PHILIPS

IntelliSpace Portal

MR LoBI

White paper

The clinical utility of a novel imaging application for serial brain imaging: **MR LoBI***

The clinical utility of a novel imaging application for serial brain imaging: MR LoBI

Assessment of change in the brain is part of the daily routine in neuroradiology, as many neurological diseases affecting this organ are progressive or require long treatment duration. Imaging, often MRI, is used in order to track disease progression or monitor patients' responses to treatment. Yet detecting change through conventional side-by-side comparisons can be a time consuming and daunting task. This is especially true when differences between time points are subtle, there are a high number of images, slice-thicknesses are not the same and scan planes are un-matched. Despite advances in imaging techniques, the PACS systems and imaging workstations currently available offer only general support for follow-up brain imaging.

Application overview

IntelliSpace Portal 9.0 features a new image processing application called MR Longitudinal Brain Imaging (MR LoBI), which aims to assist clinicians in the evaluation of serial brain imaging. MR LoBI allows monitoring of disease state and assessment of disease progression or regression as part of the diagnosis and management of neurological disorders affecting the brain. MRI scans of the same patient acquired at different time points are automatically aligned and registered (linked) upon launching in the MR LoBI application which helps simplify comparison (Figure 1). The registration algorithm is quick and robust, such that post-operative changes in the brain will hardly affect alignment. This is achieved not only between different series types but also between images acquired using different scanners.

In addition, in order for clinicians to detect subtle changes in the brain, MR LoBI includes a special feature called Comparative Brain Imaging (CoBI). This offers a mathematical subtraction of scans taken at different time points, yielding (after bias-field correction and intensity scaling) a color-coded signal for the difference in intensity between two registered scans (Figure 2). Thus, scans from different time points and of the same acquisition type (T1, T2, FLAIR) can be compared in a way that clinicians can accentuate the discrepancies between them, facilitating the visualization of changes (Figure 3). MR LoBI also includes tools for the semi-automatic segmentation of brain lesions, along with volumetric quantification of segmented volumes, allowing for quantitative lesion comparisons (Figure 4).

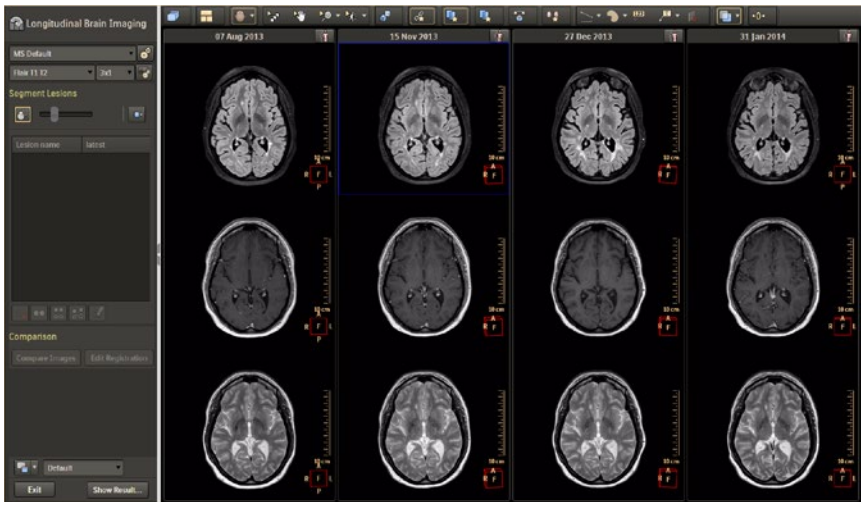

Figure 1:
Upon launching in the MR LoBI application, a process which takes a mere few seconds, multiple series acquired at different time points (and possibly using scanners of different vendors) are automatically aligned and registered (linked) to facilitate comparison. Pre-defined hanging layouts have been configured in the system and optimized for various clinical conditions (e.g. MS, brain tumors) and users can also select their own preferred layouts to facilitate their workflow. This figure depicts scans of the same patient, acquired at four consecutive time points (columns), such that three series are visible (rows) for each time point.

