Instructions for Use

Additive Orthopaedics Patient Specific Talus Spacer

Description: The Additive Orthopaedics Patient Specific Talus Spacer is an additively manufactured implant made from cobalt chromium metal alloy and produced by laser sintering. The device allows the patient to regain motion and reduce pain without an amputation or fusion until the time a fusion potentially becomes necessary.

System Components:
Total Talus Cobalt Chrome Cobalt-28 Chromium-6 Molybdenum (meeting the requirement of ASTM F75) in 3 sizes: small, nominal, and large.

Indications for Use:
The Additive Orthopaedics Patient Specific Talus Spacer is indicated for avascular necrosis of the ankle joint. The anatomical landmarks necessary for the design and creation of the Additive Orthopaedics Patient Specific Talus Spacer must be present and identifiable on computed tomography scan.

Contraindications:

- Use of implant greater than 6 months from date of patient's computed tomography (CT) scan.
- Degenerative changes in the tibiotalar, subtalar or talonavicular joints.
- Presence of an active infection.
- Gross deformity in sagittal or coronal planes. More than 15 degrees of varus or valgus deformity in the coronal plane, or more than 50% subluxation anteriorly or posteriorly of the talus in the sagittal plane.
- Osteonecrosis of the calcaneus, distal tibia or navicular.
- Known history of existing malignancy, or any systemic infection, local infection, or skin compromise at the surgical site.
- Blood supply limitations and previous infections that may prevent healing.
- Physical conditions that would eliminate adequate implant support or prevent healing, including inadequate soft tissue coverage.
- Conditions which may limit the patient’s ability or willingness to restrict activities or follow directions post-operatively during the healing period.
- Presence of neurological deficit which would prevent patient post-operative compliance.
- Sensitivity or allergy to the metal implant. Where material sensitivity is suspected, appropriate tests should be made, and sensitivity ruled out prior to implantation.

Humanitarian Device. Authorized by Federal law for use in the treatment of avascular necrosis of the ankle joint in adult patients. The effectiveness of this device for this use has not been demonstrated.
Caution: Federal law (USA) restricts this device to sale by or on the order of a physician.

Potential Adverse Effects

- Infection, deep and superficial
- Loosening or migration of the implant
- Nerve damage due to surgical trauma
- Inadequate healing
- Pain, soft tissue discomfort or abnormal sensation due to the presence of the device
- Deep and superficial infections
- Allergies or other reactions to implant materials
- Loss of anatomic position with rotation or angulation
- Bone resorption or over-production
- Untoward histological responses possibly involving macrophages and/or fibroblasts
- Migration of particle wear debris possibly resulting in a bodily response
- Embolism

Precautions

- Surgical implants may only be used for surgeries, for which the designated application of the implant is explicitly necessary and defined.
- Correct selection of the implant is extremely important. That patient's anatomy and indication will determine the size of the implant to be used.
- No partial weight-bearing or non-weight bearing device can be expected to withstand the unsupported stresses of full weight-bearing. Following surgery, the patient should employ adequate external support and restrict physical activities which would place stress upon the implant or allow movement of the implant and delay healing.
- Postoperative care is extremely important. The patient must be advised that noncompliance with postoperative instructions could lead to breakage of the implant or surrounding bones in the ankle joint. The risk of device failure may increase due to patient-related factors including activity level, weight, or noncompliance due to psychological condition.
- Patient Specific Talus Spacers are designed from patient data such as radiograph (X-ray), CT scan, or magnetic resonance imaging (MRI). Over time, a patient's anatomy can change. If a significant amount of time has elapsed from the time of collection of the patient data (date of scan) to the time of surgery utilizing a Patient Specific Talus Spacer, the implant may not fit the patient's anatomy correctly.

