Contains Nonbinding Recommendations

Orthopedic Fracture Fixation Plates – Performance Criteria for Safety and Performance Based Pathway

---

Guidance for Industry and Food and Drug Administration Staff

GUIDANCE

Document issued on April 11, 2022.

For questions about this document, contact OHT6: Office of Orthopedic Devices/DHT6C: Division of Restorative, Repair and Trauma Devices at (301) 796-5650.



U.S. Department of Health and Human Services
Food and Drug Administration
Center for Devices and Radiological Health

Preface

Public Comment

You may submit electronic comments and suggestions at any time for Agency consideration to https://www.regulations.gov. Submit written comments to the Dockets Management Staff, Food and Drug Administration, 5630 Fishers Lane, Room 1061, (HFA-305), Rockville, MD 20852. Identify all comments with the docket number FDA-2022-D-0552. Comments may not be acted upon by the Agency until the document is next revised or updated.

Additional Copies

Additional copies are available from the Internet. You may also send an e-mail request to CDRH-Guidance@fda.hhs.gov to receive a copy of the guidance. Please include the document number 19044 and complete title of the guidance in the request.

Orthopedic Fracture Fixation Plates – Performance Criteria for Safety and Performance Based Pathway

---

Guidance for Industry and Food and Drug Administration Staff

This guidance represents the current thinking of the Food and Drug Administration (FDA or Agency) on this topic. It does not establish any rights for any person and is not binding on FDA or the public. You can use an alternative approach if it satisfies the requirements of the applicable statutes and regulations. To discuss an alternative approach, contact the FDA staff or Office responsible for this guidance as listed on the title page.

I. Introduction

This guidance provides performance criteria for Orthopedic Fracture Fixation Plates in support of the Safety and Performance Based Pathway.[1] Under this framework, submitters (you) planning to submit a 510(k) using the Safety and Performance Based Pathway for Orthopedic Fracture Fixation Plates will have the option to use the performance criteria proposed in this guidance to support substantial equivalence, rather than a direct comparison of the performance of the subject device to that of a predicate device.

For the current edition of the FDA-recognized consensus standard(s) referenced in this document, see the FDA Recognized Consensus Standards Database.[2] For more information regarding use of consensus standards in regulatory submissions, please refer to the FDA guidance titled Appropriate Use of Voluntary Consensus Standards in Premarket Submissions for Medical Devices.[3]

This guidance is being implemented without prior public comment because the Agency has determined that prior public participation is not feasible or appropriate (section 701(h)(1)(C)(i) of the FD&C Act and 21 CFR 10.115(g)(2)). FDA has determined that this guidance document presents a less burdensome policy that is consistent with public health. This guidance document

[1] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/safety-and-performance-based-pathway
[2] Available at https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfStandards/search.cfm
[3] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/appropriate-use-voluntary-consensus-standards-premarket-submissions-medical-devices

is being implemented immediately, but it remains subject to comment in accordance with the Agency's good guidance practices.

The contents of this document do not have the force and effect of law and are not meant to bind the public in any way, unless specifically incorporated into a contract. This document is intended only to provide clarity to the public regarding existing requirements under the law. FDA guidance documents, including this guidance, should be viewed only as recommendations, unless specific regulatory or statutory requirements are cited. The use of the word *should* in Agency guidance means that something is suggested or recommended, but not required.

II. Background

In September 2019, FDA issued a guidance to describe an optional pathway – the Safety and Performance Based Pathway[4] – for certain, well understood device types, where a submitter could demonstrate that a new device meets FDA-identified performance criteria to demonstrate that the device is as safe and effective as a legally marketed device. In order to identify the specific set of performance criteria appropriate to satisfy a submitter's comparison to an appropriate predicate for a given device-type, FDA has determined that the performance criteria represent performance that meets the performance of one or more existing, legally marketed devices of that device type. Specifically, FDA relied on the experience and expertise of FDA staff, information in literature, and analyses of data available to FDA on legally marketed orthopedic fracture fixation plates to determine the performance criteria and associated testing methods that could support a finding of substantial equivalence for orthopedic fracture fixation plates as described in this guidance. FDA recognizes that in some cases, it may be more burdensome for a submitter to conduct testing against an appropriate predicate device to demonstrate equivalence for the necessary set of performance and technological characteristics than to demonstrate their device meets appropriate performance criteria established by FDA. Accordingly, we concluded that the optional device-specific Safety and Performance Based Pathway utilizing the performance criteria identified in this guidance provides a less burdensome policy consistent with the public health.

