Comparison between Two Designed Exercise Programs for Balance Disability in Cerebellar Stroke Patients

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ABSTRACT

The aim of this study was to determine and compare the effect of two designed programs of exercises on balance disability in cerebellar stroke patients. Twenty four cerebellar stroke patients participated in this study. Patients' age ranged from 52 to 67 years. They were randomly assigned into two matched groups. Group 1 received graduated balance exercises, while group 2 received the same program as group 1 plus graduated active exercises for the trunk, hip and knee extensors. The program was done three times per week for two months. Both static and dynamic balance was measured for both groups before and after the physiotherapy training program. Static balance was measured by using static balance test which is an ordinal clinical scale, while dynamic balance (overall stability index) was measured by using Biodex stability system. Results of this study revealed that there was a highly significant improvement regarding static balance in both groups at the end of physiotherapy training program, with a significant improvement in group 2 compared to group 1. Regarding the dynamic balance the study revealed that there was a highly significant improvement in both groups at the end of the physiotherapy program. There was no significant difference in the improvement between both groups. On conclusion, using a program of graduated balance exercises leads to improvement of both static and dynamic balance in cerebellar stroke patients. Addition of trunk, hip and knees extensors graduated active exercises can further improves static balance in those patients.
Key words: Cerebellum, Stroke, Balance.

INTRODUCTION

Cerebellar ischemic and hemorrhagic stroke are important causes of acute neurological morbidity[1]. Cerebellar damage causes impaired sitting, standing, and walking balance; abnormal postural tone; and frequent falling during locomotion[8].

A variety of balance scales have been developed for the examination of aspects of postural control. Some balance tests are used to measure the ability of a person to maintain the body's center of gravity within the base of support and to maintain stance when his or her balance is not perturbed. Other tests, often referred to as "dynamic tests", are used to assess balance in response to either self-initiated movements or external perturbations[9].

Bohannon and Leary[4] developed a test of standing balance that contains items with increasing levels of difficulty. It was found that this balance test is reliable and valid measure of balance disability. What is more is that it is quick and easy to perform[25].

The treatment of acquired impairments of balance is one of the most elusive problems that rehabilitative medicine faces[5]. Computerized systems to measure how

patients control their balance in dynamic conditions were introduced into clinical practice and proved to be useful[3].

Balance problems are thought to be common after stroke, and they have been implicated in the poor recovery of activities of daily living (ADL), mobility and an increased risk of falls[16,17].

Most studies have measured balance impairments (such as postural sway, weight distribution, or related parameters) rather than balance disability (the type of balance task that a subject can perform while maintaining an upright position, such as static or dynamic sitting or standing balance), each of which is reviewed below[7,10,18,24].

Studies of balance impairments consistently have shown that people with stroke have greater postural sway than age-matched volunteers who are healthy[7,18]. They also have altered weight distribution patterns, so that less weight is taken through the weak leg, and they have smaller excursions when moving their weight around the base of support, especially in the direction of the weaker leg. This pattern is seen in all aspects of balance static, dynamic, or responses to external perturbations and even in people with stroke with high levels of function, such as those who are ambulatory in the community[10].

Balance impairments is the focus of physical therapists' assessment and treatment plans[24]. The most consistent finding is that a lack of sitting balance in the acute stages after stroke is a robust indicator of a poor prognosis for recovery of independence in mobility or ADL[23]. The other consistent finding is a positive relationship between balance disability and other aspects of function, such as mobility, ADL, and falls[2,24]. In this study, balance disability was defined as the ability to maintain an upright position within the limits of stability or base of support[21].

The aim of this study was to compare between the effect of two designed programs of exercises on balance disability in cerebellar stroke patients.

SUBJECTS, MATERIALS AND METHODS

Subjects

Twenty four patients participated in this study. They were diagnosed clinically and radiologically as a cerebellar infarction. Their age ranged from 52 to 67 years. Fifteen were females, while eleven were males. The duration of illness ranged from seven to eleven months. Patients were classified into two matched equal groups, group 1 which received graduated standing balance exercises. While patients in group 2 received graduated standing balance exercises in addition to graduated active exercises for abdominal and back muscles, hip and knee extensors.

Inclusion criteria:

All patients had a cerebellar stroke due to cerebellar infarction, causing disturbance in both static and dynamic standing balance. All patients had the ability to stand unsupported that is grade one according to the static balance test[4].

