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K032186

510(k) AutoAlign™ Atlas-Based Image Registration

Safety and Effectiveness Summary

July 11, 2003

Prepared by:

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1.0 Introduction

This Safety and Effectiveness Summary is provided with the AutoAlign™ Atlas-Based Image Registration 510(K) Premarket submission to provide evidence of the products safety and efficacy for its stated intended use.

2.0 Intended Use

AutoAlign™ Atlas-Based Image Registration software is intended to provide an output registration matrix that may be utilized to align an MRI brain scan to a known and consistent anatomic orientation, a process known as image registration. AutoAlign™ Atlas-Based Image Registration software is intended to be marketed as a software device that can provide improvements to the manual processes of image registration. The dominant use of AutoAlign™ Atlas-Based Image Registration software is its integration into proprietary MR image software packages by MRI scanner manufacturers to allow users to generate consistent patient image registrations for image acquisition, a process otherwise known as AutoSlice Prescriptioning.

Laboratory tests were conducted to validate the effectiveness of the AutoAlign™ Atlas-Based Image Registration software. Test data indicates that when used properly, AutoAlign software will align MR Neuro images in a highly consistent manner.

AutoAlign™ Atlas-Based Image Registration software is intended to be used for patients without highly abnormal pathologies, and contains an internal alignment computation method that is used as a safety mechanism to monitor the accuracy of resultant alignments. Testing indicates a strong correlation between a successful alignment and low Measurement Index values. Product labeling states that operator intervention is needed in the case of an alignment generating high Measurement Index values.

AutoAlign demonstrates the following registration capabilities for MRI Neuro exams subject to the limitations set forth above and in product operating labeling documents:

a) The inter-subject variability of the position of the anterior commissure (AC) is 15 mm.
b) The inter-subject variability of the position of the posterior commissure (PC) is 13 mm.
c) The inter-subject variability of the positioning of the inter-hemispheric plane (as measured on sagittal views) is 6 mm.
d) The inter-subject variability of the angle formed by the inter-hemispheric plane and the anterior-posterior line (as measured on axial views) is 5.
e) The inter-subject variability of the angle formed by the inter-hemispheric plane and the superior-inferior line (as measured on coronal views) is 7 degrees.

3.0 Safety

AutoAlign™ Atlas-Based Image Registration has a feedback mechanism which measures and reports alignments which have the potential to be outside of stated specifications. This is reflected in as a "Measurement Index" value which is the average of the Mahalanobis distance for the voxel intensity of all atlas points to the patient images supplied for alignment. The higher the value of the Measurement Index, the lower of the probability of an alignment within stated specifications between the Atlas and the patient acquired imaging volumes- although not all alignments with a relatively high Measurement Index value indicate a poor alignment. Any differences between a patient's scanned volume and the normalized Atlas will generate some positive level of Measurement Index value, although the software may have been effective at performing an alignment. Product labeling states however that an operator should review all alignments generating higher than an established Measurement Index threshold.

4.0 Effectiveness

In laboratory testing, CorTechs used low-resolution multispectral MR scans from 259 randomly selected actual adult (ages 15 – 89) subjects with both normal and abnormal pathologies, which were anonymized of all patient identifiers and supplied by Siemens AG, Erlangen, Germany) to validate and test the efficacy of the AutoAlign Image Registration software.

Post alignment measurements were made by an expert (Ph.D. trained in neurosciences), and five measurements were performed and recorded:

1. position (z) of the interhemispheric plane (IHP, sagittal view, darkest slice, i.e., slice demonstrating the highest level of CSF)
2. position of the anterior commissure (AC), checked on both the sagittal and the axial views
3. position of the posterior commissure (PC)
4. angle formed by the IHP and the vertical line, in degrees, on axial views (beta)
5. angle formed by the IHP and the vertical line, in degrees, on coronal views (gamma)

Angles were calculated by selecting 2 points (AC and PC, or 2 points belonging to the IHP), on the same slice, and computing the atan.