III. Scope/Device Description

The devices that are the subject of this guidance are Class II non-spinal fracture fixation plates regulated under 21 CFR 888.3030, with the product code HRS (plate, fixation, bone). Additionally, the performance testing recommendations for non-spinal fracture fixation plates are harmonized with testing recommendations for the associated bone screws with product code HWC (screw, fixation, bone) regulated under 21 CFR 888.3040, which can be found in FDA's guidance, Orthopedic Non-Spinal Metallic Bone Screws and Washers – Performance Criteria for Safety and Performance Based Pathway[5] (hereinafter Bone Screws and Washers Guidance).

[4] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/safety-and-performance-based-pathway

[5] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/orthopedic-non-spinal-metallic-bone-screws-and-washers-performance-criteria-safety-and-performance

Intended Use/Indications for Use:
The fracture fixation plates that fall within the scope of this guidance document are intended for osteosynthesis (i.e., rigid fixation of opposing bone fragments for fracture fixation, osteotomy, or arthrodesis). The performance criteria identified in this guidance are applicable to fracture fixation plates used in the upper extremities and lower extremities and clavicle.

Fracture fixation plates that are intended for mandibular, maxillofacial, cranial, and orbital fracture fixation or for use in the thorax (i.e., rib and sternum), spine, pelvis and femoral head/neck are outside the scope of this guidance document.

For devices intended for new fracture types or abnormal bone biology (e.g., osteoporosis, metabolic bone diseases, metastatic cancer lesions, genetic disorders) within each anatomical location, additional information, in addition to testing outlined in this guidance, such as performance comparison to a predicate device, may be needed to demonstrate substantially equivalent fracture fixation performance. We recommend that you submit a Pre-Submission[6] to engage in discussion with FDA prior to submission of the 510(k).

Device Design Characteristics:
Fracture fixation plates may have varying designs to account for specific anatomical locations. The scope of this guidance document includes traditional fracture fixation plates that are positioned entirely on the cortical surface, over the osteosynthesis site. The scope is limited to plating systems where the worst case device configuration can be evaluated using four-point bend testing per ASTM F382 *Standard Specification and Test Method for Metallic Bone Plates* (e.g., straight, tubular plates). Devices that fall within the scope of this guidance document consist of fracture fixation plates and screws manufactured from the following materials:

- ASTM F136 *Standard Specification for Wrought Titanium-6 Aluminum-4 Vanadium ELI (Extra Low Interstitial) Alloy for Surgical Implant Applications (UNS R56401)*
- ASTM F1472 *Standard Specification for Wrought Titanium -6Aluminum -4Vanadium Alloy for Surgical Implant Applications (UNS R56400)*
- ASTM F1295 *Standard Specification for Wrought Titanium-6 Aluminum-7Niobium Alloy for Surgical Implant Applications (UNS R56700)*
- ASTM F67 *Standard Specification for Unalloyed Titanium, for Surgical Implant Applications (UNS R50250, UNS R50400, UNS R50550, UNS R50700)*
- ASTM F138 *Standard Specification for Wrought 18 Chromium-14 Nickel-2.5 Molybdenum Stainless Steel Bar and Wire for Surgical Implants (UNS S31673)*
- ASTM F139 *Standard Specification for Wrought 18 Chromium-14 Nickel-2.5 Molybdenum Stainless Steel Sheet and Strip for Surgical Implants (UNS S31673)*
- ASTM F1537 *Standard Specification for Wrought Cobalt-28-Chromium-6-Molybdenum Alloys for Surgical Implants (UNS R31537, UNS R31538, and UNS R31539)*

Premarket submissions should describe anatomical use location of each plate and identify the screws that are compatible with each plate. Submissions should include a geometric comparison

[6] See the FDA guidance "Requests for Feedback and Meetings for Medical Device Submissions: The Q-Submission Program" available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/requests-feedback-and-meetings-medical-device-submissions-q-submission-program for more information.

of each subject plate/screw combination to a legally marketed predicate plate/screw combination for use in the same anatomical region to demonstrate similarities in technological features. The following characteristics should be described for each component included in the submission and compared between the subject and predicate devices:

- Plate characteristics:
  - Plate Footprint (Lengths, Widths, Shape)
  - Plate Prominence (Thickness)
  - Plate fixation (Number of screw holes and pattern)
  - Compatible screw size(s)
  - Material

- Screw characteristics (for screws associated with a particular plate):
  - Diameter
  - Overall length
  - Threaded length
  - Thread profile
  - Fixed or variable angle and, if variable angle, a comparison of angulation allowed by the screws with respect to the plate
  - Locking or non-locking
  - Material

Sufficient description, such as detailed engineering drawings, should be provided to demonstrate that screws mate appropriately with the plates in order to perform their intended function.

