Vascular

Flex-APS (Flexible Active Pixel Shift) Real Time Auto Pixel Shift for interventional neurology

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1. Introduction

It has been 6 months since Hakujikai Memorial Hospital obtained a new Trinias application on a trial basis that assists interventional neurology. This article describes the utility and practicality of this application.

2. Advantages and Disadvantages of Digital Subtraction Angiography

Digital subtraction angiography (DSA) is an imaging method used widely with angiography systems for interventional neurology. DSA allows observation of vessel information isolated from other anatomical structures by acquiring a mask image before injecting contrast media, then subtracting this mask image from live images acquired during contrast media injection. DSA has the advantages of low contrast resolution and spatial resolution, but also the shortcoming of susceptibility to patient movement. Patient movement between mask image and live image causes misregistration artifacts that can hinder a correct diagnosis.
Recently, an increasing number of cases of interventional neurology, including therapeutic procedures, are being performed under local anesthesia. Although these patient's head is retained firmly and the patient is asked to remain motionless before acquisition in these cases, it is not uncommon for the head to move slightly due to respiratory fluctuation or from the heat sensation and pain associated with injection of contrast media, which leads to misregistration artifacts.

3. Conventional Method of Artifact Correction (Pixel Shift Processing)

Pixel shift processing is a commonly used method for correction of misregistration artifacts. Pixel shift processing eliminates misregistration artifacts from DSA images by performing a linear transformation of the mask image using parallel displacement, rotation, enlargement, shrinkage, etc. of the image to compensate for body movement occurring between mask image and live image acquisition. However, due to the linear nature of the correction performed by pixel shift processing, image correction is sometimes inadequate when there is movement in only part of the image, or when body movement causes twisting in the image. Pixel shift processing has also disrupted a smooth workflow when image correction must be revised by performing frame-by-frame postprocessing to account for different movement between frames, and because checking against a reference in real time can only be performed with images that have not undergone pixel shift processing.

4. Artifact Correction by Flex-APS

Flexible Active Pixel Shift (Flex-APS) is an application that resolves the shortcoming of pixel shift processing mentioned above. Flex-APS is able to correct for twisting or partial movement of the body by determining motion vectors for every pixel in all frames of live images relative to the mask image **(Fig. 1)**, and subtracting the mask image after nonlinear transformation of the mask image based on these vectors **(Fig. 2)**. This allows acquisition of fully corrected DSA images even during body movement that conventional pixel shift processing is unable to correct for. Also, since this correction is performed in real time, all