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Warnings

- Surgeon's must evaluate the patient's contralateral side in addition to the affected talus, to determine if the patient is a candidate for a Patient Specific Talus Spacer. If the surgeon believes there are deformities on the affected side or the contralateral side, then the patient may not be a suitable candidate for a Patient Specific Talus Spacer.
- It is mandatory that the user, surgeon and surgery personnel are acquainted with the respective-surgical technique and implants used.
- The trained expert staff is obligated to examine the surgical implant and its packaging for damages prior to each application, i.e., use in case of the implant or its packaging being damaged or deformed, it is not to be used.
- Improper selection, placement, positioning, alignment and fixation of the implant may result in unusual stress conditions and a subsequent reduction in the service life of the prosthetic implant.
- Malalignment or inaccurate implantation can lead to excessive wear and/or failure of the implant or procedure.
- Inadequate preclosure cleaning (removal of surgical debris) can lead to excessive wear.
- Improper preoperative or intraoperative implant handling or damage (scratches, dents, etc.) can lead to crevice corrosion, fretting, fatigue fracture and/or excessive wear.
- Do not modify the Additive Orthopaedics Patient Specific Talus Spacer.
- The surgeon is to be thoroughly familiar with the Patient Specific Talus Spacer and surgical procedure prior to performing surgery. For further information, contact Additive Orthopaedics and consult the Surgical Technique Guide.
- Do not reuse the Additive Orthopaedics Patient Specific Talus Spacer. Reuse of this product may result in infection or other systemic complications that may affect the patient's overall health. Additionally, the reuse of this product could adversely affect function of the device. Any implant that has been damaged, mishandled, or removed from the sterile field may have surface damage that could result in implant fracture and/or particulate and should be discarded.
- This is a patient specific implant, do not use in a patient other than the one listed in the product labeling and/or the physician order form.

MR Safety Information

The Additive Orthopaedics Patient Specific Talus Spacer has not been evaluated for safety and compatibility in the MR environment. It has not been tested for heating, migration, or image artifact in the MR environment. The safety of Additive Orthopaedics Patient Specific Talus Spacer in the MR environment is unknown. Scanning a patient who has this device may result in patient injury.

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Directions for Use

This outlines the basic procedure for device implantation, which is described more fully in the Surgical Technique Guide. It is the responsibility of the surgeon to be familiar with the procedure before use of the products. Each surgeon must evaluate the appropriateness of the surgical technique used based on personal medical training and experience. As the manufactures of this device, Additive Orthopaedics does not practice medicine and does not recommend this or any other surgical technique for use on any specific patient.

1. Prepare the insertion site using standard surgical techniques. A straight skin incision is made over the anterior ankle, similar to the anterior approach used for a total ankle replacement.
2. The anterior capsule of the tibiotalar joint is then opened, and the talus divided into sections using a chisel. Once divided, the talus is then resected.
3. Assess articulations through dorsiflexion and plantarflexion of the ankle as well as inversion and eversion. Flexibility at the midfoot is also demonstrated through multiple planes of movement.
4. Once the proper size is determined insert the corresponding Patient Specific Talus Spacer.
5. It is recommended to confirm the fit of the implant using fluoroscopy.

How Supplied

Additive Orthopaedics Patient Specific Talus Spacers are provided to the hospital non-sterile. Only sterile devices should be used in surgery. Additive Orthopaedics Patient Specific Talus Spacers have been cleaned and inspected. Unless otherwise indicated, these devices are NOT STERILE and MUST be sterilized prior to use. Single Use Only. Do Not Reuse. Do not use any component from an opened or damaged package.

Disclaimer

Additive Orthopaedics has verified through laboratory testing that its Patient Specific Talus Spacers are suitable for the specific sterilization methods and cycles for which they have been tested.

Health care personnel bear the ultimate responsibility for ensuring that any particular packaging method or material, including a reusable rigid container system, is suitable for use in sterilization processing and sterility maintenance in a particular health care facility. Testing should be conducted in the health care facility to ensure that requirements and conditions essential to sterilization can be achieved.

In the event that health care personnel fail to properly sterilize the device as required, Additive Orthopaedics does not accept responsibility or liability for any damages or otherwise arising from a lack of sterility of an implantable device supplied in a clean but non-sterile condition.

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Cleaning and Decontamination

Non-sterile Additive Orthopaedics Patient Specific Talus Spacers are supplied in a cleaned condition in clean packaging materials. Further cleaning other than sterilization is not required. Use care in handling a device once the device is removed from the packaging in order to prevent any inadvertent contamination, damage, or otherwise jeopardize the integrity of the device.

Sterilization

Double wrap devices in accordance with local procedures, using standard techniques such as those described in ANSI/AAMI ST46-1993. Be sure to sterilize in FDA cleared sterilization wraps or pouches.