The mean positions of the IHP, AC and PC were calculated, then the distance, in 3-D between each individual measurement and the corresponding mean, and finally the mean

and stdev of these distances. It is expressed as the spatial dispersion of the IHP, AC and PC around their centers of gravity.

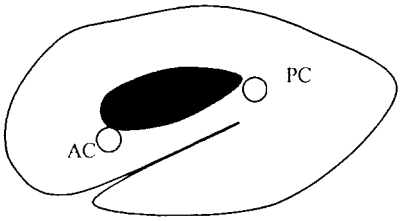
The means and stdev of the 3 angles were calculated. The referential center is the voxel (64, 64, 64), positions are given in mm.

- The mean position of the IHP is –0.285
- The mean position of AC is (-2.74, -18.2, +1.56), which becomes AC reference
- The mean distance between individual AC and the reference is 3.90 (± 3.38)
- The mean position of PC is (+8.73, +14.0, -0.439), which becomes PC reference
- The mean distance between individual PC and the reference is 2.69 (± 1.34)

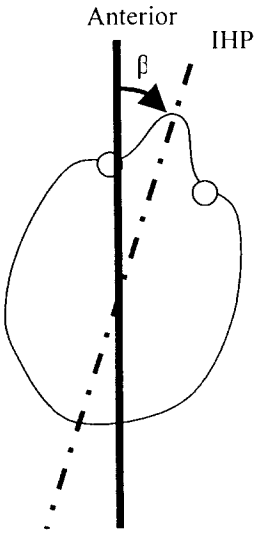
Angles are given in degrees.

- The mean angle between the IHP and the anterio-posterior line (beta) is 0.789 (± 1.13)
- The mean angle between the IHP and the superio-inferior line (gamma) is –0.465 (± 0.717)

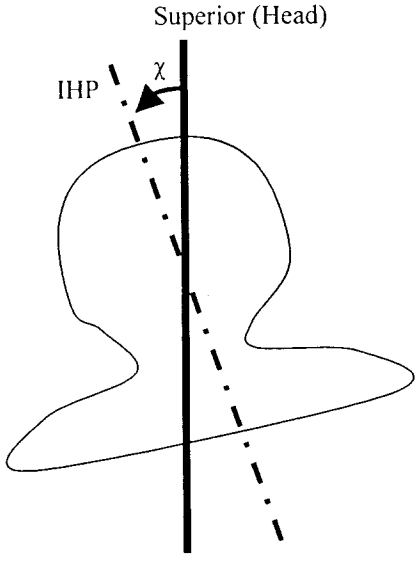
Figure A: Schematic of Anatomic Orientations and Landmarks used for Image Volume Alignment with Atlas



Sagital Plane



TransAxial Plane



Coronal Plane

AC= Anterior Commissure
IHP= Interhemispheric Plane
PC= Posterior Commissure

An error is defined as a failed anatomic alignment not identified as such by an abnormal or high Measurement Index. The software design objective was, therefore, to minimize the number of failed alignments generating a low Measurement Index value. Successful alignments which are accompanied by an abnormally high Measurement Index value do not have a meaningful safety risk, since they merely result in MR operator intervention to confirm image registration.

The software is logically designed so that it is probabilistically impossible to generate inappropriate image registration without also generating a high Measurement Index value. **Any variability in pixel intensity between the acquired image volume and the normalized Atlas results in an increased Measurement Index value. Since the AutoAlign algorithm uses all voxels from the acquired image volume as comparison points to the normalized Atlas, the probability of an error occurring (i.e.- an alignment outside of specifications not identified with a high measurement index) is vanishingly small. Testing of 259 acquired MR image volumes indicated there was no case in which image alignments did not meet or exceed stated specifications. Furthermore, cases are tightly clustered well below a Measurement Index limit at which an error message would be generated.**

One example of data generated from validation of the software on 259 MR cases supplied by Siemens, AG, Erlangen, Germany, is presented below.