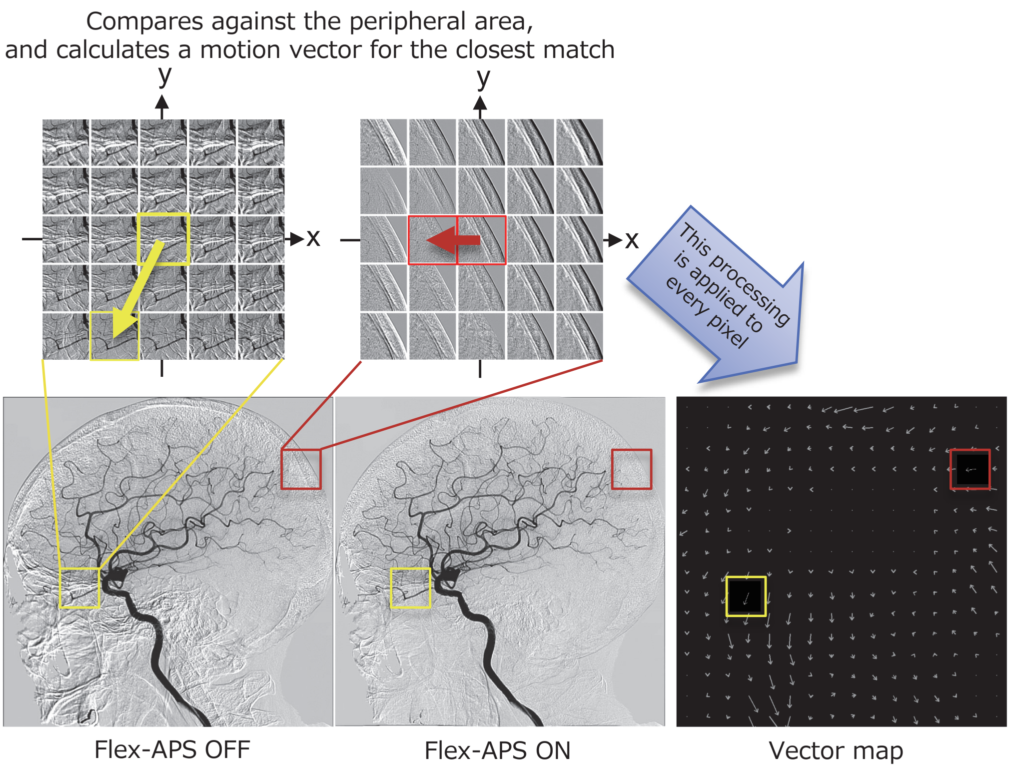


Fig.1 Motion Vector Calculation by Flex-APS

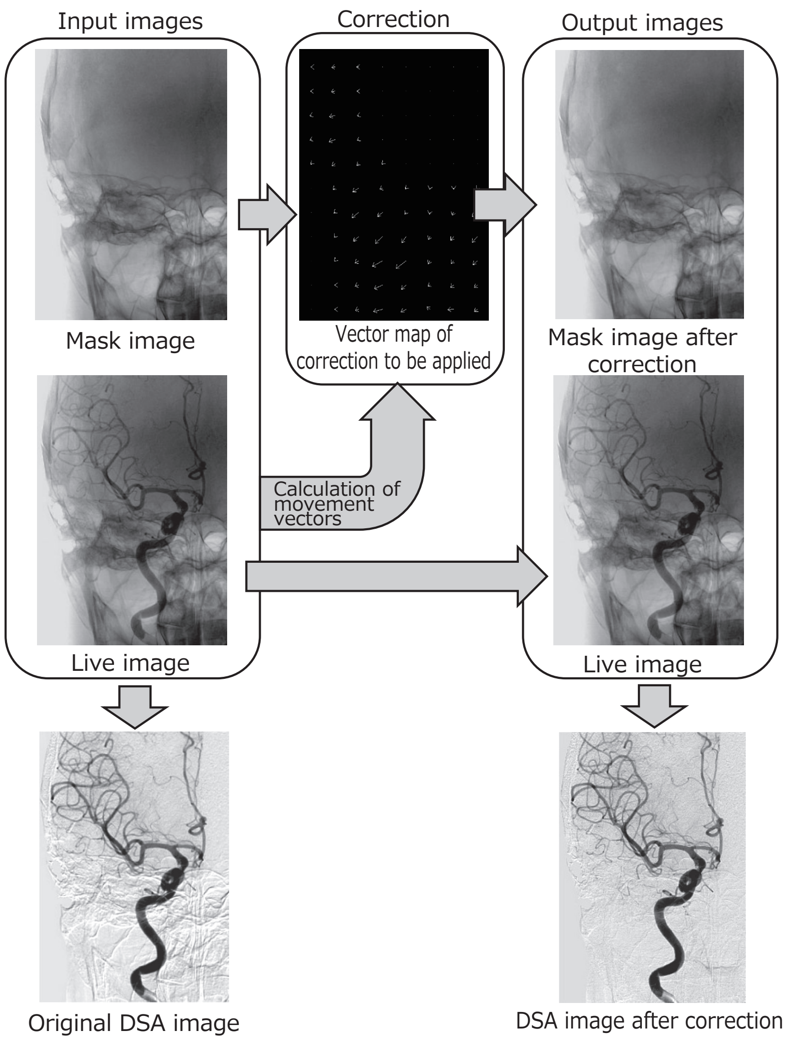


Fig.2 Process of Correction by Flex-APS

frames displayed during imaging are DSA images corrected by Flex-APS. This application gives effective artifact reduction, so is best suited to interventional neurology performed under local anesthesia.

5. Clinical Utilization of Flex-APS

Since introducing Flex-APS, all interventional neurology are now performed under local anesthesia as we are better equipped to deal with a certain degree of patient movement. Even under general anesthesia, respiratory fluctuation is visible after 4.5-inch magnification and a vessel roadmap cannot be used for an extended period of time. Although using local anesthesia further shortens this period of time, it allowed the procedure to be performed without stress. Furthermore, since Flex-APS performs pixel shift processing in real time, it has the distinct benefit of producing clear live images and reference images, which improves 2D visibility.

With regard to intracranial stenting, though the visibility of perforating branches has improved since introducing Flex-APS, the time being taken to determine positioning for intracranial stenting has in fact increased. This increase is attributed to previously indistinguishable vessels now becoming visible and giving us more to contend with during procedures. However, this increase has also coincided with an increase in procedure safety and prevented postoperative strokes.

Flex-APS has also been very useful during aneurysm coiling as the pixel shift processing also works on the coil mass. There were times at the end of coiling when we were unsure whether the image contained an artifact or contrast media had flowed into the margin of the aneurysm. This type of situation has decreased greatly since introducing Flex-APS (**Fig. 3**). A characteristic feature of Flex-APS is that high signal intensity metals are matched with high accuracy by pixel shift processing. This allows us to perform pixel shift processing of the coil mass and obtain a clear view of the flow of contrast fluid into the aneurysm or into surrounding vessels. The result has been a higher percentage of coil packing compared to before introducing Flex-APS.

This pixel shift processing is also applied in a similar manner for stents during carotid artery stenosis (CAS) procedures, and produces clearer images that also increase patient satisfaction when observed as postoperative images.