Implants with the following features are outside the scope of this guidance for the Safety and Performance Based Pathway:

- Plating systems with non-uniform worst-case structurally critical regions that cannot physically fit between the loading rollers of a four-point bend test and/or do not maintain contact of all loading rollers throughout the test.[7]
- Devices with features intended to promote dynamization at the fracture site (i.e., secondary bone healing through callus formation)
- Combination products
- Resorbable devices
- Additively manufactured devices
- Devices with coatings
- Devices that utilize surgical techniques or associated instruments outside the standard of care
- Devices with complex geometries, modularity, non-traditional technological characteristics or unique technological characteristics that impact the risk of soft tissue irritation or the structural integrity of the construct (e.g., design features that warrant fatigue evaluations, dynamic components or mechanisms, non-traditional plate and

[7] As stated in ASTM F382, plates with non-uniform segments (e.g., asymmetry, curvatures) may not be able to be adequately evaluated in four-point bend testing. Uniform cross sections are preferred for this test as non-uniform designs may deflect asymmetrically resulting in uneven loading under the loading rollers.

screw interfaces, screw characteristics that differ substantially in design from predicates or recognized consensus standards for orthopedic bone screws).
- Devices sterilized using novel sterilization methods as described in FDA's guidance Submission and Review of Sterility Information in Premarket Notification (510(k)) Submissions for Devices Labeled as Sterile.[8]

FDA may determine, on a case-by-case basis, that additional data are necessary to evaluate whether the device is appropriate for the Safety and Performance Based Pathway. In situations where you determine that additional testing outside of those identified in this guidance are necessary to make a determination regarding whether the device is appropriate for the Safety and Performance Based Pathway, we would encourage you to submit a Pre-Submission[9] to engage in discussion with FDA prior to submission of the 510(k).

IV. Testing Performance Criteria

If your device is appropriate for submission through the Safety and Performance Based Pathway, and you choose to use that option, we do not expect you to provide direct comparison testing against a legally marketed predicate device to demonstrate substantially equivalent performance characteristics. To ensure that the performance criteria outlined in this guidance remain contemporary and to take into account relevant data from recent clearances, FDA recommends that you provide a results summary for all tests evaluated in addition to the other submission information (e.g. Declaration of Conformity (DoC)) recommended below for each test or evaluation below. Consistent with FDA policy for all 510(k) submissions, for all 510(k) submissions under the Safety and Performance Based Pathway, FDA may request and review underlying data demonstrating that a new device meets the FDA-identified performance criteria and testing methodology, as necessary. Unless otherwise identified in the sections below, test information such as results summary, test protocols, and complete test reports should be submitted as part of the 510(k) as described in FDA's guidance Safety and Performance Based Pathway. For additional information regarding the submission of non-clinical bench testing information, please see FDA's guidance Recommended Content and Format of Non-Clinical Bench Performance Testing Information in Premarket Submissions.[10]

Mechanical Bench Testing

The following mechanical tests should be performed in conformance with the FDA currently-recognized version of ASTM F382 *Standard Specification and Test Method for Metallic Bone Plates* and ASTM F543 *Standard Specification and Test Methods for Metallic Medical Bone Screws*. You should provide a rationale identifying how you identified the worst-case design for each bench test. A complete worst-case rationale for plates should address the indications (e.g., anatomical location), geometry (e.g., the location between the outermost screw holes that will have the highest stress under loading), and labeling (e.g. rehabilitation activity, post-operative

[8] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/submission-and-review-sterility-information-premarket-notification-510k-submissions-devices-labeled
[9] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/requests-feedback-and-meetings-medical-device-submissions-q-submission-program
[10] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/recommended-content-and-format-non-clinical-bench-performance-testing-information-premarket

loading). For each anatomical location, we recommend that you perform testing on plate designs that represent the worst case for bending strength and bending structural stiffness performance. The worst case for compatible screw designs should also be identified. All mechanical testing should be performed on the final, finished versions of the devices unless certain processes (e.g., sterilization) can be rationalized to have no impact on the mechanical strength of the device. Acceptance criteria are listed below for each test.[11]

For each mechanical test below, you should provide a report as specified in the relevant reporting sections of ASTM F382 or ASTM F543, in addition to a DoC to the consensus standard. Any protocol deviations should be thoroughly described and justified; however, note that certain protocol deviations may invalidate comparison to the performance criteria listed below, resulting in the need for submission of a Traditional, Special, or Abbreviated 510(k), as appropriate.

