Imagen Technologies, Inc.
% Donna-Bea Tillman, Ph.D.
Senior Consultant
Biologics Consulting
1555 King Street, Suite 300
ALEXANDRIA VA 22314

July 30, 2020

Re: K193417
Trade/Device Name: FractureDetect (FX)
Regulation Number: 21 CFR 892.2090
Regulation Name: Radiological computer assisted detection/diagnosis software for fracture
Regulatory Class: Class II
Product Code: QBS
Dated: June 29, 2020
Received: June 30, 2020

Dear Dr. Tillman:

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 control provisions of the Act. Although this letter refers to your product as a device, please be aware that some cleared products may instead be combination products. The 510(k) Premarket Notification Database located at https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm identifies combination product submissions. 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. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

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); medical device reporting (reporting of medical device-related adverse events) (21 CFR 803) for

devices or postmarketing safety reporting (21 CFR 4, Subpart B) for combination products (see https://www.fda.gov/combination-products/guidance-regulatory-information/postmarketing-safety-reporting-combination-products); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820) for devices or current good manufacturing practices (21 CFR 4, Subpart A) for combination products; and, if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR 1000-1050.

Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR Part 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to https://www.fda.gov/medical-devices/medical-device-safety/medical-device-reporting-mdr-how-report-medical-device-problems.

For comprehensive regulatory information about medical devices and radiation-emitting products, including information about labeling regulations, please see Device Advice (https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance) and CDRH Learn (https://www.fda.gov/training-and-continuing-education/cdrh-learn). Additionally, you may contact the Division of Industry and Consumer Education (DICE) to ask a question about a specific regulatory topic. See the DICE website (https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance/contact-us-division-industry-and-consumer-education-dice) for more information or contact DICE by email (DICE@fda.hhs.gov) or phone (1-800-638-2041 or 301-796-7100).

Sincerely,

For

Thalia T. Mills, Ph.D.
Director
Division of Radiological Health
OHT7: Office of In Vitro Diagnostics
and Radiological Health
Office of Product Evaluation and Quality
Center for Devices and Radiological Health

Enclosure

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Food and Drug Administration

Indications for Use

Form Approved: OMB No. 0910-0120
Expiration Date: 06/30/2020
See PRA Statement below.

510(k) Number *(if known)*
K193417

Device Name
FractureDetect (FX)

Indications for Use *(Describe)*
FractureDetect (FX) is a computer-assisted detection and diagnosis (CAD) software device to assist clinicians in detecting fractures during the review of radiographs of the musculoskeletal system. FX is indicated for adults only.
FX is indicated for radiographs of the following industry-standard radiographic views and study types.

Study Type (Anatomic Area of Interest+)	Radiographic View(s) Supported*
Ankle	Frontal, Lateral, Oblique
Clavicle	Frontal
Elbow	Frontal, Lateral
Femur	Frontal, Lateral
Forearm	Frontal, Lateral
Hip	Frontal, Frog Leg Lateral
Humerus	Frontal, Lateral
Knee	Frontal, Lateral
Pelvis	Frontal
Shoulder	Frontal, Lateral, Axillary
Tibia / Fibula	Frontal, Lateral
Wrist	Frontal, Lateral, Oblique

*For the purposes of this table, "Frontal" is considered inclusive of both posteroanterior (PA) and anteroposterior (AP) views.
+Definitions of anatomic area of interest and radiographic views are consistent with the American College of Radiology (ACR) standards and guidelines.

Type of Use *(Select one or both, as applicable)*

X Prescription Use (Part 21 CFR 801 Subpart D) ☐ Over-The-Counter Use (21 CFR 801 Subpart C)

CONTINUE ON A SEPARATE PAGE IF NEEDED.

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In accordance with 21 CFR 807.87(h) and (21 CFR 807.92) the 510(k) Summary for the FractureDetect (FX) is provided below.