Recommendations for Sterilization

These instructions are recommended for the care, maintenance and sterilization of Additive Orthopaedics Patient Specific Talus Spacers. They are intended to assist health care personnel in safe handling practices, effective sterilization of Patient Specific Talus Spacers. The instructions are intended to assist the hospital and central supply management in developing procedures for safe and effective processing of implants. Hospital personnel, including those in receiving and central sterile supply departments (CSSD), as well as in the operating room (OR), may be directly involved in handling devices. Hospital directors and other management in each of these departments should be informed of these instructions and recommendations to ensure safe and effective processing and to prevent damage or misuse of devices.

Responsibilities of the User

General. Health care personnel bear the ultimate responsibility for ensuring that any packaging method or material is suitable for use in sterilization processing and sterility maintenance. DO NOT ATTEMPT TO STERILIZE THE DEVICE IN THE PACKAGING MATERIALS SUPPLIED.

Sterility. Users should conduct testing in the health care facility to ensure that the conditions essential to sterilization can be achieved and are acceptable for the steam sterilization process. ANSI/AAMI ST46 Steam Sterilization and Sterility Assurance in Health Care Facilities provides guidelines for design and personnel considerations, processing recommendations, care of sterilizers, quality control, and quality process improvement.

Sterility

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sterilized prior to use. Single Use Only. Do Not Reuse. Do not use any component from an opened or damaged package.

Additive Orthopaedics implantable devices can be steam autoclaved, and repeated autoclaving will not adversely affect them, unless otherwise indicated on the labeling.

Implantable devices may be autoclaved using a full cycle. Set forth below is a recommended minimum cycle for steam sterilization that has been validated by Additive Orthopaedics under laboratory conditions.

The validation protocols were performed in accordance with AAMI ST79:2017 Steam Sterilization and Sterility Assurance in Health Care and AAMI ST79-2017 Containment Devices for Reusable Medical Device Sterilization. Be sure to sterilize in FDA cleared sterilization wraps or pouches. In accordance with our validation results, the following cycles are recommended for wrapped goods:

- Use a validated, properly maintained and calibrated steam sterilizer following the manufactures recommendations to ensure that the maximum load is not exceeded.
- Effective steam sterilization can be achieved using the following cycles:
- Dynamic Air Removal Steam Exposure Temperature
    - 132C (270F) Exposure Time- 4 minutes
    - Minimal drying time- 30 minutes, Minimal cooling time- 30 minutes
- Store sterile packaged implants in a manner that provides protection from dust, moisture, insects, vermin, and extremes of temperature and humidity

Storage and Shelf Life

Additive Orthopaedics Patient Specific Talus Spacers that have been wrapped to maintain sterility should be stored in a constant, well-regulated environment for temperature and humidity. Devices should not be subject to environmental extremes including temperature and moisture. Care must be exercised in the handling of wrapped devices to prevent damage to the sterile barrier. The health care facility should establish a shelf life for wrapped devices based upon the type of sterile wrap used and the recommendations of the sterile wrap manufacturer. The user must be aware that maintenance of sterility is event-related and that the probability of a contaminating event increases over time, with handling, and whether woven or non- woven materials, pouches, or container systems are used as the packaging method.

Clinical Data

Data from 32 cases in 31 patients were evaluated to demonstrate the safety and probable benefit of the Patient Specific Talus Spacer when used in the indicated population. The data collection was approved by the Duke University Institutional Review Board.

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The primary safety endpoint was the proportion of patients who underwent a secondary subsequent surgical intervention ("SSSI"). Other safety endpoints assessed included adverse events ("AEs"), device or procedure related AEs, AEs by severity, and serious AEs ("SAEs").

The probable benefit endpoint was the reduction in baseline level pain following surgery using the Visual Analog Scale ("VAS") for pain. The secondary probable benefit endpoints assessed included ankle range of motion ("ROM") and Foot and Ankle Outcome Scores ("FAOS"). FAOS subscales, pain, symptom (stiffness, swelling, etc.), activities of daily living ("ADL"), ability to perform sports and recreational activities ("Sport/Rec"); and foot/ankle-related quality of life ("QoL") were also assessed.

A summary of the patient demographics is provided below in **Table 1**. Thirty-one (31) patients were treated for a total of 32 operations; 1 patient had a Patient Specific Talus Spacer implanted in both the left and right ankles.