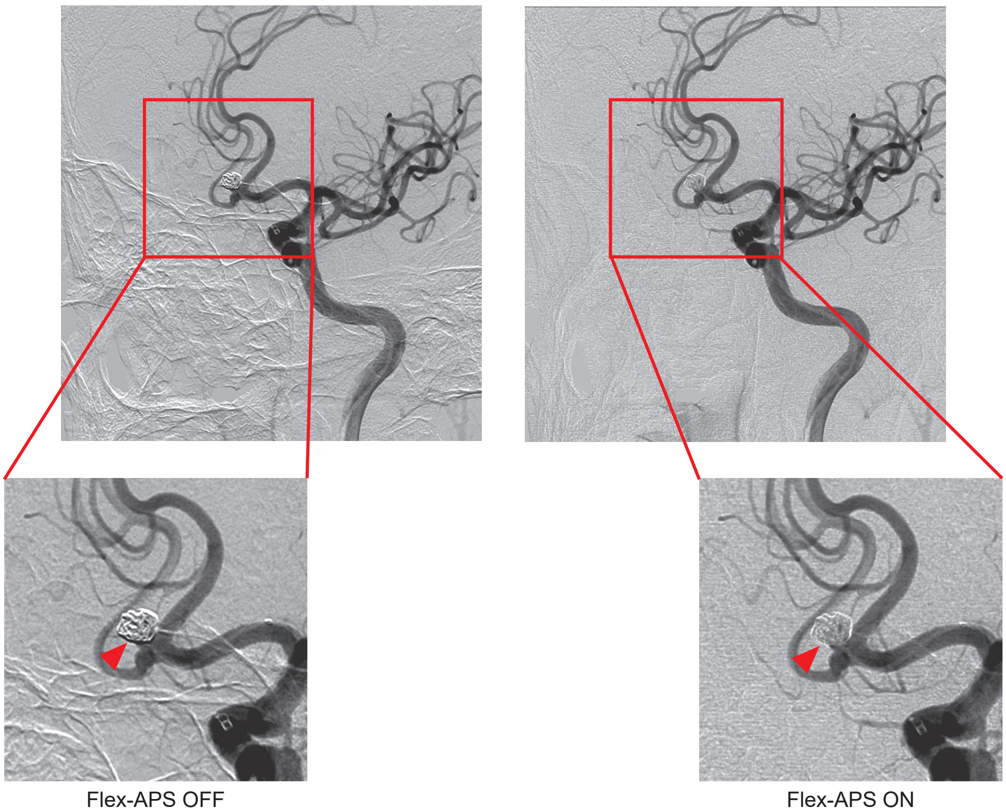
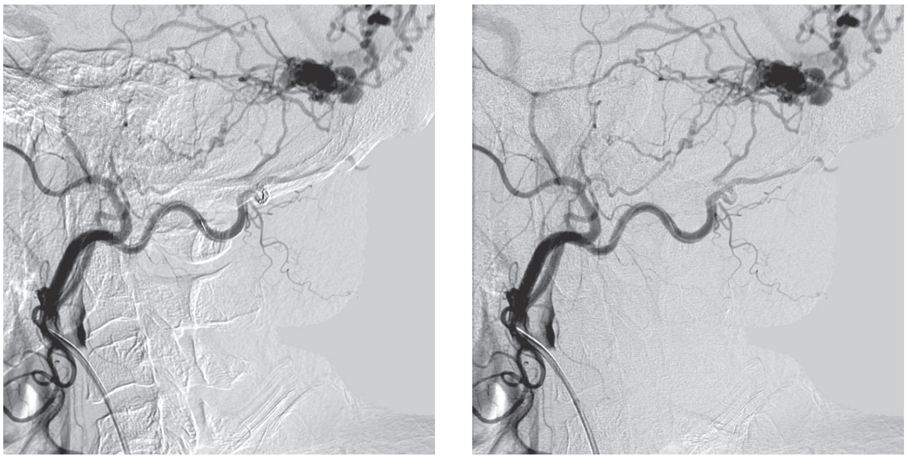


Fig.3 Example Use of Flex-APS (During Coiling)



Flex-APS OFF　　Flex-APS ON

Fig.4 Example Use of Flex-APS (During dAVF)

This approach is also used during arteriovenous malformation (AVM) and dural arteriovenous fistula (dAVF) procedures, and has resulted in clearer depiction of arterioles and penetrating branches, while pixel shift processing of the coil has made microcatheter manipulation easier **(Fig. 4)**.

6. Future Utilization of Flex-APS in interventional neurology

Although craniotomy-based procedures currently exist for all brain disorders, endovascular therapy is being undertaken as an alternative approach to cerebrovascular diseases. To ensure differentiation of endovascular therapy from craniotomy-based procedures, we need to focus on the advantages afforded by endovascular therapy being a minimally invasive procedure. These advantages must be used to benefit patients by use of local anesthesia and shorter hospitalization times. Due to the ability to accommodate in real time for small body movements that occur during local anesthesia and produce clearer images, Flex-APS promises to become an essential application that will lead to improved procedures.