussion

The present study revealed that stroke was most commonly seen in men. Totally, 67.5% of men were affected by stroke whereas only 32.5% were women. Male gender was a risk factor for stroke and the leading causative factors for stroke were hypertension 10(50%) in both groups, diabetes 35% in the study group, and 25% in the control group. Previous study suggested that the incidence of stroke was higher in men than in women in all age classes, and women would be older than men when they suffered their first stroke. The prevalence of stroke was higher among men up to the age of approximately 80 years, after which it becomes higher in women and the 3 leading stroke-related Comorbidities in the study were hypertension (n = 82, 86.5%), history of cardiac-related co-morbidities, including arrhythmias, faulty heart valves and coronary artery disease (n = 62. 64.6%), and diabetes (n = 37, 38.5%) [10,11,12].The present study found the major type of stroke was ischemic stroke comprising 75% of the stroke patients, 25% of the stroke patients had hemorrhagic stroke type. Ischemic stroke comprises the major stroke type and was

mainly due to modifiable risk factors. Habibi-koolaee M et.al, evaluated that out of 375 specified stroke cases, 70.7% were ischaemic and 29.3% were hemorrhagic strokes [13,14].

CTAR exercise is a therapeutic swallowing exercise to strengthen the suprahyoid muscles, to prevent the patients from aspiration pneumonia. The CTAR alone with conventional therapy will stimulate the supra hyoid muscles (geniohyoid, digastric, mylohyoid and stylohyoid muscles) and oral muscles (orbicularis oris, buccintor, superior pharyngeal constrictor and hypoglossus muscles). Continuous stimulation of the suprahyoid muscle will regenerate the neurons, which will help those muscles to pull the hyoid and larynx upwards and result in swallowing without aspiration [6]. The degree of swallowing assessment was performed by GUSS and FOIS. Compared with the control group, the experiment group showed a significant improvement in swallowing capacity. Previous study showed similar findings, CTAR exercise improved the swallowing ability compared to conventional dysphagia treatment for four weeks. The functional dysphagia assessment (FDS) in the study group showed greater improvement in the following factors: residue in the oral cavity, laryngeal elevation, residue in valleculae, and residue in pyriform compared to the control group ($p= 0.044, 0.039, 0.037, 0.047$), CTAR induced greater muscle activation of supra hyoid muscle (SHM) and helped in improving swallowing and reduced the risk of aspiration [15].

This study evaluates there was a progressive improvement in oral diet assessed by FOIS scale. When comparing the findings of both the group, experiment group showed better oral intake diet after the intervention. As the oral muscle exercises helps the patients in chewing the diet, and reduce from aspiration. Similar to this finding Kim HH et.al, FOIS evaluation score showed a significant ($p<0.001$)improvement in the study group compared with the control group, which indicated that patients were able to safely swallow food items of various consistencies and viscosities [6].Ji-su park et.alin their study showed that among 37 stroke patients, after 4 weeks of mCTAR exercises intervention, they concluded there was no significant between the groups in swallowing but the CTAR exercise was more enjoyable and exciting than other exercise which motivates patient to perform [3].

The nasogastric (NG) tubes can be removed earlier after intervention by CTAR exercises. It showed, out of 20 stroke patients in the study group who were on NG tube feeding, 9(45%)had their NG tube removed. After performing CTAR along with conventional exercises for 14 days of intervention, some patients' NG tube had been removed within 10 days of performing their intervention. In the control group, among 18 patients who were on the NG tube feeding after performing the normal conventional exercises only 3 (15%)patients NG tube removal was possible. Kim HH et.alin their study has evaluated NG tube clearance and oral diet. At the end of the intervention, three out of 12 patients in the study group (25%) and two out of 13 stroke patients in the control group (13%) had their NG tubes removed. Hence, the study demonstrated that mCTAR exercise can reduce aspiration, improve oral intake levels, and helped in early NG tube removal in stroke patients with dysphagia [6].

Patient revealed that they had better vocal improvement and able to swallow better after performing the CTAR with conventional therapy. This exercise also reduces the risk of aspiration. Hence, the combination of both CTAR and conventional therapy, in stroke patients would enable rapid improvement in swallowing and also their level of oral intake.

Limitations

The limitation of this study are as follows: First, generalization of the study would be limited, as this is a single-center study, secondly sample size of the study might not be sufficient to generalize to a larger population and thirdly, the follow-up is only for two weeks. Hence, long-term effects could not be ascertained.

Conclusion

CTAR exercises are very effective exercises that can be easily performed by the stroke patient and they will enhance muscle strength and helps in improving swallowing ability. The study concluded that there is a significant change in improving the swallowing capacity among stroke patients with dysphagia in

the study group than the control group. So, for generalization further multi-centric studies can be conducted in a larger sample.

