Implant arthroplasty versus arthrodesis for end stage hallux rigidus

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End stage arthritis of the first metatarsophalangeal joint (MTPJ) is a debilitating condition that affects thousands of patients yearly. The treatments for it have been well known and studied for many years, however, controversy still remains with the different surgical options available. Arthrodesis has always been considered the mainstream treatment for advanced hallux rigidus, but with newer technologies and development of more functional implants, implant arthroplasty has become more popular and may someday surpass arthrodesis. The purpose of this paper is to review the two procedures and provide a literature-based comparison of the overall outcomes. Three retrospective studies with variable methods were reviewed and used to compare the two procedures and their results. Utilizing this data, it was concluded that arthrodesis produces overall superior results with better patient satisfaction and fewer complications, but has lower functionality as it does not restore the first MTPJ motion.

Key words: Hallux rigidus, arthrodesis, implant arthroplasty.

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End stage arthritis of the first metatarsophalangeal joint is a painful condition that results in significant limitation of motion of the joint. The condition has been well documented and studied over the years, however, surgical treatment still remains controversial. There are numerous surgical options which can be categorized into joint destructive and joint sparing procedures. Our main focus is to compare arthrodesis and implant arthroplasty for the treatment of end stage hallux rigidus.

Etiology

There are two main causes of hallux rigidus; congenital or adult-acquired. The congenital form has an onset during the teenage years caused by an underlying structural deformity such as an abnormally long hallux proximal phalanx or a long first metatarsal. The adult acquired form typically affects patients in their 40’s or 50’s due to high impact activities such as running or dancing. Abnormal biomechanics of the foot contribute to hallux rigidus which includes excessive pronation, hypermobile first ray, or metatarsal primus elevatus. Hallux rigidus is most commonly seen bilaterally, however, it can be seen unilaterally in cases when trauma is the cause of the pathology. Other causes include neuromuscular imbalance, metabolic disorders, or post-surgical complications.
Clinical Presentation

Initially, the patient will present with a painful and stiff big toe joint specifically with weight-bearing forces or increased during activity. Activities that require excessive extension of the first MTPJ will exacerbate the symptoms [3]. They will complain of pain at the first MTPJ when wearing high heeled shoes. Patients may complain of pain with certain shoes due to soft tissue irritation from rubbing of the shoe gear. In earlier stages of the arthritis, pain will mainly be present with palpation to the dorsal aspect of the first metatarsal head with a possible palpable dorsal exostosis on physical exam. As the condition progresses, pain will be present during passive end range of motion of the metatarsophalangeal joint. With severe arthritis, there will be crepitus and pain during midrange motion of the joint. Gait alteration or compensatory changes may also cause lateral metatarsalgia [3]. Other common clinical findings include plantar hyperkeratotic lesions specifically at the plantar aspect of the hallux IP.

Classification

Today, the most widely used classification for hallux rigidus remains the Regnauld Classification as described below [1]:

- Grade I: Mild limitation of dorsiflexion, mild dorsal spurring, pain, no sesamoid involvement, subchondral sclerosis, mild sesamoid enlargement.
- Grade II: Broadening and flattening of the metatarsal head and base of the proximal phalanx, focal joint space narrowing, structural first ray elevatus, osteochondral defect, sesamoid hypertrophy.
- Grade III: Worsening loss of joint space, near ankylosis, extensive osteophyte formation, osteochondral defects, extensive sesamoid hypertrophy, with or without joint mice.

Treatment for hallux rigidus can be divided into 2 groups: joint sparing versus joint destructive procedures. Joint sparing procedures include cheilectomy, first metatarsal osteotomy, and phalangeal osteotomy.

Figure 1 Radiographic evaluation of hallux rigidus as described by Regnauld. Images A/B corresponds with Grade I/II Regnauld. Images C/D corresponds with Grade III. Images E/F corresponds with Grade IV.

Surgical Treatment

Joint destructive procedures include excisional arthroplasty, implant arthroplasty, and arthrodesis. The procedure chosen is determined by the underlying deformity or the stage of hallux rigidus. In the earlier stages, cheilectomy or a decompression osteotomy of the first metatarsal is sufficient to relieve patient symptoms. However, the patient should be made aware that hallux rigidus is a progressive disorder and further surgical intervention in the future may be necessary. For the later stages of hallux rigidus, implant arthroplasty and arthrodesis are the most viable available options. Prior to any procedure, every surgeon must take into consideration each patient’s biomechanical factors, lifestyle, age, activity level, as well as their overall short-term or long-term expectations to the surgery [2]. Surgeons must also consider their own past outcomes as well as experience and comfort level with the types of procedures proposed [2].
Implant arthroplasty

Implant arthroplasty for the first MTPJ was first introduced in the 1950’s, however, it became more mainstream in the early 1970’s when Dow Corning’s Silastic implant gained widespread use and acceptance [4]. Within a few years of its use, however, various complications resulted from the implant such as reactive synovitis, fractures of the material, fibrous hyperplasia, and lymphadenitis which discredited these implant [4]. In the late 1970’s to early 1980’s, a variety of new designs created by Swanson, LaPorta, Lawrence, Sgarlato, and Hetal aimed to eliminate these complications by creating new hinged, non-articulating silicone implants with the addition of grommets [4]. These implants were later referred to as second generation first MTPJ implants. The 1990’s brought about different materials such as metallic hemi-implants (unipolar) or total joint implants (bipolar) which reduced the complications from the traditional silicone implants and are still used today.