Compatible Screw Mechanical Testing

FDA's Bone Screws and Washers Guidance can be leveraged to assess mechanical testing of bone screws that are compatible with the fracture fixation bone plate. The worst-case bone screw size that is compatible with the worst-case bone plate for each anatomical location should be selected for mechanical testing. Torsional Strength and Driving Torque Testing of the screw should be performed and compared to the performance criteria identified in Section III of the Bone Screws and Washers Guidance.

FDA does not consider individual screw pullout strength testing (Section III, Test #3, in the Bone Screws and Washers Guidance) to be necessary for demonstrating that a plating system has substantially equivalent fixation because multiple screws are intended to be used with the plating system to minimize the risk of en-bloc plate pull-out. Therefore, FDA does not recommend the use of the Axial Pullout Strength criteria for screws used with a subject plating system because these criteria are representative of partially threaded bone screws, which may not be generally comparable to all screws types intended for use with plates.

FDA believes that the substantial equivalence of construct fixation can be demonstrated through a comparison of the number of screws used with each plate and a comparison of subject screws to the predicate (e.g., the number of screw holes, the screw type, screw diameter, overall length, threaded length and thread profile). This comparative approach can accommodate the variety of plates and their screw types that have been cleared through 510(k) and provides a least burdensome method that is sufficient to demonstrate substantial equivalence.

For screws intended for stand-alone use outside of the plating construct, the Bone Screws and Washers Guidance is applicable in its entirety.

Bone Plate Mechanical Testing

[11] It should be noted that ASTM F382 and ASTM F543 are recognized in full by FDA. FDA believes that for the purposes of the Safety and Performance Based Pathway, the testing, methods and criteria identified in this section on mechanical bench testing represent the least burdensome approach to demonstrating substantial equivalence for this pathway, although alternative or additional methods or acceptance criteria are identified in the recognized consensus standard for some tests. The supplementary information sheet (SIS) for ASTM F382 and ASTM F543 will be revised to reflect this information upon finalization of this guidance.

1. **Test name:** Static Four-Point Bending
Methodology: FDA-recognized version of ASTM F382 *Standard Specification and Test Method for Metallic Bone Plates.* The worst-case bone plate(s) for each anatomic region should be selected for mechanical testing.
Performance Criteria:

Intended Anatomical Location of Bone Plate		Minimum Bending Strength (N-m)	Minimum Bending Structural Stiffness ($N\text{-}m^2$)
Upper Extremity	Humerus	11.6	4.39
	Elbow (Distal Humerus and Ulna)	6.7	0.89
	Hand, Wrist and Forearm	1.6	0.18
Lower Extremity	Femur & Proximal Tibia	26.3	8.66
	Distal Tibia	11.9	3.49
	Fibula	2.3	0.17
	Foot	1.2	0.13
Other	Clavicle	11.9	1.69

Performance Criteria Source: Criteria are based on aggregated mechanical testing data submitted to FDA in 510(k) submissions for orthopedic bone plates previously found to be substantially equivalent.
Additional Considerations: A minimum of five samples should be tested for each worst-case plate being evaluated. In addition, analysis of the data available to FDA on existing devices has shown that five samples should be adequate based on the mean bending strength and mean bending structural stiffness testing results compared to the criteria for each nominal diameter. To be considered a successful result, either: (1) All samples should meet or exceed the acceptance criteria listed above, or (2) the average of all samples should meet or exceed the criteria above and the standard deviation should be ≤ 10% of the calculated averages.
Submission Information: Results summary and DoC

<u>Sterilization (devices labeled as sterile) and Reprocessing (end-user sterilized) Validation</u>

2. **Test name:** Sterilization (for devices labeled as sterile) and Reprocessing (end-user sterilized)
Methodology: Current FDA recognized version of the following consensus standards (as applicable):
    - International Organization for Standardization (ISO) 17665-1: *Sterilization of health care products – Moist heat – Part 1: Requirements for the development, validation, and routine control of a sterilization process for medical devices*
    - ISO 11135-1: *Sterilization of health care products – Ethylene oxide- Part 1: Requirements for development, validation, and routine control of a sterilization process for medical devices*

- ISO 11137-1: *Sterilization of health care products—Radiation—Part 1: Requirements for development, validation, and routine control of a sterilization process for medical devices*
- ISO 11607-1: *Packaging for terminally sterilized medical devices – Part 1: Requirements for materials, sterile barrier systems and packaging systems*
- ISO 11607-2: *Packaging for terminally sterilized medical devices – Part 2: Validation requirements for forming, sealing and assembly processes*

Performance Criteria: Validation testing should demonstrate the cleanliness and sterility of, or the ability to clean and sterilize to a sterility assurance level of 10^{-6}, the device and device-specific instruments.