Table 1: Patient Demographics

Age (n=31)	
Mean±SD	43 ± 15.3
Range	20-69
Gender (n=31)	
Male, n (%)	8 (25.8%)
Female, n (%)	23 (74.2%)
BMI (n=31)	
Mean±SD	31 ± 6.96
Range	20-48
Smoking Status (n=31)	
Current, n (%)	4 (12.9%)
Former, n (%)	3 (9.7%)
Never a smoker, n (%)	24 (77.4%)
Laterality (n=32)	
Left, n (%)	17 (54.8%)
Right, n (%)	13 (41.9%)
Both, n (%)	1 (3.2%)
Prior Surgeries (n=31)	
0, n (%)	15 (48.4%)
1, n (%)	9 (29.0%)
2, n (%)	5 (16.1%)
≥ 3, n (%)	2 (6.5%)

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Safety

Adverse event data was collected during the study. Three (3) related adverse events were reported in 3 cases: 2 pain events related to the treatment and 1 scar tissue formation event related to the treatment that resulted in a superficial peroneal neuroma. A table of related adverse events is provided below:

Table 2: Related Adverse Events

	AEs	Total Patients with AEs n (%)
Any AE	3	3 (9%)
General Disorders and Administration Site Conditions		
Chills	0	0%
Impaired Healing	0	0%
Mechanical Complication of the implant		
Pain	2	2 (6%)
Pyrexia	0	0%
Wound Necrosis	0	0%
Infections and Infestations		
Infection	0	0%
Superficial	0	0%
Deep	0	0%
Injury, poisoning and procedure complications		
Loosening of the device	0	0%
Fracture	0	0%
Inury	0	0%
Joint Injury	0	0%
Post procedural haematoma	0	0%
Musculoskeletal and connective tissue disorders		
Myositis	0	0%
Soft Tissue Necrosis	0	0%
Scar Tissue	1	1 (3.1%)
Skin and Subcutaneous tissue disorders		
Blister	0	0%
Skin Necrosis	0	0%

In addition, there were 3 reoperations reported in 3 of 32 cases (9.4%). Two (2) of the reoperations are unrelated to the Patient Specific Talus Spacer or the associated procedure, and are most likely due to pre-existing comorbidities, while 1 reoperation

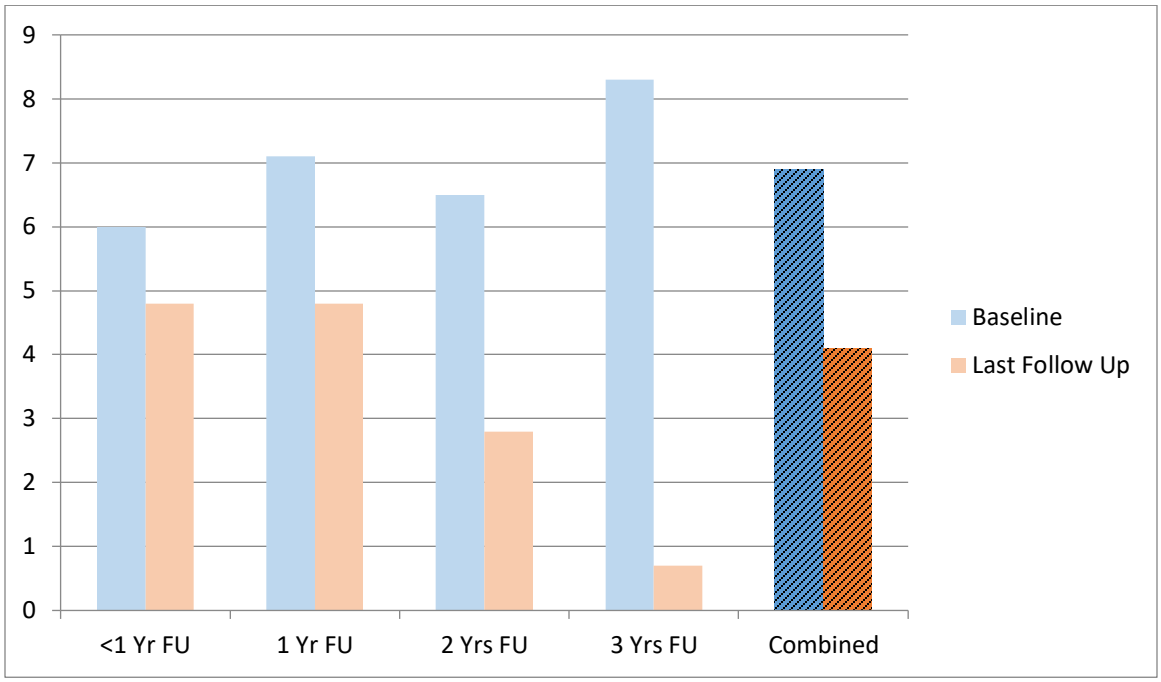
was related to the treatment and is associated with the scar tissue reported in **Table 2** above. In one patient, irrigation and debridement of tissue near the surgical site was required 6 months after the surgery to promote healing of the infected tissue and contracture with tibial anterior release. The infection was associated with a prior surgery for a vascularized pedicle graft. Approximately 3 years after the procedure, a below the knee amputation was performed to address an underlying neurological condition. The reoperation for this patient is not related to the treatment. Another patient underwent surgical treatment of superficial peroneal neuroma ("SPN") after implantation of the device. Although neuromas are generally uncommon, they may occur after direct trauma or operation. This event was classified as possibly related to the treatment procedure. The third patient experienced progression of talus AVN to tibial AVN, after implantation of the Patient Specific Talus Spacer. This patient presented pre-operatively with cancer with widespread AVN in lower right extremity. The patient ultimately underwent revision surgery with a total ankle replacement ("TAR"). Chronic pain, including prior to the Patient Specific Talus Spacer procedure, was a long-term problem for this patient, thus it was not related to the treatment.

