Improved speech understanding in noise and better sound quality with the Baha Divino™

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Martin Kompis has been working with Baha in Berne since 1996, although the system has been in use at the clinic since 1992 with more than 170 patients treated to date. Previously, Prof. Häusler had also been treating Baha patients in Geneva since 1987.

Background
In a study comparing the new Baha Divino™ and the Baha® Compact in seven adult, unilaterally fitted Baha® users, statistically significant advantages of the Divino regarding speech understanding in noise and overall sound quality were found. This article summarises selected results from a larger study performed at the University-ENT clinic of Berne, Switzerland.

The Baha system is used increasingly in the treatment of conductive or mixed hearing losses. Its success is based on a number of well documented, unique advantages over both conventional air conduction and bone conduction aids, such as leaving the external auditory canal open and providing a stable acoustical coupling without static pressure.

The only ear-level Baha sound processors that have been available until recently, the Baha® Compact and the older Baha® Classic, are basically linear aids using analogue technology. While such simple signal processing is adequate for the treatment of purely conductive hearing losses with preserved binaural hearing, there are users who suffer from an additional sensorineural hearing loss or who use only one Baha device and might therefore benefit from more complex signal processing technology. Recently, a new device, the Baha Divino™ (see Fig. 1), featuring more sophisticated signal processing, has been developed. We report on first experiences and the results of a study comparing the Divino with the Compact in seven unilaterally implanted patients.

Seven adult subjects, aged between 19 and 66, who had previously been fitted with the Baha system at our clinic participated in the study. All participants had been using their sound processor unilaterally on a daily basis for at least two years. All had a substantial conductive hearing loss in both ears, some combined with a moderate sensorineural component.

All subjects participated in two sessions 3 months apart, with the option of additional visits for fine-tuning of the new device’s settings between these sessions. During the first session, air and bone conduction thresholds were measured for each ear. Then free-field measurements in the unaided condition and in an aided condition using a Baha® Compact device were conducted. Measurements included free-field thresholds using narrow-band noise and speech audiometry in quiet (Freiburger monosyllabic words) and in noise (Basler sentence test). All tests were

Materials and methods
Two types of Baha sound processors, the Baha® Compact and the Baha Divino™, were compared. In contrast to the Compact, the Divino features straightforward digital signal processing with audiologist-adjustable compression in addition to a low frequency gain adjustment. For noisy environments, a built-in two-microphone directional noise reduction system can be activated by the user.

Fig. 1. The Baha Divino™
performed in German. For the Freiburger monosyllabic words, the percentage of correctly repeated words at 50, 65 and 80 dB SPL was measured. For the Basler sentence test, the signal-to-noise ratio (SNR) in dB, at which 50% of the key words were understood correctly, was measured. The speech signal was emitted from a loudspeaker in front of the listener whilst noise was emitted either from the same direction or from behind. After these tests, but still within the first session, a Baha Divino™ was fitted and the subjects were asked to use this new device for the next 3 months. Our study group were also given a questionnaire inquiring about their experience with the new device which was to be returned after 3 months.

Three months after the first session, pure tone audiometry and unaided and aided free-field thresholds with the Compact as well as speech audiometry in quiet were repeated to ensure that no significant change in the hearing of the subjects had occurred. Speech audiometry in quiet and in noise was then performed using the Divino. For measurements in quiet, the Divino was set to its omnidirectional mode. To test the effect of the directional two-microphone noise reduction system, speech tests in noise were performed both with the directional two-microphone system switched on and off respectively.

Results

Pure tone audiometry and speech audiometry using the Baha® Compact yielded essentially the same results at 0 months and at 3 months. The aided free-field thresholds were also very similar for the Compact and the Baha Divino™. Speech understanding in quiet using monosyllabic words (Fig. 2) improved substantially at all tested sound pressures between 50 and 80 dB with both of the Baha devices when compared to the unaided conditions. There was no statistically significant difference between the Compact and the Divino in these tests.

Fig. 3 shows the results from the speech reception thresholds (SRT) in noise, presented at a level of 70 dB. For noise arriving from the front, the difference between the three aided conditions was small (0.4–0.9 dB) and not statistically significant. Comparing test situations with noise from the front and from the rear, a statistically significant difference (p=0.03) was found for the Baha Divino™, when using the directional two-microphone noise reduction mode, with an average improvement of 1.9 dB. For noise coming from behind, the Divino in its directional two-microphone noise reduction mode was found to be clearly better than the Compact (average SNR improvement 2.3 dB, p=0.04).

Table 1 shows the answers to the most pertinent questions from the questionnaire after the 3 month evaluation. In all aspects covered by these questions, the Baha Divino™ was rated more favourably than the wearers’ own (previous) Baha device. This advantage is statistically significant for overall sound quality and for listening to a single speaker in quiet (Wilcoxon signed rank test, p<0.047).

Discussion and summary

Speech tests in quiet did not reveal any statistically significant advantage of the Baha Divino™ when compared to the Baha® Compact. However, it is possible that some individuals do benefit from the new device even in these situations. Although the group as a whole did not, one subject showed a small but reproducible improvement in terms of free-field thresholds and speech recognition in quiet. We think that this improvement is due to the compression limiting the output, which enabled her to use a louder setting at low levels than with her previous sound processor.

When the two-microphone noise-reduction system was activated, a statistically significant improvement in speech understanding in noise of approximately 2 dB was found when the speech signal was presented from the front and noise from
the rear. Care must be taken when comparing these measurements with results from the literature [e.g. 4,5] because small differences in the experimental setting or in the populations tested may influence the results. In our experiments, subjects were not allowed to adjust the volume control when switching to the directional mode. It can be speculated that larger improvements would have been obtained if adjustments to the volume control had been allowed.

On average, the Baha Divino™ was clearly rated more favourably than their own Compact for all listening situations considered. An individual analysis reveals that 4 subjects perceived substantial improvements with the Divino in the majority or in all situations listed in Table 1, whereas 3 subjects reported only a minor benefit.

In summary, an advantage of the Baha Divino™ over the Baha® Compact was found. There is a gain of approximately 2 dB for speech understanding in noise if the noise is emitted from the rear and the target signal from the front, and a higher subjective rating of overall signal quality and speech understanding in various listening conditions.

Fig 3. Speech recognition threshold in noise

Fig. 3. Speech reception threshold in noise. Speech is presented from the front, noise from the front or from the back, respectively. Individual values and averages (horizontal lines) are shown.