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Procedia Social and Behavioral Sciences 23 (2011) 164–166

Procedia Social and Behavioral Sciences

Academy of Aphasia 2011

Lateralisation of the Arcuate Fasciculus Predicts Aphasia Recovery at 6 Months

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Background

Perisylvian language areas are connected through the arcuate fasciculus, a long association pathway that can be visualised using MR-based diffusion tensor imaging (DTI) tractography (Catani et al., 2005). Volumetric measurements of the arcuate fasciculus in healthy subjects show that direct connections between temporal and frontal areas are left-lateralised in most but not all subjects (Catani et al., 2007). In this study, we combined language assessments (Western Aphasia Battery-Revised (WAB-R); Kertesz, 2007) and DTI tractography in patients with post-stroke aphasia to identify anatomical predictors of recovery based on lateralisation patterns (Figure 1.A).

Methods

Nine right-handed subjects (6 males, 3 females) were assessed within 2 weeks of symptom onset using WAB-R and DTI. Follow-up assessment was conducted 6 months thereafter. We scored each patient on the WAB-R to obtain i) the severity of impairment (Aphasia Quotient (AQ) = 0-100, with 0 = very severe, 100 = normal language) and ii) taxonomical classification. Lateralisation of the arcuate was determined by virtual dissections of arcuate fibres in both hemispheres; patients were clustered into three groups accordingly (left-lateralised; left-lateralised/bilateral; bilateral). Statistical analysis was performed in IBM SPSS 19.

Results

At baseline, all subjects scored below cut-off (AQ = 93.8) for clinically significant aphasia. At follow-up, all subjects improved and two recovered. Tractography dissections of the arcuate fasciculus showed that three male patients were extremely left-lateralised with an $AQ_{(median)} = 81$. Another three subjects (2F, 1M) were left-lateralised/bilateral with an $AQ_{(median)} = 87.20$. The remaining subjects (1F, 2M) were bilateral with an $AQ_{(median)} = 95.20$. The latter included the two recovered subjects. Severity of impairment highly correlated with

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1877–0428 © 2011 Published by Elsevier Ltd.
doi:10.1016/j.sbspro.2011.09.221

laterality (r = 0.896, p<= 0.001). Comparison of means of language performances across all groups revealed significant differences (H(2) = 6.489, p<0.05) (Figure 1.B). Post hoc pair-wise comparison showed a significant difference between left-lateralised and bilateral subjects (p<0.05).

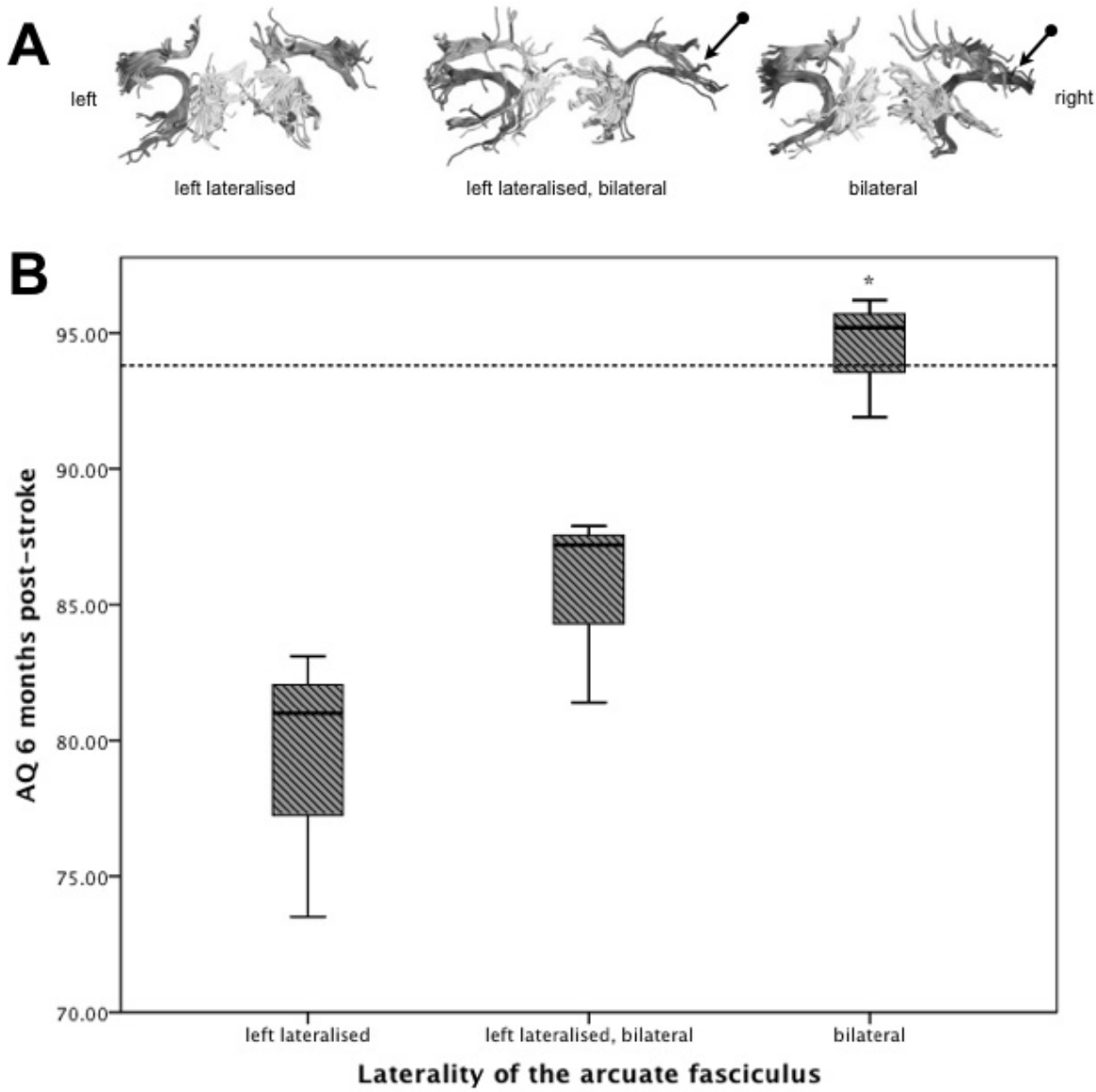

Figure 1. **A** shows the three laterality groups of the arcuate fasciculus in healthy subjects (left-lateralised, left-lateralised/bilateral, bilateral) depicting the three segments of the arcuate fasciculus for both hemispheres. For both bilateral groups one can appreciate the long segment in the right hemisphere (arrow). **B** shows the 6 months follow-up language performance (AQ, Aphasia Quotient) in relation to arcuate laterality. Dotted line indicates the cut-off for normal language function (AQ=93.8).

Conclusion

Our preliminary results indicate a strong relationship between the degree of lateralisation of the arcuate fasciculus and the language performances at 6 months after stroke-induced aphasia. We showed that the group with the most bilateral representation of the arcuate fasciculus significantly outperforms the left-lateralised group. These results may indicate that the underlying white matter anatomy may be relevant to aphasia recovery post stroke.

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