1. SUBMITTER

Submitter:	Imagen Technologies, Inc 151 West 26th Street, Suite 1001 New York, NY 10001
Primary Submission Correspondent:	Donna-Bea Tillman, Ph.D. Senior Consultant Biologics Consulting 1555 King St, Suite 300 Alexandria, VA 22314 410-531-6542 dtillman@biologicsconsulting.com
Secondary Submission Correspondent:	Robert Lindsey, Ph.D. Chief Science Officer Imagen Technologies, Inc 151 West 26th Street, Suite 1001 New York, NY 10001 917-830-4721 rob@imagen.ai
Date Prepared	June 23, 2020

2. DEVICE

Device Trade Name:	FractureDetect (FX)
Device Common Name or Classification Name:	Radiological computer assisted detection/diagnosis software for fracture
Regulation:	21 CFR 892.2090
Regulatory Class:	II
Product Code:	QBS

3. PREDICATE DEVICE

Predicate Device: OsteoDetect (DEN180005)

4. DEVICE DESCRIPTION

FractureDetect (FX) is a computer-assisted detection and diagnosis (CAD) software device designed to assist clinicians in detecting fractures during the review of commonly acquired adult radiographs. FX does this by analyzing radiographs and providing relevant annotations, assisting clinicians in the detection of fractures within their diagnostic process at the point of care. FX was developed using robust scientific principles and industry-standard deep learning algorithms for computer vision.

FX creates, as its output, a DICOM overlay with annotations indicating the presence or absence of fractures. If any fracture is detected by FX, the output overlay is composed to include the text annotation "Fracture: DETECTED" and to include one or more bounding boxes surrounding any fracture site(s). If no fracture is detected by FX, the output overlay is composed to include the text annotation "Fracture: NOT DETECTED" and no bounding box is included. Whether or not a fracture is detected, the overlay includes a text annotation identifying the radiograph as analyzed by FX and instructions for users to access labeling. The FX overlay can be toggled on or off by the clinicians within their PACS viewer, allowing for uninhibited concurrent review of the original radiograph.

5. INTENDED USE/INDICATIONS FOR USE

FractureDetect (FX) is a computer-assisted detection and diagnosis (CAD) software device to assist clinicians in detecting fractures during the review of radiographs of the musculoskeletal system. FX is indicated for adults only.

FX is indicated for radiographs of the following industry-standard radiographic views and study types.

Study Type (Anatomic Area of Interest+)	Radiographic View(s) Supported*
Ankle	Frontal, Lateral, Oblique
Clavicle	Frontal
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Femur	Frontal, Lateral
Forearm	Frontal, Lateral
Hip	Frontal, Frog Leg Lateral
Humerus	Frontal, Lateral
Knee	Frontal, Lateral
Pelvis	Frontal
Shoulder	Frontal, Lateral, Axillary
Tibia / Fibula	Frontal, Lateral
Wrist	Frontal, Lateral, Oblique

*For the purposes of this table, "Frontal" is considered inclusive of both posteroanterior (PA) and anteroposterior (AP) views.
+Definitions of anatomic area of interest and radiographic views are consistent with the American College of Radiology (ACR) standards and guidelines.

6. SUBSTANTIAL EQUIVALENCE

Comparison of Indications

The predicate device for FractureDetect (FX) is Imagen Technologies' OsteoDetect (DEN180005) which has the following FDA-granted Indications for Use:

> *OsteoDetect analyzes wrist radiographs using machine learning techniques to identify and highlight distal radius fractures during the review of posterior-anterior (PA) and lateral (LAT) radiographs of adult wrists.*

OsteoDetect and FX both analyze adult radiographs using machine learning techniques to identify and highlight fractures. FX is intended for use across more study types (anatomic areas of interest) than OsteoDetect. The differences in Indications for Use do not constitute a new intended use, as both FX and OsteoDetect are intended to identify fractures in radiographs.

Technological Comparisons

The table below compares the key technological feature of the subject devices to the predicate device (OsteoDetect, DEN180005).

Table 1: Technological Comparison

	FractureDetect (FX)	**OsteoDetect**
Number	TBD	DEN180005
Applicant	Imagen Technologies	Imagen Technologies
Device Name	FractureDetect	OsteoDetect
Classification Regulation	892.2090	892.2090
Product Code	QBS	QBS
Image Modality	X-ray	X-ray
Study Type (Anatomic Areas of Interest)	Ankle Clavicle Elbow Femur Forearm Hip Humerus Knee Pelvis Shoulder Tibia / Fibula Wrist	Wrist
Clinical Finding	Fracture	Fracture
Patient Population	Adults ≥ 22 years of age	Adults ≥ 22 years of age
Intended User	Clinicians	Clinicians
Machine Learning Methodology	Supervised Deep Learning	Supervised Deep Learning
Platform	Secure local processing and delivery of DICOM images	Secure local processing and delivery of DICOM images
Image Source	DICOM node (e.g., imaging device, intermediate DICOM node, PACS system, etc.)	Imaging device or intermediate DICOM node
Image Viewing	PACS system, image annotations toggled on or off	PACS system, image annotations made on copy of original image
Privacy	HIPAA Compliant	HIPAA Compliant

