



Designation: F 1622 – 95 (Reapproved 2000)

## Standard Test Method for Measuring the Torsional Properties of Metallic Bone Screws<sup>1</sup>

This standard is issued under the fixed designation F 1622; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers the testing of stainless steel, cobalt-based, and titanium-based bone screws for the determination of torsional yield strength, maximum torque, breaking angle, and torque versus angle of rotation. The described test method is intended to be used as a means of evaluating the mechanical properties of bone screws.

### 2. Terminology

#### 2.1 Definitions:

2.1.1 *breaking angle*—angle of rotation at which the screw demonstrates its most rapid decrease in torque.

2.1.2 *gage length*—the distance between the holding device, for example, a split collet, and the underside of the screw head. If a screw is manufactured according to ASTM or ISO specifications, the ASTM or ISO designation should be provided.

2.1.3 *grip length*—the length of threads held fast in the split collet or other holding mechanism.

2.1.4 *maximum torque*—the largest value of torque recorded during the period of rotation until the screw fails in shear (that is, breaks into two separate parts).

2.1.5 *torsional yield strength*—the point at which the screw reaches its proportional limit. This will be determined by the offset method. A2° offset value will be used.

### 3. Summary of Test Method

3.1 *Determination of Torsional Yield Strength, Maximum Torque, and Breaking Angle*—This test method measures torque versus angle of rotation when a bone screw is stressed to failure. The shaft of the bone screw is fixed in a holding device (for example, vise split collet, threaded insert, etc.) while torque is applied to the head of the screw at a constant rate, until a clean break occurs. A plot of torque versus angle of rotation is recorded on an X-Y recorder. This plot will also record the torsional yield strength, maximum torque, and breaking angle. Alternate methods to store measurement data are acceptable.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.21 on Osteosynthesis.

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### 4. Significance and Use

4.1 This test method is used to measure the torsional yield strength, maximum torque, and breaking angle of the bone screw under standard conditions. The results obtained in these tests are not intended to predict the torque encountered in inserting or removing a bone screw in human or animal bone. This test method is intended only to measure the uniformity of the product tested or to compare the mechanical properties of different, yet similarly sized, products.

### 5. Apparatus

5.1 *Testing Fixture*—A suitable testing fixture shall be provided for conducting the test. It should incorporate the functions illustrated in Fig. 1 for the torsional yield strength—maximum torque—breaking angle test. It shall be sufficiently rigid to not deflect or deform under the conditions of loading encountered during the test.

5.2 *Torque Wrench*—A motor driven torque wrench capable of applying the torsional force at a constant rate of 3 r/min.

5.3 *Torque Transducer*—A suitable transducer to translate the mechanical parameter of torque, both in the clockwise and counter-clockwise rotation, into an electrical signal amenable to continuous recording with an X-Y plotter.

5.4 *Potentiometer*—A variable resistance electrical component that changes resistance proportionally to the rotation of the armature, by means of a pulley, of the torque wrench. Other systems that can measure rotation with a minimum resolution of 1° may be used.

5.5 *Split Collet and Split Collet Holder*—A mechanical device used to clamp onto the bone screw to prevent its rotation while being stressed. Other holding devices that prevent the rotation of the screw during testing without significantly damaging its mechanical integrity may be used. One such method is to insert a threaded stopper into the opposite side of a test block. The test block for this holding mechanism will accommodate the insertion of a threaded stopper on the other side of the test block. The threaded stopper will prevent the screw from being completely inserted into the test block and will allow the torsional strength of the screw to be measured. This holder will be modified according to the size of the testing specimen so that the gage length of the specimen will be the same as that outlined in 6.1.

5.6 *d-c Voltage Supply*—Used to supply a constant voltage

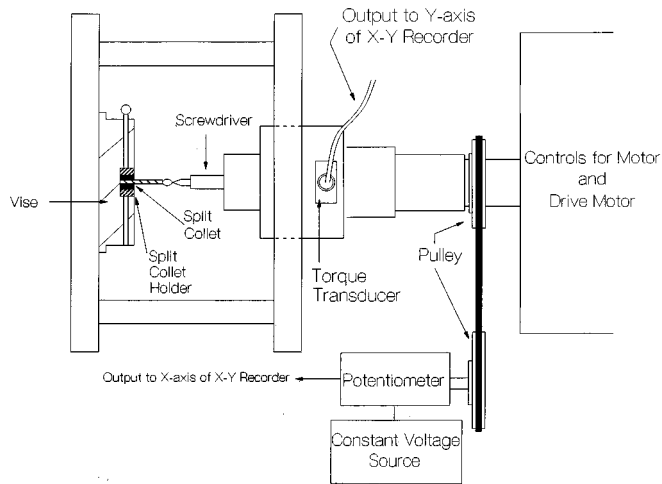


**FIG. 1 Testing Apparatus for Torsional Yield Strength—Maximum Torque—Angle of Rotation**

supply to the potentiometer.