Probable Benefits

VAS pain scores were assessed prior to treatment and at the most recent follow-up time point, as shown in **Figure 1**. The total study population, as well as each cohort, experienced mean improvement on VAS pain; across cohorts the magnitude of the improvement was positively correlated with the duration of follow-up.

At baseline, the mean VAS score for the study population was 6.9 cm ± 2.0 and scores ranged from 3-10 cm, with 10 representing maximum pain intensity. Mean change from baseline for the entire study population was -2.8 cm ± 3.1. For the cohort analysis, mean improvement from for the <1 year, 1 year, 2 years, and 3 years cohorts was -1.2 cm ± 2.7, -2.2 cm ± 2.8, -3.7 cm ± 2.3, and -7.7 cm ± 3.2. Thus, improvement on VAS pain was consistent across duration of follow up. As anticipated, due to the lengthy recovery period associated with this patient population, VAS pain outcomes improved on average the longer the follow-up period.

Figure 1: VAS Pain (cm) - Mean Baseline and Last Follow-Up by Duration of Follow-up



Ankle ROM values were assessed for each patient, and reported based on the last follow-up data (**Figure 2**). The data summary presents outcomes for the entire study population, as well as by cohort based on duration of follow-up period (i.e., < 1 year, 1 year, 2 years, and 3 years).

As anticipated, patients still in active recovery from the device procedure (i.e., < 1 year of follow up) reported deterioration from baseline; the other cohorts either reported mean improvement or no change. When patients with < 1 year of follow up are excluded from the study population the mean improvement for the remaining subjects is 5.9 degrees. Patients with 2-year follow-up data showed the greatest mean improvement in ankle ROM compared to baseline (25 degrees).