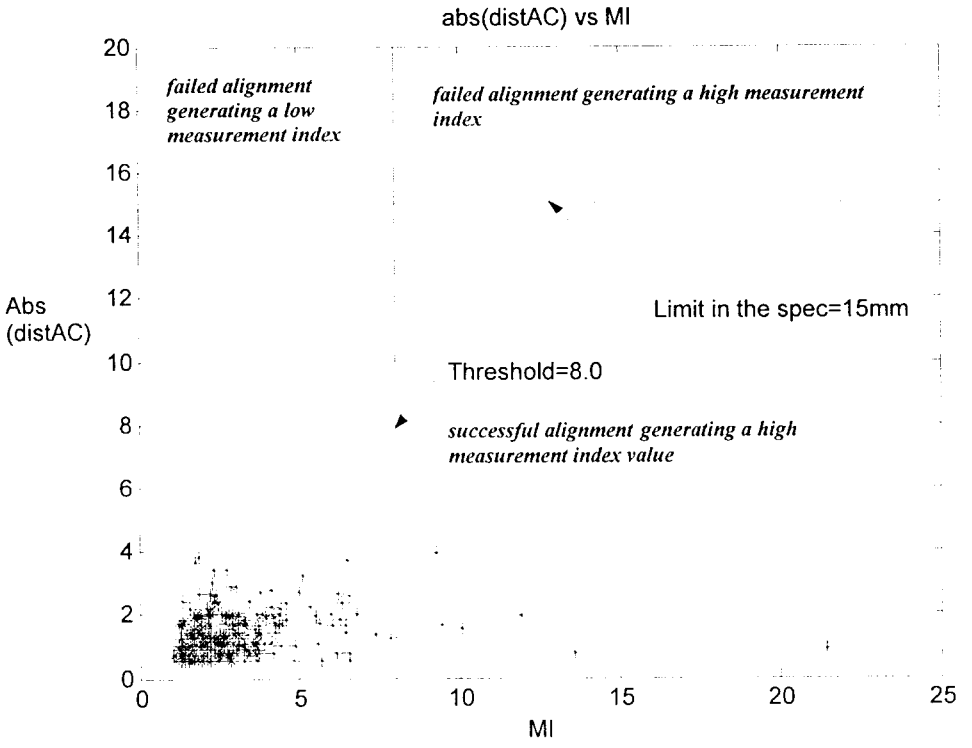


Figure 4.1: The inter-subject variability of the position of the anterior commissure, abs(distAC), vs. Measurement Index (MI). The Threshold is the Measurement Index value at which operator intervention is recommended. Note: In this test case, while the 6 of the 259 alignments generated a Measurement Index value greater than 8, all were within specifications of the intra subject position of the anterior commissure (ac) by measurement.

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
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OCT 14 2003

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Re: K032186
Trade/Device Name: AutoAlign™ Image Registration Software
Regulation Number: 21 CFR 892.2050
Regulation Name: Picture archiving and communications system
Regulatory Class: II
Product Code: 90 LLZ
Dated: July 11, 2003
Received: July 17, 2003

Dear Dr. Green:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Part 801); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820); and if applicable, the electronic product radiation control provisions (sections 531-542 of the Act); 21 CFR 1000-1050.

This letter will allow you to begin marketing your device as described in your Section 510(k) premarket notification. The FDA finding of substantial equivalence of your device to a legally marketed predicate device results in a classification for your device and thus, permits your device to proceed to the market.