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Conflict of Interest
No potential conflict of interest relevant to this article was reported

Ethical Issues
Ethical clearance has obtained from Institute ethics committee for human studies, JIPMER (IEC. No-JIP/CON/IEC/M.Sc./2020/MSN/2).

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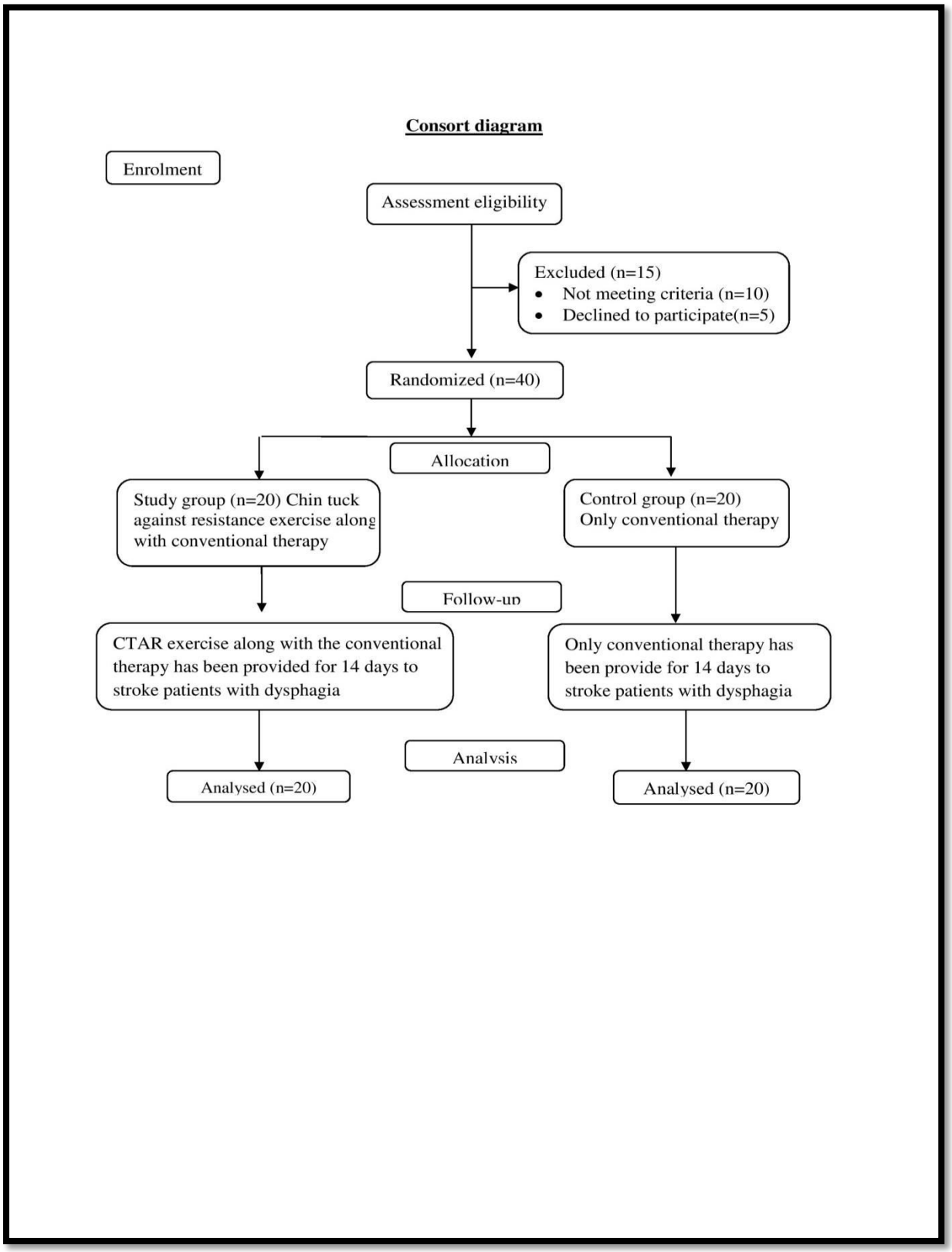
Consort diagram
Enrolment
Assessment eligibility
Excluded (n=15)
Not meeting criteria (n=10)
Declined to participate(n=5)
Randomized (n=40)
Allocation
Study group (n=20) Chin tuck against resistance exercise along with conventional therapy
Control group (n=20) Only conventional therapy
Follow-up
CTAR exercise along with the conventional therapy has been provided for 14 days to stroke patients with dysphagia
Only conventional therapy has been provide for 14 days to stroke patients with dysphagia
Analysis
Analysed (n=20)
Analysed (n=20)