**5.7 X-Y Plotter**—A suitable recorder to plot torque versus angle of rotation. This plot shall be calibrated in units of pounds-force inches or newton-metres for torque and degrees for angle of rotation. The value of torque shall have a resolution of 5 % of torsional yield strength. The angular displacement scale shall have a minimum sensitivity of 10°/cm so as to provide accurate offset measurement capability at a 2° angular displacement.

**5.8 Test Specimen**—The test specimen shall be a completely fabricated and finished bone screw.

## 6. Procedure

**6.1 Torsional Yield Strength, Maximum Torque, and Breaking Angle**—Place the specimen in the holding device so that five threads, below the head of the screw, are exposed outside the holding device (for example, split collet, and so forth). If the test specimen cannot accommodate this setup because the screw is too small or is partially threaded, alternate procedures may be used. For fully threaded screws that are too small, the gage length of the specimen should represent 20 % of the threaded portion of the test specimen. For partially threaded screws, a large enough portion of the screw thread should be gripped to firmly secure the screw so that it does not rotate when under torsional load. There are no specific requirements on the gage length or the grip length in this case; however, it is most desirable to have at least one full thread exposed if this situation is possible. Since the gage length and grip length can vary for these screws, the only requirement is that both be reported.

**6.2** The gage length or grip length should be kept the same length for test screws of similar design. If a split collet and collet holder are employed, the following test method is appropriate: place the split collet in the collet holder. Clamp the split collet and holder in the vise. The clamping force of the vise should be sufficient to prevent rotation of screw or the split collet. Drive the specimen in the direction of insertion, using an appropriate size and configured screwdriver bit, by applying a torsional force with the motordriven torque wrench. If an axial

load is required to maintain the screwdriver bit in the screw head, its value should be noted. The torque wrench should be driven at a rate of 3 r/min. A potentiometer is attached, by means of a pulley, to the driving armature of the torque wrench. The electrical output of the potentiometer is connected to the X axis of the X-Y plotter. The electrical output of the torque transducer is connected to the Y axis of the X-Y plotter. Continue driving the specimen until a clean break occurs. Using a potentiometer is only one method in which to measure the angle of rotation. Alternative testing apparatus may be used to measure the angle of rotation.

**6.3** The simultaneous use of two chart recorders may simplify the ability to accurately measure torsional yield strength by the offset method. One chart recorder with an angular displacement scale or sensitivity of 50°/cm is convenient for measuring maximum torque and breaking angle. A second chart recorder with an angular displacement scale or sensitivity of 10°/cm or less is suggested to provide accurate offset measurement capability for measuring a 2° angular displacement. Alternatively, one chart recorder and a digital storage oscilloscope may be used.

**6.3.1** The torsional yield strength will be determined by the offset method (Fig. 2), using the torque versus angle of rotation curve produced in 6.1 and 6.2.

**6.3.1.1** On the torque versus angle of rotation curve, locate Point *m* equal to a rotation of 2°. Draw *mn* parallel to *OA*, and locate *b*, the intersection of *mn* with the torque versus angle of rotation curve. Torque *B* is defined as the torsional yield strength.

**6.3.1.2** The maximum torque is determined by the largest value of torque on the torque versus angle of rotation curve.

**6.3.1.3** The breaking angle is determined from the torque versus angle plot shown in Fig. 3. The breaking angle is

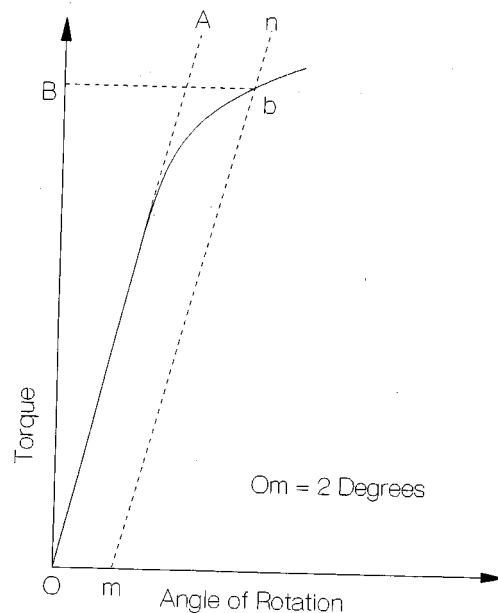


**FIG. 2 Offset Method**