FX differs from OsteoDetect in detecting fractures across more study types (anatomic areas of interest) and in obtaining images from a generic DICOM node (as compared to directly obtaining images from the Imaging device). FX also displays its outputs as a toggleable overlay on the original image, whereas OsteoDetect directly annotated a copy of the original image. However, the conditions of use, overall design of the software, and the basic functionality that FX provides to the user is equivalent to that of OsteoDetect.

7. PERFORMANCE DATA

Biocompatibility Testing

There are no direct or indirect patient-contacting components of the subject device. Therefore, patient contact information is not needed for this device.

Electrical safety and electromagnetic compatibility (EMC)

The subject device is a software-only device, therefore; electrical safety and EMC testing is not applicable.

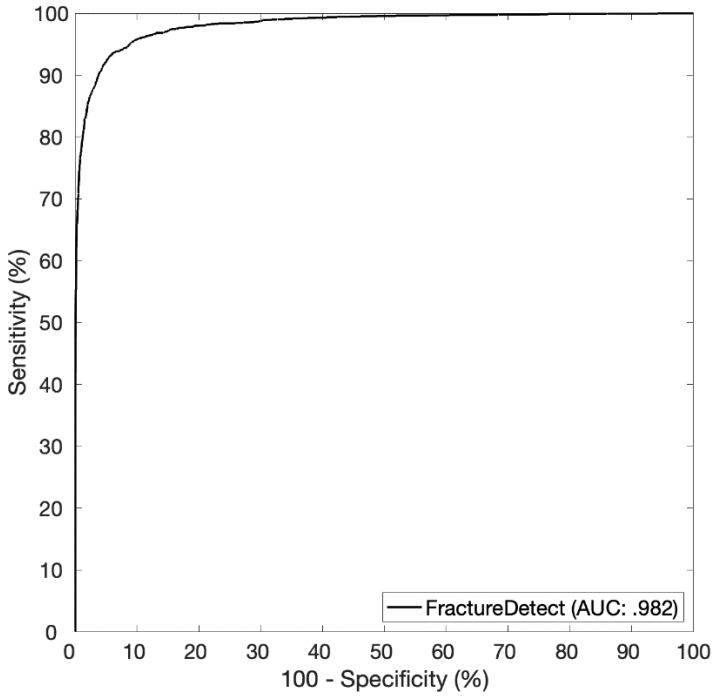
Software Verification and Validation Testing

Software verification and validation testing were conducted and documentation was provided as recommended by FDA's Guidance for Industry and FDA Staff, "Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices." The software for this device was considered moderate level of concern, since a malfunction of, or a latent design flaw in, the Software Device lead to an erroneous diagnosis or a delay in delivery of appropriate medical care that would likely lead to Minor Injury.

Bench Testing

Imagen conducted a standalone performance assessment on 11,970 radiographs for all study types (anatomic areas of interest) and views in the Indications for Use. The results of standalone testing demonstrated that FX detects fractures of the musculoskeletal system in radiographs with high sensitivity (0.951; 95% Wilson's Confidence Interval (CI): 0.940, 0.960), high specificity (0.893; 95% Wilson's CI: 0.886, 0.898), and high Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC) (0.982; 95% Bootstrap CI: 0.9790, 0.9850). Additionally, the results demonstrated that FX performs with high accuracy across study types (anatomic areas of interest) and across potential confounders such as image brightness and different x-ray manufacturers.

FractureDetect (FX) ROC Curve



Abbreviations: AUC=Area Under the Curve; ROC=Receiver Operating Characteristic

FractureDetect (FX) AUC per Study Type

Study Type (Anatomic Area of Interest)	AUC	95% Bootstrap CI
Ankle	0.983	(0.972, 0.991)
Clavicle	0.962	(0.948, 0.975)
Elbow	0.964	(0.940, 0.982)
Femur	0.989	(0.983, 0.994)
Forearm	0.987	(0.977, 0.995)
Hip	0.982	(0.962, 0.995)
Humerus	0.983	(0.974, 0.991)
Knee	0.996	(0.993, 0.998)
Pelvis	0.982	(0.973, 0.989)
Shoulder	0.962	(0.938, 0.982)
Tibia / Fibula	0.994	(0.991, 0.997)
Wrist	0.992	(0.988, 0.996)

Abbreviations: AUC=Area Under the Curve; CI=confidence interval.