Performance Criteria Source: FDA's guidance:

- Submission and Review of Sterility Information in Premarket Notification (510(k)) Submissions for Devices Labeled as Sterile[12]
- Reprocessing Medical Devices in Health Care Settings: Validation Methods and Labeling[13]

Submission Information: You should provide a description of the packaging (sterile barrier system) and how it will maintain the device's sterility, and a description of the package test methods, but not package test data. When using an Established Category A sterilization method, you should provide the information in Section V.A. of the FDA guidance Submission and Review of Sterility Information in Premarket Notification (510(k)) Submissions for Devices Labeled as Sterile; generally, the validation data itself is not needed to demonstrate substantial equivalence.

Biocompatibility Evaluation

To identify the biocompatibility endpoints to include as part of your biocompatibility evaluation you should use Attachment A of the FDA guidance Use of International Standard ISO 10993-1, "Biological evaluation of medical devices – Part 1: Evaluation and testing within a risk management process,"[14] referred to in the rest of this document as the FDA Biocompatibility Guidance for brevity. FDA considers the devices covered by this guidance to be categorized as Implanted Devices in contact with tissue/bone with a "permanent" contact duration of > 30 days, and, accordingly, you should assess the endpoints below per Attachment A of the FDA Biocompatibility Guidance.

- Cytotoxicity
- Sensitization
- Irritation or Intracutaneous Reactivity
- Acute Systemic Toxicity
- Material-Mediated Pyrogenicity
- Sub-acute/Sub-chronic Toxicity

[12] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/submission-and-review-sterility-information-premarket-notification-510k-submissions-devices-labeled

[13] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/reprocessing-medical-devices-health-care-settings-validation-methods-and-labeling

[14] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/use-international-standard-iso-10993-1-biological-evaluation-medical-devices-part-1-evaluation-and

- Genotoxicity
- Implantation
- Chronic Toxicity
- Carcinogenicity

Rationale in Lieu of Testing: If the subject device is manufactured from the identical raw materials using identical manufacturing processes as a predicate device with the same type and duration of tissue contact, and any changes in geometry are not expected to impact the biological response, this is typically sufficient to establish substantially equivalent biocompatibility if documentation such as that outlined in Attachment F of the FDA Biocompatibility Guidance is also provided.

Testing: In rare cases, if you determine that testing is needed to address some or all of the identified endpoints, FDA recommends that complete test reports be provided for all tests performed unless a declaration of conformity without supplemental information can be appropriately provided, as discussed in Attachment E of the FDA Biocompatibility Guidance. Any test-specific positive, negative, and/or reagent controls should perform as expected, and protocol deviations should be thoroughly described and justified; however, note that certain protocol deviations may invalidate comparison to the performance criteria listed below. As described in the FDA guidance, Safety and Performance Based Pathway,[15] if a device cannot rely entirely on performance criteria identified by FDA to demonstrate substantial equivalence for its submission, it is not appropriate for the Safety and Performance Based Pathway program; however, the previously established 510(k) programs in which direct performance comparisons against appropriate predicates are conducted, including Traditional, Special, and Abbreviated 510(k)s, remain available.

3. **Test name:** Biocompatibility endpoints (identified from FDA Biocompatibility Guidance)
   Methodology: Current FDA recognized versions of biocompatibility consensus standards
   Performance Criteria: All direct tissue contacting components of the device and device-specific instruments should be determined to have an acceptable biological response.
   Performance Criteria Source: The FDA Biocompatibility Guidance
   Additional Considerations: For any biocompatibility test samples with an adverse biological response, the biocompatibility evaluation should explain why the level of toxicity seen is acceptable. Some comparison testing against a legally marketed predicate may be necessary (and is considered appropriate under the Safety and Performance Based Pathway) to support such a rationale as explained in the FDA Biocompatibility Guidance. For standard biocompatibility test methods that include comparison device control samples, the legally marketed comparison device control samples should perform as expected.
   Submission Information: Refer to FDA Biocompatibility Guidance

[15] Available at https://www.fda.gov/regulatory-information/search-fda-guidance-documents/safety-and-performance-based-pathway