All patients were submitted to: a thorough design of history taking and clinical neurological examination, computed tomography (CT) brain, magnetic resonance imaging (MRI) cervical spine, doppler on carotid & vertebral arteries, blood sugar level, ECG and complete blood picture.

Exclusion criteria:

Patients who had inner ear affection, cognitive dysfunction, peripheral neuropathy or other orthopedic problem, visual filed or hemineglect problems or vascular problems affecting standing were excluded.

Evaluation procedures:

The following methods were performed; while the patient in standing position; before and at the end of treatment program.

1. Static balance assessment:

The functional standing balance Scale consists of 3 components: weight distribution, balance with movement, and balance without movement. The balance without movement (static balance test) component of this test consisted of three tasks. It was used to evaluate the subjects' ability to maintain positions of increasing difficulty by diminishing the base of support from standing with feet apart to standing with feet together. The score is based on the length of time the subject can maintain the stance under each condition. The scale ranges from zero (unable to stand) till four (stands with feet together for 30 seconds or more). Three trials were done & the average was recorded[4].

2. Dynamic balance assessment:

Biodex stability system (3) was used to measure dynamic standing balance. It contains a movable balance platform, which provides up to $20°$ surface tilt from horizontal. The degree to which the platform tilted during balance assessment was dictated by the subject's balance ability. This test assessed patient's ability to control angle of tilt. Patient was instructed to achieve a centered position on a slightly unstable platform, by shifting position of feet till keeping the cursor centered on the screen. The actuator controls the degree of surface instability (eight grades). Test duration was set for twenty seconds, for three trials. Average (mean values) of overall stability index (SI) was calculated for each patient. Report included overall stability index; which represents subject's ability to control balance in all directions. A high stability index indicates a lot of movement and therefore less stability. On the contrary, lower SI is interpretated as a better balance score[22].

Treatment procedures

Treatment program was performed three times per week, for six weeks.

Physiotherapy program for group (1):

Physiotherapy program consisted of graduated standing balance exercises, through shifting the head forward, backward, right and left rotation. This was followed by raising both arms gradually upwards till the maximum. Then, moving trunk forwards, backwards and sideward to the right and to the left. This was followed by pushing the patient to different directions from stride position then from walk standing. Then, standing on one foot alternatively. Lastly, balance board training. The graduation of exercises was adjusted according to initial patient's evaluation grades of static and dynamic standing balance.

Physiotherapy program for group (2):

Physiotherapy program consisted of the same program of group (1) in addition to graduated active exercises for the abdominal and back muscles in the sagittal plane as well as hip and knee extensors.

Each exercise in each group was repeated twenty times with rest period of one minute every ten repetitions.

Data analysis

Statistical analysis was performed with Statica package (release 4.5, statsoft Inc. 1993. Mean and standard deviation were calculated for all values. t-test was used to compare means for stability index before and after treatment. Wilcoxon signed test was used for comparison between pre- and post treatment scores of the MAS. Level of significance was set at $P<0.05$.
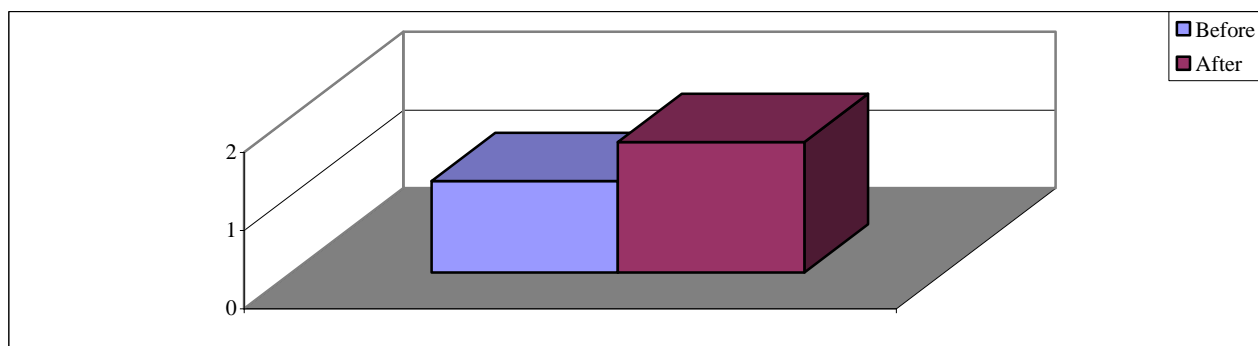
RESULTS

I: Static balance:
Group (1):

- There was a highly statistically significant improvement regarding static balance at the end of the physiotherapy program (P< 0.01), (table 1 and figure 1).