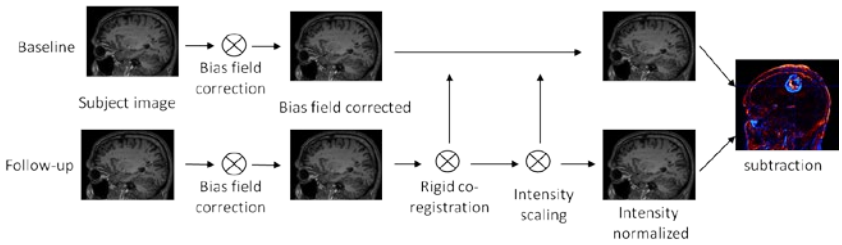

Figure 2:
Image processing pipeline in the Comparative Brain Imaging (CoBI) feature

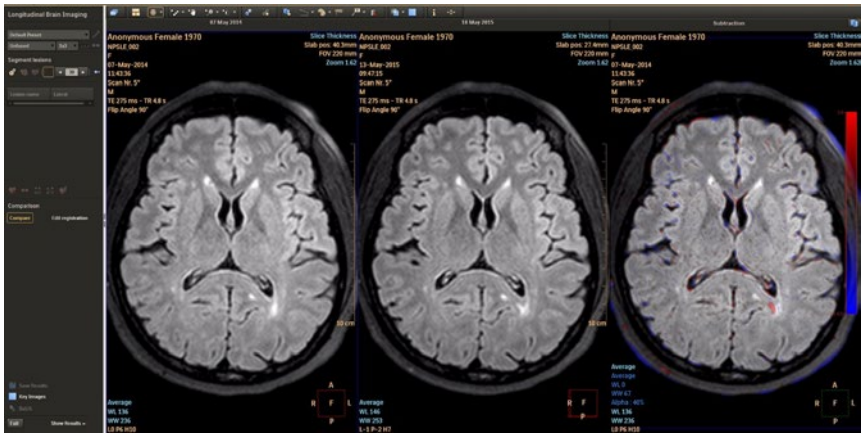

Figure 3:
CoBI functionality facilitates the clinician to detect subtle changes: the lesion next to the left parietal horn of the ventricle, was not detected in conventional scan reading. With the improved detection the clinician had the added insight necessary to change the diagnosis from from 'stable' to 'progressive disease'.

Figure 4:
LoBI provides tools for semi-automatic segmentation of brain lesions and for quantitative tracking of lesions over time.

Authors

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Study

In this study, a group of experienced neuroradiologists and neuroradiologists in training evaluated the utility of MR LoBI in clinical routine, using a variety of cases from patients with a range of neurological symptoms and disorders.
The goals of the study were to gauge whether interpretation of follow-up brain imaging using MR LoBI is perceived as beneficial relative to the present way of working, using standard PACS systems. The users' perception of the benefits was assessed in several domains, including: (i) time saving, (ii) ease of detection facilitates the clinician to detect subtle changes, (iii) diagnostic confidence, (iv) improved standardization (repeatability) of image interpretation and (v) enriched reporting to referring physicians.