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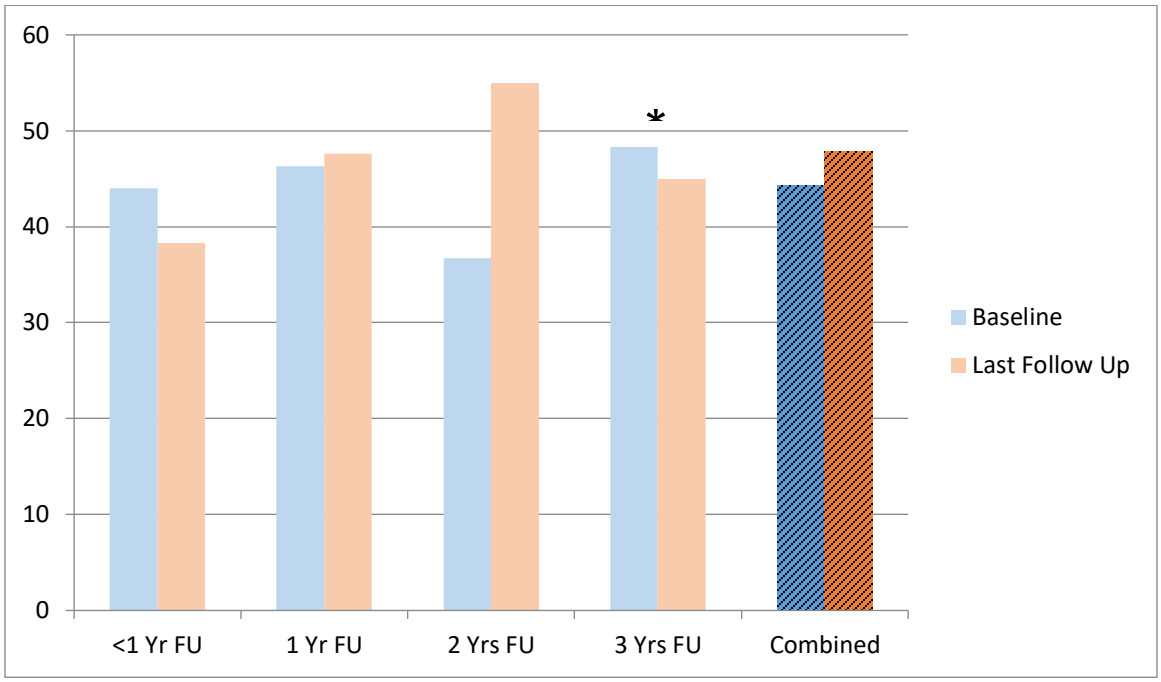
Figure 2: Ankle ROM - Mean Baseline and Last Follow-Up by Duration of Follow-up



*In the 3 Yr Cohort, while mean ROM at last follow up is lower than baseline, the mean change from baseline to last follow up still showed improvement.

Average combined FAOS score, as well as each separate subscale (Pain, Symptoms, Sport/Rec, ADL, and QoL), were assessed pre-operatively and post-operatively. The mean change for FAOS average combined score and each subscale are reported with the last follow-up data combined (**Figure 3**). The data summary presents outcomes for the entire study population. As seen in **Figure 3** below, patients showed an increase for each subscale at the last follow up.

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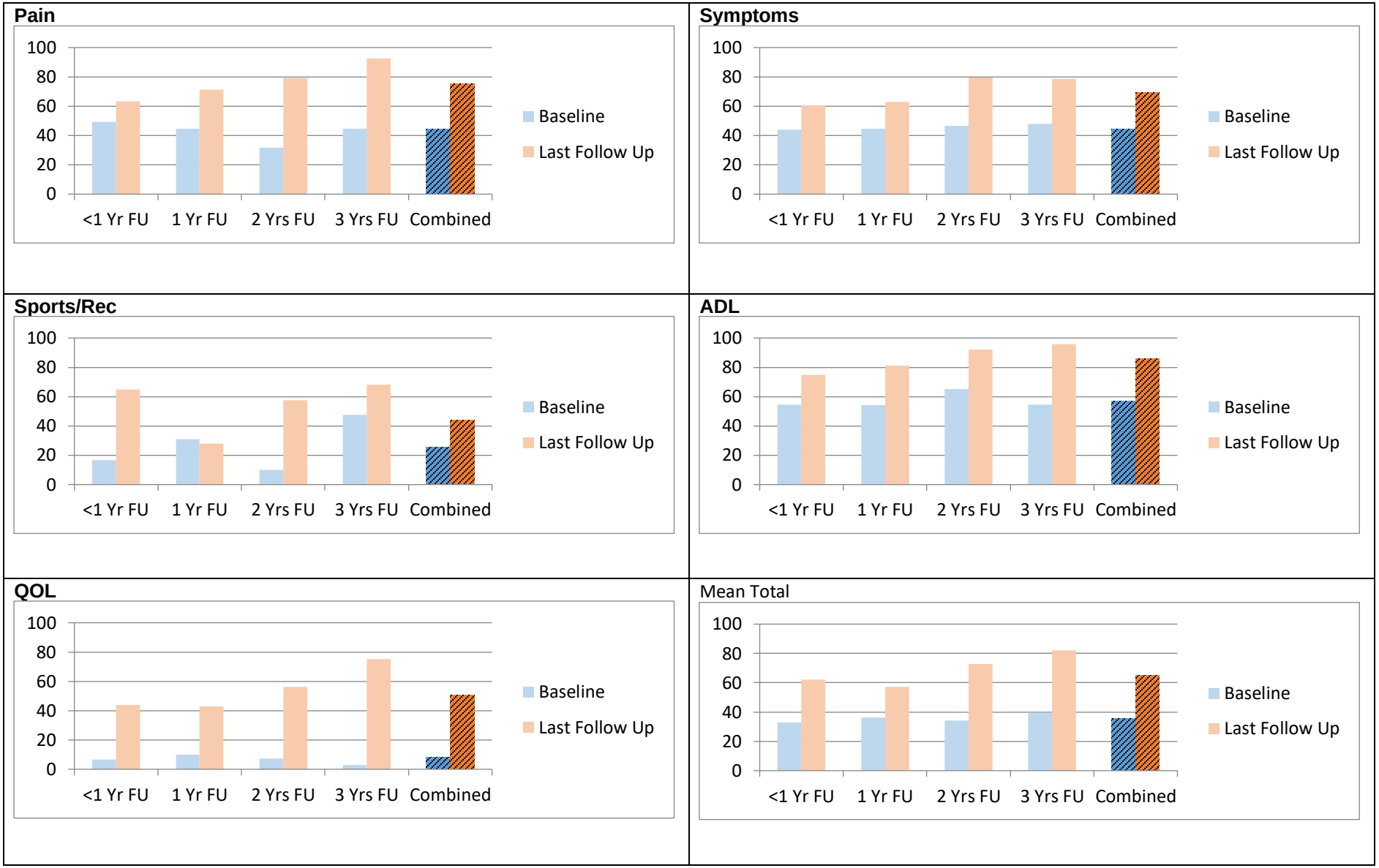
Figure 3: Mean FAOS Subscales Mean Baseline, Last Follow-Up and Change from Baseline by Duration of Follow-up