Table (1): Mean difference of static standing balance of group (1).

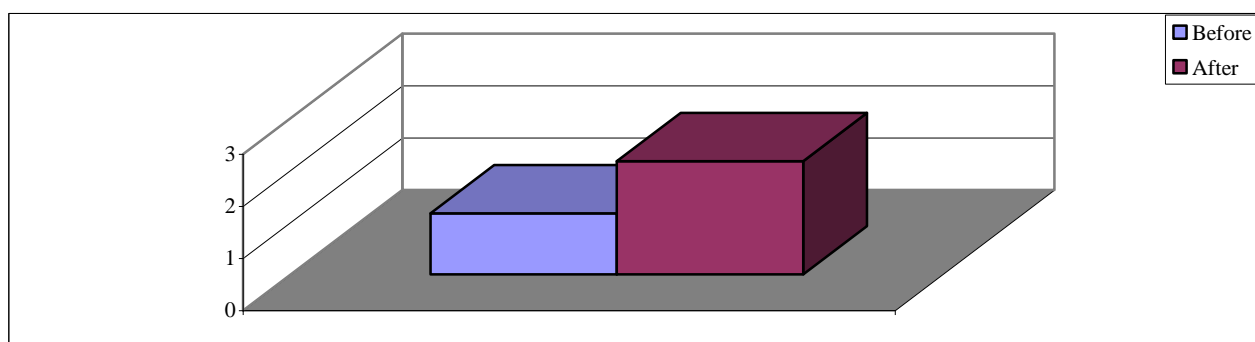| Item	Static standing balance	
	Before	After
Mean	1.17	1.67
Mean difference	0.5	
S.D ±	0.52	
T	3.33	
P	$< 0.01^{**}$	

**Highly significant

Fig. (1): Mean difference of static standing balance of group 1 Group (2).

- There was a highly statistically significant improvement regarding static balance at the end of the physiotherapy program (P< 0.01), (table 2 and figure 2).

Table (2): Mean difference of static standing balance of group 2.

Item	Static standing balance	
	Before	After
Mean	1.17	2.17
Mean difference	1	
S.D ±	0.6	
T	5.77	
P	$< 0.01^{**}$	

**Highly significant

Fig. (2): Mean difference of static standing balance of group 2.

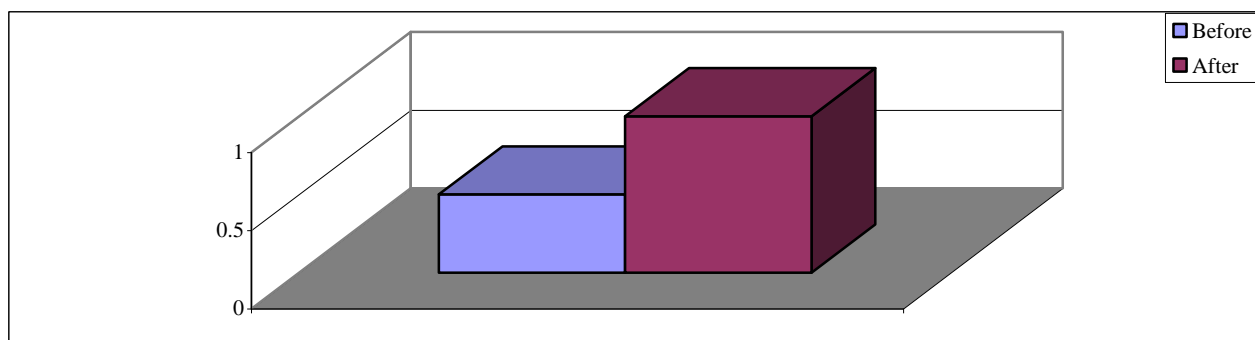Comparison between group 1 and group 2 for standing balance:

By comparing the degree of improvement in static standing balance in both groups (1 & 2), there was a significant improvement in static standing balance in group (2) compared to group (1). (P< 0.05) (table 3 and figure3).