Methods

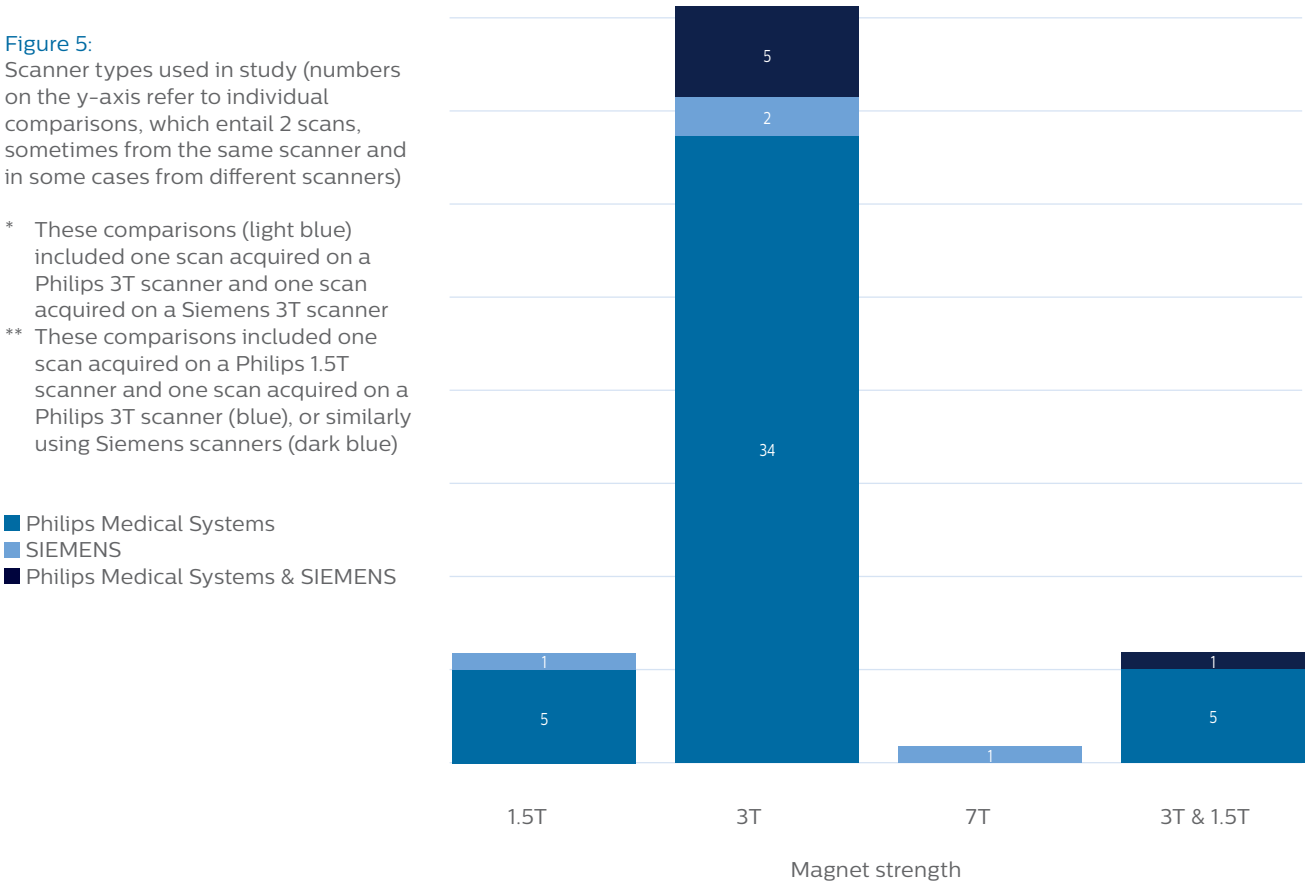
Comparison studies

Neurologists analyzed brain scans of different patients (see below) acquired at different time points in order to assess disease progression (hereafter: "comparison studies"). Image interpretation was performed first on a standard PACS system, used in the clinical routine of each radiologist, and then using the MR LoBI application, making use of the CoBI functionality for change visualization. Each radiologist noted the following parameters for each comparison study:

- The clinical conclusion: disease progression/stable/remission/other
- Whether CoBI had an impact on their clinical decision
- Whether new, previously undetected, lesions or pathologies were detected when using CoBI
- The perceived benefit, if any, of using CoBI in each specific case

Figure 5:
Scanner types used in study (numbers on the y-axis refer to individual comparisons, which entail 2 scans, sometimes from the same scanner and in some cases from different scanners)

* These comparisons (light blue) included one scan acquired on a Philips 3T scanner and one scan acquired on a Siemens 3T scanner
** These comparisons included one scan acquired on a Philips 1.5T scanner and one scan acquired on a Philips 3T scanner (blue), or similarly using Siemens scanners (dark blue)



Cases used in study

Scans from 46 different patients were used in this study, each including at least two acquisitions from different time points. Nine cases were interpreted twice, each time by a different radiologist; a further three cases had three or four time points each (thus yielding two or three comparison studies each, respectively) and 34 cases were interpreted by a single radiologist each, yielding 59 comparison studies in total. Comparisons were performed by five experienced neuroradiologists, actively practicing in Germany, the Netherlands, USA, and India, as well as two neuroradiologists in training (residents). The distribution of clinical indications in listed in Figure 6.

