

Functional Doppler sonography in a patient with global aphasia but sustained song recognition

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Abstract

Functional transcranial Doppler sonography (fTCD) provides an appropriate noninvasive method to evaluate hemispheric activation by cognitive tasks. We report a 62 year old right handed woman, no musician, with left cerebro-vascular accident (LCVA) leading to global aphasia and right hemiparesis. The patient was investigated 30 days and 6 months after stroke onset with bilateral Doppler sonography of the middle cerebral artery with 3 different acoustic stimuli (music without language content; music with language content; language without music). Neither language nor music stimulation induces any change of cerebral blood flow velocity (CBFV) in the left hemisphere. However, language stimulation induces a significant decrease ($p=0.032$) and music with language content induces a significant increase ($p=0.020$) of CBFV on the right hemisphere as compared to baseline whereas pure music does not induce any changes at all. As expected, acoustic stimulation cannot induce any change in left CBFV in patients with LCVA. In the right hemisphere, however, language stimulation lead to a significant decrease of CBFV when presented alone and to a significant increase of CBFV when presented as music. We conclude that in our patient with global aphasia but sustained song recognition acoustical language stimulation is recognized as language but cannot be processed on the left hemisphere. Independent from aphasia, language together with music can lead to an increase of CBFV on the right hemisphere.

Key words: fTCD, music, cerebrovascular accident, stroke

Funktionelle Dopplersonographie bei einer Patientin mit globaler Aphasie und erhaltener Liederkennung

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Zusammenfassung

Die funktionelle transkranielle Dopplersonographie (fTCD) stellt eine nichtinvasive Methode zur Beurteilung der Hemisphärenaktivierung während unterschiedlicher kognitiver Aufgaben dar. Wir untersuchten eine 62jährige, rechtshändige, nicht musikalisch ausgebildete Patientin mit linksseitigem ischämischen Insult, der zu einer globalen Aphasie geführt hatte, 30 Tage und 6 Monate nach dem Ereignis. Wir führten eine bilaterale TCD der A. cerebri media (MCA) durch, während 3 unterschiedliche akustische Stimuli (Musik ohne Sprache; Musik mit Sprache; Sprache ohne Musik) über je 3 Minuten präsentiert wurden. Veränderungen der Blutflußgeschwindigkeit (CBVF) der linken Hemisphäre wurden nicht induziert. Sprachstimulation bewirkte einen signifikanten Abfall ($p=0,032$), Musik mit Sprache bewirkte einen signifikanten Anstieg ($p=0,020$) der CBVF in der rechten Hemisphäre, während reine Musik überhaupt keine Veränderungen der CBVF zeigte. Wie erwartet kann eine akustische Stimulation keinen Anstieg der linken CBVF nach großem linkshirnigen Infarkt hervorrufen. In der rechten Hemisphäre jedoch führt eine alleinige Sprachstimulation zu einem signifikanten Abfall, und die Präsentation von Sprache als Musik zu einem signifikanten Anstieg der CBVF. Wir schließen daraus, daß unsere Patientin mit globaler Aphasie und erhaltener Liederkennung akustische Sprachstimulation als Sprache erkennt, jedoch nicht in der linken Hemisphäre verarbeiten kann. Unabhängig von der Aphasie kann Sprache zusammen mit Musik zu einem Anstieg der CBVF in der rechten Hemisphäre führen.

Schlüsselwörter: fTCD, Musik, ischämischer Infarkt, Schlaganfall

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Introduction

Functional transcranial Doppler sonography (fTCD) provides an appropriate noninvasive method to evaluate hemispheric activation induced by cognitive tasks [1, 3, 4, 6]. Cerebral

blood flow velocity (CBFV) increases during language processing on the left hemisphere [1, 6] and increases during music perception of non-musicians on the right hemisphere [2, 5]. However, only little is known about changes of CBFV during mental tasks in patients with hemispheric damage.

| | 30 days after stroke onset | | 6 months after stroke onset | |
|---------------------------------------|----------------------------|---------------|-----------------------------|-----------------|
| | left MCA | right MCA | left MCA | right MCA |
| music without language content (cm/s) | 12.13 ± 0.72 | 51.25 ± 3.79 | 23.69 ± 0.79 | 65.25 ± 1.29* |
| music with language content (cm/s) | 12.25 ± 0.58 | 54.19 ± 2.95* | 24.19 ± 1.68 | 65.94 ± 1.95* |
| language without music (cm/s) | 11.63 ± 0.96 | 47.94 ± 4.77* | 26.00 ± 1.26*** | 66.19 ± 2.04*** |
| baseline (cm/s) | 11.38 ± 1.02 | 51.31 ± 3.63 | 23.81 ± 0.54 | 63.06 ± 1.84 |

Tab. 1: Mean cerebral blood flow velocity (CBFV) ± simple standard deviation in cm/s; *p<0.05, **p<0.01, ***p<0.001 in comparison to baseline (ANOVA with repeated measures and post-hoc t-test)

Case report

A 62 year old right handed woman, non-musician, with left cerebro-vascular accident (LCVA) leading to global aphasia and right hemiparesis was investigated. The patient was unable to speak and to repeat even simple words or phrases but could reproduce a known song almost without mistakes. Bilateral Doppler sonography of the middle cerebral artery (MCA) was performed 30 days and six months after stroke onset in a depth of 52 mm. CBFV was measured bilaterally during the presentation of three different acoustical stimuli with a single duration of three minutes:

1. excerpts of the Firework Music by G. F. Händel (music without language content)
2. chanson by R. Mey (music with language content)
3. spoken historical text

The mean CBFV was evaluated continuously every 10 seconds and the mean CBFV with standard deviation for each stimulation period and the baseline was calculated. Changes of CBFV on one side were analysed by analysis of univariate variance (ANOVA) with repeated measures, a post-hoc comparison between two periods was performed by Student's t-test.

Results

The mean CBFV with simple standard deviation is presented in the table separately for every period.

30 days after stroke onset, neither language nor music stimulation induce any changes of CBFV in the left hemisphere which shows, as expected, a lower CBFV than the right one. However, language stimulation induces a significant decrease ($p=0.032$) and music with language content induces a significant increase ($p=0.020$) of CBFV on the right hemisphere as compared to baseline whereas pure music does not induce any significant changes at all.

After rehabilitation which transformed the global aphasia into a transcortical motor one and lead to an improvement of the right hemiparesis, CBFV increases in both hemispheres. Now, CBFV on the left hemisphere increases statistically highly significant ($p<0.001$) after language stimulation. Music stimulation with language ($p<0.001$) as well as music stimulation without language ($p<0.002$) induce increase of CBFV on the right hemisphere. These findings are also confirmed when analysing the interhemispheric differences.

Discussion

As expected, acoustical stimulation cannot induce any changes of the left CBFV in patients with LCVA early after stroke onset. In the right hemisphere of our patient, however, language stimulation lead to a significant decrease of CBFV when presented alone and to a significant increase of CBFV when presented with music. We conclude that in our patient with global aphasia but sustained song recognition acoustical language stimulation is recognized as language but cannot be processed on the left hemisphere. Independent from aphasia, language together with music can lead to an increase of CBFV on the right hemisphere where it is, most probably, functionally processed.

After rehabilitation with improvement of aphasia, CBFV increases even after marked LCVA in the left hemisphere due to language stimulation and in the right hemisphere due to music stimulation with and without music as expected from studies in normal subjects [1, 2, 5]. Our findings suggest that changes of distinct functional processing after hemispheric infarction are associated with changes of CBFV.

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