Table (3): Comparison between the degree of improvement of static standing balance in group 1 and group 2.

Item	Static standing balance	
	Group(1) post-pre	Group(2) post-pre
Mean	0.5	1
S.D ±	0.56	
t	2.17	
P	< 0.05*	

*Significant

Fig. (3): Comparison between the degree of improvement of static standing balance in group 1 and group 2.
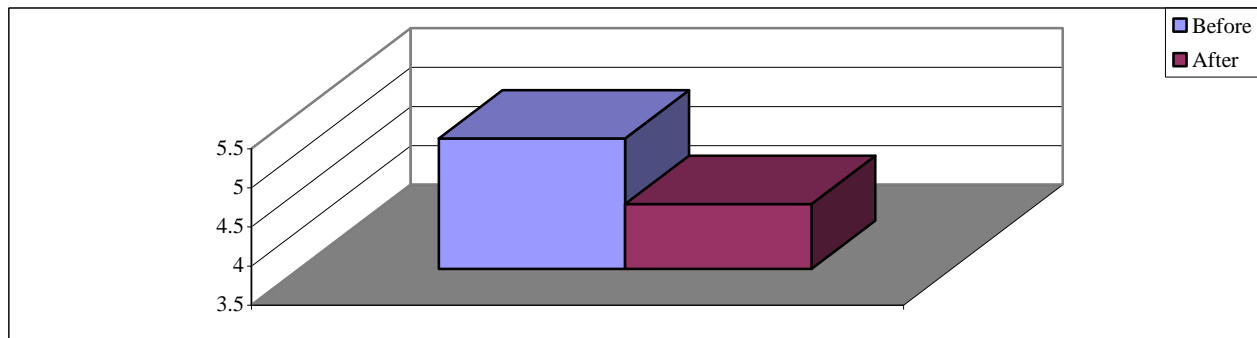
II: Dynamic balance:
Group (1):
- There was a highly statistically significant improvement regarding dynamic balance at

the end of physiotherapy program (P< 0.01), (table 4 and figure 4).

Table (4): Mean difference of dynamic standing balance of group 1.

Item	Dynamic standing balance	
	Before	After
Mean	5.17	4.33
Mean difference	0.83	
S.D $\pm$	0.58	
t	- 4.95[**]	
P	< 0.01	

**Highly significant

Fig. (4): Mean difference of dynamic standing balance of group 1.
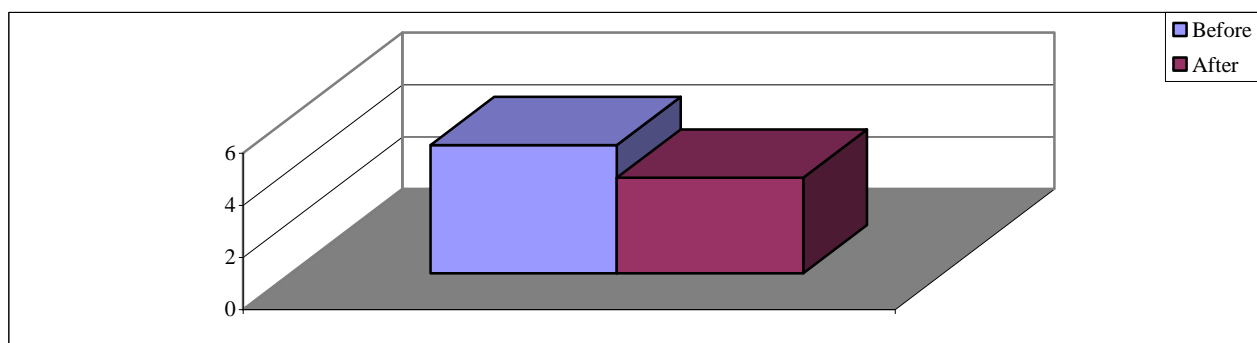
Group (2):
- There was a highly statistically significant improvement regarding dynamic balance at the end of physiotherapy program (P< 0.01), (table 5 and figure 5).

Table (5): Mean difference of dynamic standing balance of group 2.