Images were acquired on a variety of scanners (Figure 5). The majority (87%) of comparison studies included at least one scan acquired on a Philips scanner, and 74% of comparisons were between scans acquired on a Philips scanner of the same magnetic field strength. 13% of comparisons included two scans acquired on Siemens scanners. Some comparisons (15%) included scans acquired on different scanners, either in magnetic strength (11%) or in vendor (4%).

Distribution of Clinical Indicators

n=46 different clinical cases

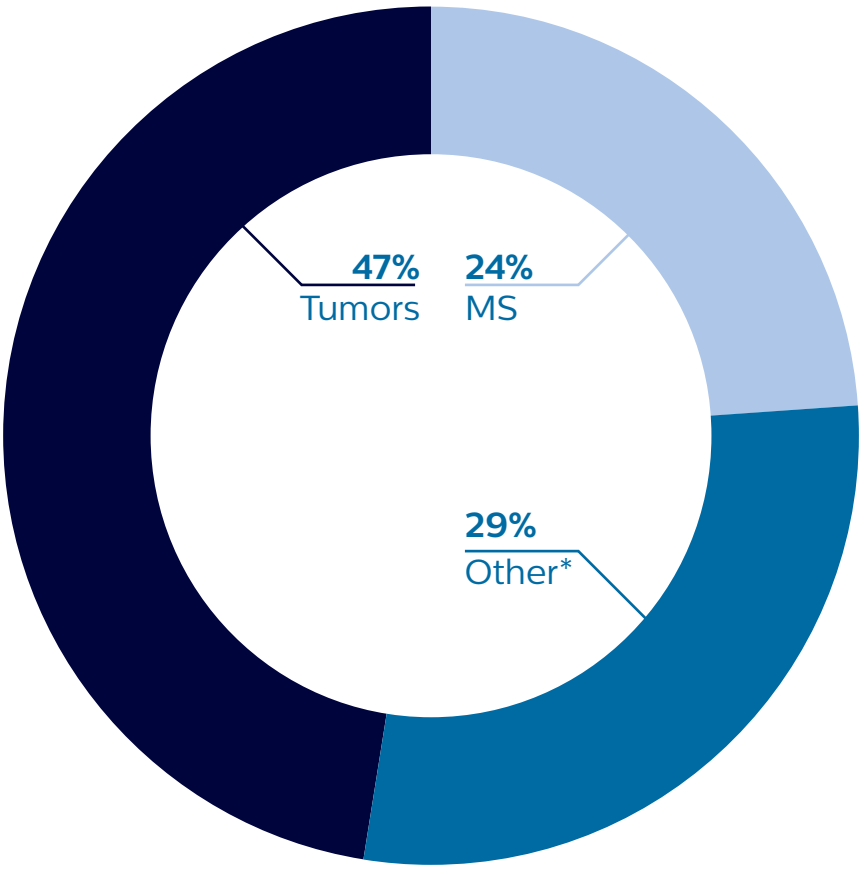


Figure 6:
Percentage of cases per clinical indication

* Other indications included: brainstem tuberculoma, tuberculosis, aqueduct stenosis, neurocysticercosis, neuro wipple, cerebral vasculitis, cognitive decline, CADASIL, RVC, and NPSLE.

Results

Detection of changes overlooked using standard PACS reading

In 5 out of 14 (36%) multiple sclerosis (MS) cases used in this study, new lesions or changes to existing lesions, that were not previously highlighted using standard PACS reading, but clinicians identified using CoBI. This was also the case in 3 of 28 (11%) brain tumor cases, and in 4 of 17 (24%) cases of other neurological indications. In total, the use of CoBI led clinicians to the detection of new brain lesions or changes to existing lesions in 20% of the cases analyzed in this study (Figure 7). This in turn led to a change in final interpretation in three cases. In one MS case as well as in one case of neuropsychiatric systemic lupus erythematosus (NPSLE), the radiologist's interpretation was changed from stable to progressive; in one case of neurocysticercosis, interpretation was changed from remission to progression.