If you desire specific advice for your device on our labeling regulation (21 CFR Part 801), please contact the Office of Compliance at one of the following numbers, based on the regulation number at the top of the letter:

8xx.1xxx	(301) 594-4591
876.2xxx, 3xxx, 4xxx, 5xxx	(301) 594-4616
884.2xxx, 3xxx, 4xxx, 5xxx, 6xxx	(301) 594-4616
892.2xxx, 3xxx, 4xxx, 5xxx	(301) 594-4654
Other	(301) 594-4692

Additionally, for questions on the promotion and advertising of your device, please contact the Office of Compliance at (301) 594-4639. Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21CFR Part 807.97) you may obtain. Other general information on your responsibilities under the Act may be obtained from the Division of Small Manufacturers, International and Consumer Assistance at its toll-free number (800) 638-2041 or (301) 443-6597 or at its Internet address http://www.fda.gov/cdrh/dsma/dsmamain.html.

Sincerely yours,

Nancy C. Brogdon

Nancy C. Brogdon
Director, Division of Reproductive,
Abdominal and Radiological Devices
Office of Device Evaluation
Center for Devices and Radiological Health

Enclosure

K032186

Statement of Indications for Use

AutoAlign™ Atlas-Based Image Registration software is intended to provide an output registration matrix that may be utilized to align an MRI brain scan to a known and consistent anatomic orientation, a process known as image registration. AutoAlign™ Atlas-Based Image Registration software is intended to be marketed as a software device that can provide improvements to the manual processes of image registration. The dominant use of AutoAlign™ Atlas-Based Image Registration software is its integration into proprietary MR image software packages by MRI scanner manufacturers to allow users to generate consistent patient image registrations for image acquisition, a process otherwise known as AutoSlice Prescriptioning.

AutoAlign™ Atlas-Based Image Registration labeling for the device contains instructions for the safe and effective use of this software as demonstrated by testing on 259 acquired image volumes (as detailed below). Labeling may vary in accordance to the proprietary MRI manufacturers systems, but includes the following language:

> The accuracy of the auto alignment is affected by the subject's deviation from the embedded reference neuroanatomic Atlas. In general, the effectiveness of standardized image registration as measured by the AutoAlign™ Atlas-Based Image Registration software decreases when the subject's brain includes pathologic features not present in the normal brain, lacks features normally present, or is structurally different than that defined in the pre-existing neuroanatomic Atlas of the normal brain. The accuracy of the AutoAlign™ Atlas-Based Image Registration alignment program can also be degraded by patient motion or by artifacts which are introduced into the patient scanning process. If there is a clinical requirement to characterize a mass lesion or other abnormal pathological feature which differs significantly from the normal brain, the user should not rely upon the AutoAlign feature for image registration and should manually perform image registration. To assure adequate registration is achieved, the software calculates a Measurement Index (MI) which reflects the adequacy of alignment. If the Measurement Index exceeds specified anatomic limits, user intervention is required.
>
> Factors which degrade the technical quality of MR images or pathologic processes which significantly affect neuroanatomic structure may decrease the alignment accuracy of the Autoalign software. Such factors include:
>
> a. Patient's motion during scan.
> c. Artifacts affecting overall image quality.
> d. Brains showing gross amount of structural abnormality.
> e. Resections must not be larger than 30 cc.
> f. Tumors must not be larger than 15 cc.

AutoAlign demonstrates the following registration capabilities for MRI Neuro exams subject to the limitations set forth above and in product operating labeling documents:

a) The inter-subject variability of the position of the anterior commissure (AC) is less than 15 mm.
b) The inter-subject variability of the position of the posterior commissure (PC) is less than 13 mm.
c) The inter-subject variability of the positioning of the inter-hemispheric plane (as measured on sagittal views) is less than 6 mm.
d) The inter-subject variability of the angle formed by the inter-hemispheric plane and the anterior-posterior line (as measured on axial views) is less than 5.
e) The inter-subject variability of the angle formed by the inter-hemispheric plane and the superior-inferior line (as measured on coronal views) is less than 7 degrees.

Prescription Use ✓

Nancy C Brogdon
(Division Sign-Off)
Division of Reproductive, Abdominal,
and Radiological Devices
510(k) Number K032186