Animal Testing

Not applicable. Animal studies are not necessary to establish the substantial equivalence of this device.

Clinical Data

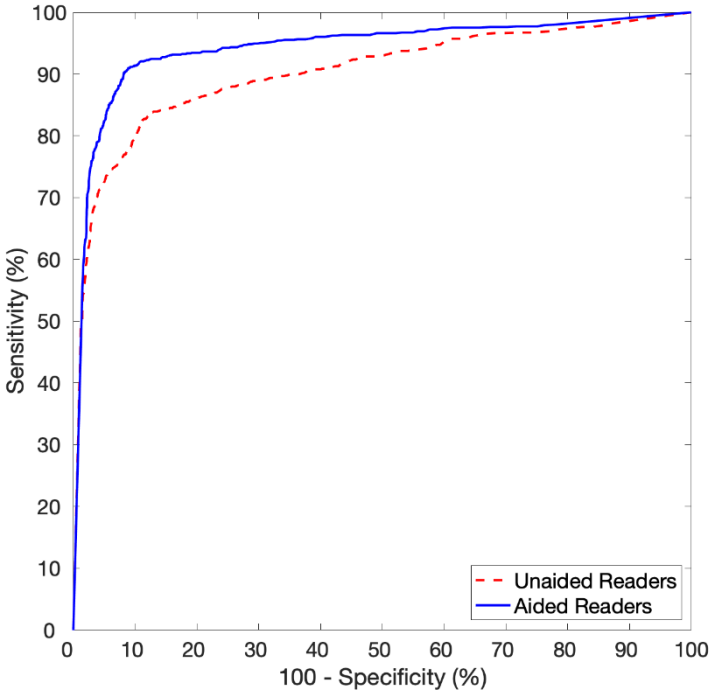
Imagen conducted a fully-crossed multiple reader, multiple case (MRMC) retrospective reader study to determine the impact of FX on reader performance in diagnosing fractures. The primary objective of the study was to determine whether the diagnostic accuracy of readers aided by FX ("FX-Aided") is superior to the diagnostic accuracy of readers unaided by FX ("FX-Unaided") as determined by the Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC) curve.

24 clinical readers each evaluated 175 cases in FX's Indications for Use under both FX-Aided and FX-Unaided conditions. Each case had been previously evaluated by a panel of three U.S. board-certified orthopedic surgeons or U.S. board-certified radiologists who assigned a ground truth binary label indicating the presence or absence of a fracture. The MRMC study consisted of two independent reading sessions separated by a washout period of at least one month in order to avoid memory bias. For each case, each reader was required to provide a binary determination of the presence or absence of a fracture and provide a confidence score representing his or her certainty.

The results of the study found that the diagnostic accuracy of readers in the intended use population is superior when aided by FX than when unaided by FX, as measured at the task of fracture detection using the AUC of the ROC curve as calculated by the DBM modeling approach.

Clinical Reader Study Results

FX-Aided vs FX-Unaided ROC Curves



Abbreviations: ROC=Receiver Operating Characteristic.

In particular, the study results demonstrated:

- Reader AUC was significantly improved from 0.912 to 0.952, a difference of 0.0406 (95% CI: 0.0127, 0.0685), across the 175 cases within FX's Indications for Use, spanning 12 study types (anatomic areas of interest) (p=.0043).
- Reader sensitivity improved from 0.819 (95% Wilson's CI: 0.794, 0.842) to 0.900 (95% Wilson's CI: 0.880, 0.917).
- Reader specificity improved from 0.890 (95% Wilson's CI: 0.879, 0.900) to 0.918 (95% Wilson's CI: 0.908, 0.927).

8. CONCLUSION

Both the proposed device (FX) and the predicate device (OsteoDetect) are computer assisted detection and diagnostic devices that accept as input radiographs in DICOM format and use machine learning techniques to identify and highlight fractures. The overall design of the software and the basic functionality that it provides to the end user are the same. The differences in technological characteristics do not raise different questions of safety and effectiveness. The results of standalone and clinical studies demonstrate that the subject device performs in accordance with specifications and meets user needs and intended use and that FX can be found to be substantially equivalent to OsteoDetect.