Perceived benefit of using MR LoBI relative to standard PACS reading

Use of MR LoBI for the interpretation of follow-up brain imaging was deemed beneficial in 85% of cases analyzed in this study (79% of MS cases, 86% of brain tumor cases and 88% of other cases). The most cited benefit was faster interpretation of change (in 41% of comparisons), followed by enhanced confidence (in 32% of comparisons) and easier comparison (in 25% of cases), as depicted in Figure 8. Figure 8 depicts the perceived benefit by clinical indication.

In addition, four of the five experienced neuroradiologists (80%), who completed an extended questionnaire after completing the study, reported that use of MR LoBI could serve to enhance reporting to referring physicians, facilitate standardization of follow-up assessment either across radiologists or across patients, and that it increased their diagnostic confidence (Figure 10).

New changes detected using CoBI (versus PACS)

n=56 longitudinal studies interpreted by 7 neuro-radiologists

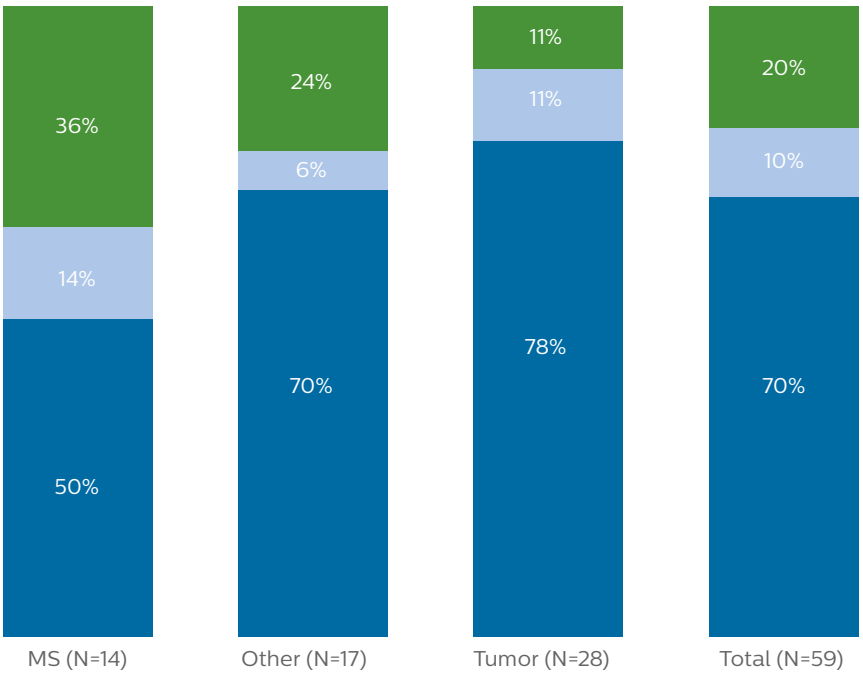
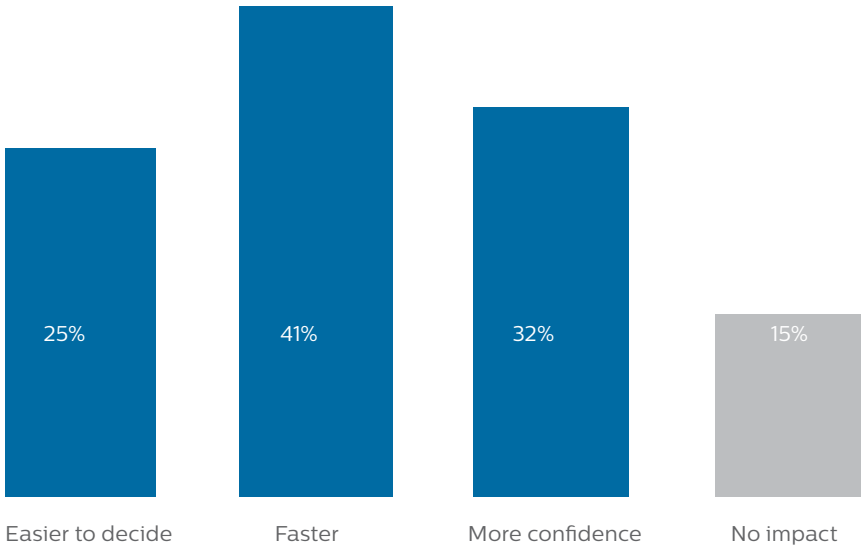