Item	Dynamic standing balance	
	Before	After
Mean	4.92	3.67
Mean difference	1.25	
S.D $\pm$	0.62	
t	- 6.98	
P	< 0.01[**]	

**Highly significant

Fig. (5): Mean difference of dynamic standing balance of group 2.
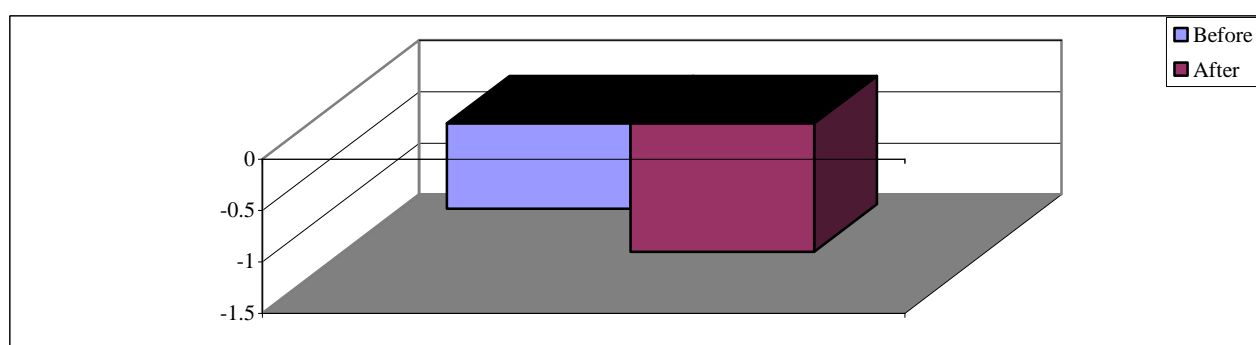
Comparison between group 1 and group 2:

By comparing the degree of improvement in dynamic standing balance in both groups (1 & 2), there was no significant difference in between. (P > 0.05) (table 6 and figure 6).

Table (6): Comparison between the degree of improvement of dynamic standing balance in group (1) and group (2).

Item	Dynamic standing balance	
	Group(1) post-pre	Group(2) post-pre
Mean	- 0.83	- 1.25
S.D ±	0.60	
t	1.71	
P	> 0.05 ns	

ns non significant

Fig. (6): Comparison between the degree of improvement of dynamic standing balance in group (1) and group (2).

DISCUSSION

This study was conducted to compare the effects of two physiotherapeutical programs on static and dynamic balance in cerebellar stroke patients. Patients were classified into two equal groups, group 1 which received graduated balance exercises. While patients in group 2 received graduated balance exercises in addition to graduated active exercises for trunk, hip & knee extensors.

Both static and dynamic balance were assessed by the static balance test and overall stability index before and after the end of treatment program which lasted for six weeks.

Results revealed that there was a significant improvement regarding static and dynamic standing balance in both group 1 and 2.

The trivial improvement of balance in cerebellar stroke patients could be credited to the previous reports indicating that excellent functional recovery frequently occurs among survivors of cerebellar infarction[12,14].

Improvement in the post training score on static standing balance test is in agreement with the study by Garland and Willems in recovery of standing balance and functional mobility after stroke where all subjects showed an improvement in functional balance over the course of one month of rehabilitation resulting in an increased gait speed[11].

Corresponding to this study it was found that the balance training in ambulatory hemiplegics may be a useful exercise in

improving balance and may result in better out comes of fall reduction and improved function[20].

Quite the opposite to the result of this study Chen et al., established that the static balance functional measurement of stroke patients in the trained group; with the Smart Balance Master; did not significantly improve when compared with the control group after six months of follow up. They supposed the reason was that the training protocol especially emphasized weight shifting skills, which benefit dynamic balance function more[6].

Additionally, there was significant improvement in static standing balance when comparing both groups in favor to G2. This could be attributed to the effect of training trunk muscles. As claimed by Shah and Jayavant 2006 trunk control allows the body to remain upright, to adjust to weight shifts, to control movement against the constant pull of gravity. Thus the training protocol which provides increased postural & trunk control may have improved balance[20]. Concurring with the result of this study it was found that Peak torque values for trunk flexion and extension were lower in the stroke patients than in the controls. The differences were significant for trunk flexion and for trunk extension. These findings indicate trunk flexion and extension muscle weakness in stroke patients can interfere with balance, stability, and functional disability[13].