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Conclusion

The patients who were implanted with the Patient Specific Talus Spacer in the above study received a clinically meaningful probable benefit from the device. As discussed above, baseline VAS pain score were reduced by -2.8 cm postoperatively, from 6.9 cm (moderate to severe pain) to 4.1 cm (mild pain). ROM also improved on average, especially when limiting the analysis to those patients who had at least 1 year of follow-up and thus had adequate time to rehabilitate. Functional outcomes based on FAOS subscales also improved, with average improvement on all subscales exceeding the associated MIC threshold except Sport/Rec. Moreover, the rate of reoperation was low, with 9.4% of cases resulting in reoperation. Improvement in pain and function measures, accompanied by a low rate of reoperation, is particularly meaningful to AVN talus patients who have limited options and high risk of needing to undergo fusion or amputation. The favorable probable benefit to risk profile of the device is further demonstrated by the activity levels reported for some patients post-operatively, which include returning or continuing in their career, engaging in recreational activities, and returning to walking.

Packaging and Labeling

- Additive Orthopaedics LLC devices should be accepted only if the factory packaging and labeling arrive intact.
- Contact customer service if the package has been opened or altered.

Symbol	Description
	Catalog number
	Lot number
	Manufactured by (legal manufacturer of device)
	Date of Manufacture

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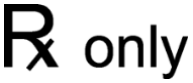
	Do not re-use/single use only
	Expiration date/use-by date
Symbol	**Description**
	Caution: U.S. federal law restricts this device to sale by or on the order of a physician.
	Do not use if package damaged
	Non-sterile
	Caution, consult accompanying documents

Recommended CT Scanners:

- GE/Lightspeed RT 16*
- GE MEDICAL SYSTEMS BrightSpeed*
- GE MEDICAL SYSTEMS Discovery CT750HD*
- GE MEDICAL SYSTEMS LightSpeedVCT*
- Siemens/Sensation 64*
- Siemens/Sensation 65*
- Siemens/Somatom Definition AS*
- Siemens/Somatom Definition Flash*

**The average exposure time for the patient is 1681 ms. Please refer to the manufacturer's instructions for use for more information regarding patient dose. The CT Scanners use a helical CT image acquisition with a reconstruction algorithm of Moderate / Soft Tissue or Equivalent.*

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Additive Orthopaedics understands the concern about keeping the radiation doses to patients as low as possible; therefore, please use these guidelines as appropriate for your patients." For general radiation safety concerns, you may wish to additionally reference publicly available information such as Imaging Wisely or FDA's Computed Tomography webpage http://www.fda.gov/Radition-EmittingProducts/RadiationEmittingProducttsandProcedures/MedicalImaging/MedicalXRays/ucm115317.htm)

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