Figure 7:
Percentage of comparison studies, per indication, where the use of CoBI led clinicians to the detection of previously un-detected changes (values in the chart are rounded to the nearest percent)

CoBI's impact on follow-up brain scan reading

n=59 longitudinal studies interpreted by 7 neuro-radiologist

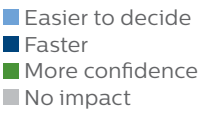
Figure 8:
Distribution of the impact, as cited by neuroradiologists, that the use of CoBI had on comparison studies. (Since more than one impact type was sometimes cited for a single comparison study, values in the chart do not add up to 100%)

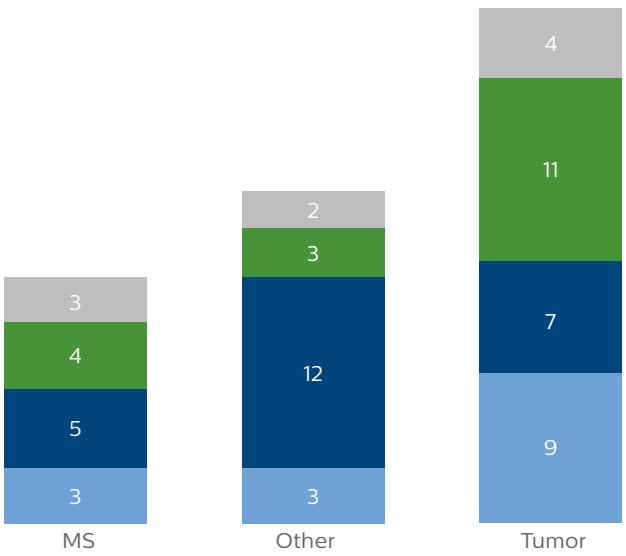


CoBI's impact on follow-up brain scan reading

n=59 longitudinal studies interpreted by 7 neuro-radiologist

Figure 9:
Distribution per clinical indication of the impact, as cited by neuroradiologists, that the use of CoBI had on comparison studies

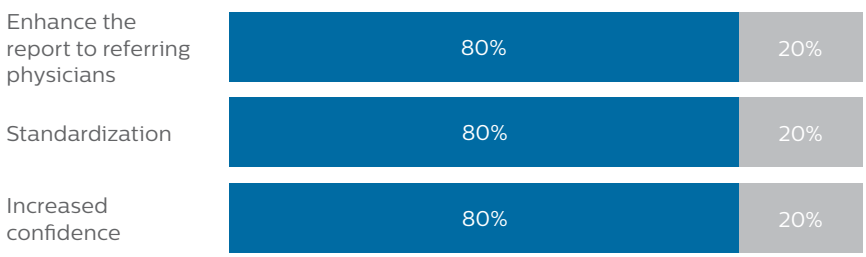




CoBI Benefit

Summary of responses by 5 experienced neuro-radioloogists after using CoBI

Figure 10:
Neuroradiologists' perception of the overall benefit of using CoBI in follow-up assessments



Conclusions

As a result of ageing populations and a growing number of patients with neurological deficits, radiologists increasingly face the challenge of detecting and characterizing brain pathologies. Brain pathologies are often evaluated in relation to an earlier state of the same patient. Yet the image viewing systems that are currently available offer limited support for this kind of image interpretation.

In this study**, the clinical utility and perceived benefits of a novel image processing application (MR LoBI) designed to facilitate the interpretation of follow-up brain scans, were evaluated by neuroradiologists from various countries, using scans of different patients with diverse neurological indications, and acquired on MRI scanners from multiple vendors. Results indicate that by using MR LoBI with the integrated CoBI feature, radiologists were able to detect and visualize changes in the brain. Therefore, MR LoBI indeed facilitated the interpretation of follow-up scans, by accentuating changes that might otherwise have gone un-noticed or been difficult to detect. This was achieved by simplifying and thus accelerating the comparison process, and by standardizing it across cases and readers. This resulted in greater diagnostic confidence, and better diagnosis.

* Pending 510(k), not available for sale in the US
** Results are specific to the institution where they were obtained and may not reflect the results achievable at other institutions

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