The study done by Tyson and her colleagues pointed to the importance of knowing which factors influence a patient's balance abilities most strongly so that they can be targeted during rehabilitation. Therefore they indicated that weakness and sensory deficits have the most impact on balance[26].

As for the significance of adding trunk strengthening exercises to the balance training program Karatas et al., claimed that even mild weakening of trunk muscles in stroke patients can interfere with balance, stability, and functional disability. Although manual trunk muscle testing may reveal nothing abnormal in such cases, it must be kept in mind that most of these individuals have mild trunk muscle weakness. Likewise they recommended that trunk muscle strengthening program should be included as part of the rehabilitation program. Reestablishing trunk muscle function may improve stability, and make easier the reeducation of limb muscles and help the patient better manage daily living activities[13].

The results of this study concealed no significant difference regarding dynamic standing balance in both groups 1 & 2 ($P > 0.05$).

Sustaining the results of this study, Kligytė and his colleagues declared that weakness or loss of lower extremity muscle strength as a result of cerebrovascular accident has a poor influence on dynamic balance problems in people post-stroke. Moreover they added that post-stroke dynamic balance problems can not be solved by using only lower extremity muscle strengthening exercises[15].
Intensive mass practice with constraint-induced movement therapy for the lower extremity can improve motor function, mobility, dynamic balance, weight-bearing symmetry and walking ability in chronic post stroke patients. Long-term follow-up showed that the effects persisted for these five subjects[19].

On conclusion, using a program of graduated balance exercises leads to improvement of both static and dynamic balance in cerebellar stroke patients. Addition of trunk, hips and knees extensors graduated active exercises can further improve static balance in those patients.

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الملخص العربي

مقارنه بين برنامجين من التمرينات لعلاج مشاكل الاتزان في مرضى السكتة الدماغية المخيخية

تهدف هذه الدراسة إلى معرفة تأثير برنامجين للعلاج الطبيعي على مرضى السكتة الدماغية المخيخية الذين يعانون من عدم الاتزان و المقارنة بين البرنامجين . شارك في هذه الدراسة أربعة وعشرون مريضا يعانون من السكتة الدماغية المخيخية تراوحت أعمارهم ما بين 52 و 67 عام – وتم تقسيمهم عشوائيا إلى مجموعتين – المجموعة (1) تلقت تمارين اتزان متدرجة والمجموعة (2) تلقت نفس برنامج المجموعة الأولى بالإضافة إلى تمارين ايجابية متدرجة لعضلات الجذع والعضلات المستخدمة لفرد مفاصل الفخذين والركبتين – وتم عمل البرنامج لكلتا المجموعتين بواقع ثلاث مرات أسبوعيا لمدة شهرين . تم قياس الاتزان الساكن والمتحرك لكلا المجموعتين قبل وبعد برنامج العلاج الطبيعي – وقد تم قياس الاتزان الساكن بواسطة المقياس الاكلينيكى المرتب بينما تم قياس الاتزان المتحرك بواسطة جهاز الاتزان (بيودكس) . أظهرت نتائج الدراسة وجود تحسن ذو دلالة إحصائية كبيرة في الاتزان الساكن لكلا المجموعتين بعد الانتهاء من برنامج العلاج الطبيعي – وكان التحسن أفضل في المجموعة الثانية (دال إحصائيا) مقارنة بالمجموعة الأولى . وكذلك أظهرت النتائج وجود تحسن ذو دلالة إحصائية كبيرة في الاتزان المتحرك لكلا المجموعتين بعد الانتهاء من برنامج العلاج الطبيعي مع عدم وجود فروق ذات دلالة إحصائية في تحسن كلتا المجموعتين . ونستخلص من هذه النتائج أنه يمكن استخدام تمارين الاتزان المتدرجة في إحداث تحسن في وظائف الاتزان الساكن والمتحرك في مرضى السكتة المخيخية – كما يمكن إضافة التمارين الايجابية المتدرجة لعضلات الجذع والعضلات المستخدمة لفرد مفاصل الفخذين والركبتين للبرنامج وذلك يؤدى إلى تحسن أفضل للاتزان الساكن لهؤلاء المرضى .

الكلمات الدالة : المخيخ – السكتة الدماغية – الاتزان .

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