These newer implants are referred to as third generation first MTPJ implants [5]. The development of these third-generation implants was a result of advancements in technologies and an improvement in the properties of silicone elastomers. [4]. Lawrence et al published a study in March 2013 which discusses the success of these new third-generation implants in 54 patients with 70 implants having an average follow up period of 66.4 months. Patients had an average postoperative American Orthopaedic Foot and Ankle Society (AOFAS) score of 88.2 and an average VAS score of 8.5 with 10 being the highest [4]. Very little data is published in the long term success for some of the latest designs, but technology continues to evolve with new advancements in foot and ankle orthopedic biologics being made every day. Although implants have been around since the 1950’s, they are still evolving and changing, and therefore considered investigational in the minds of some surgeons.

Arthrodesis

Arthrodesis remains the gold standard surgical treatment for end stage 1st MTPJ arthritis with predicable outcomes and patient satisfaction. The procedure was first described in 1984 for the treatment of hallux valgus. Although joint functionality is decreased since the motion is completely eliminated, the procedure provides stability through the medial column for a plantigrade foot during ambulation and a stable lever arm for propulsion [3]. Therefore, this procedure is often indicated for patients with an active lifestyle allowing them to return to their daily recreational activities without painful motion at the joint [1].

The main focus for a successful procedure and better overall outcome is not so much the technique used but rather the position of the fusion. The sagittal plane position is determined by the normal declination of the first metatarsal relative to the floor and transverse plane position is based relative to the lesser toes [3]. The hallux should be positioned in 10° of dorsiflexion relative to the weightbearing surface and 15 to 20° of abduction ensuring that the hallux does not impinge against the second toe [6]. In addition, the frontal plane and rotational correction should be maintained in a neutral position making sure the toenail faces straight upward [6]. Fixation is based on surgeon preference but most commonly used with the greatest success are dorsal plates or crossed cannulated screws. Non-union rates for arthrodesis range from 0-23% with union rates ranging from 91-100% [1].

Data

Multiple studies on arthrodesis and implant arthroplasty have been performed with sufficient long term follow-up comparing the two procedures. We reviewed three recent articles describing results from both procedures in attempts to compare outcomes of 1st MTPJ arthrodesis and implant arthroplasty. One study published in 2012 by Kim et al looked at 158 patients (105 female and 53 male). The patients had undergone one of three procedures: arthrodesis, hemi-implant or resectional arthroplasty. The patients were followed for an average of 159 weeks. Function, alignment and subjective assessment of pain were evaluated and their outcomes determined were successful procedure versus need for further intervention. Out of the 158 patients, 51 underwent arthrodesis, 52 hemi-implants and 55 resectional arthroplasty. There were three revisional surgeries performed, two with bone graft and one without.
In the arthrodesis group, complications included non-union, malunion, metatarsalgia and continued first MTPJ pain. Complications in the hemi-implant category included radiolucency around the implant, bony overgrowth into the joint, migration into the joint, dorsal drift of the hallux, cystic changes to the implant, metatarsalgia, elevation of the first ray, subsidence of the implant and continued first MTPJ pain. Two revisional surgeries were performed for this category with removal of implant and resectional arthroplasty. Complications of the arthroplasty group included floating hallux, metatarsalgia, sesamoiditis and remodeling of the first metatarsal head. There were no revisional surgeries required for this group. No statistical significant difference was found when comparing the procedures for function, alignment and subjective pain with an average follow up of 3 years.

A second study published by Raikin et al, in 2008 performed 21 hemi-arthroplasties and 27 arthrodesis in 46 patients. The patients were followed for an average of 79 months. The patient satisfaction rates were quantified in four categories: excellent, good, fair and poor. The outcomes for the hemiarthroplasty were excellent or good for 12 cases, fair in two cases and poor or failed in seven. The mean pain score level was 2.4 out of 10. There were five hemiarthroplasties that failed, four were revised into arthrodesis and one into revisional hemiarthroplasty. The fusion rate was 100% for the 27 arthrodesis and no revisional surgery was required. The patients were followed for a mean of 30 months and the outcomes for the arthrodesis group was twenty-two excellent or good, four fair, and one poor. The mean pain score level was 0.7 out of 10.

The most recent study conducted by Erdil et al, published in 2013 reviewed 38 patients who had a total joint replacement, hemiarthroplasty or arthrodesis and were followed for at least two years. Out of the 38 cases, 12 were total joint replacement (group A), 14 were hemiarthroplasties (Group B) and 12 were arthrodesis (Group C). Complications of the procedures included one superficial soft tissue infection (Group A), One non-displaced first metatarsal fracture due to non-compliance (Group A), metatarsalgia (Two in group A, Two in group B and Three in group C) and delayed union. There were no major complications that required revisional surgical intervention and were resolved with conservative treatment. Functional outcomes were evaluated using American Orthopaedic Foot and Ankle Society-Hallux metatarsophalangeal interphalangeal (AOFAS-HMI) scale and Visual analog scale (VAS). With regards to AOFAS-HMI score there was no significant difference between groups A and B. Group C had a significantly lower AOFAS-HMI score which was expected due to the lack of range of motion. With regards to the VAS score there was also no significance between groups A and B. The VAS score was also decreased in group C.

Discussion

First metatarsophalangeal joint implant arthroplasty versus arthrodesis in hallux rigidus is a controversial topic and most often depends on each individual case presentation. The studies mentioned above cover multiple methods to quantify each procedure. The first study focused on function, alignment and subjective pain. The second looked at patient satisfaction, and the third study looked at orthopaedic functionality and scoring post surgically. This variety allows us to best analyze the outcomes of each procedure.

The first study by Kim et al. indicated similar long term overall patient satisfaction with both arthrodesis and hemi-implant. The arthrodesis had the least amount of complications and revisional surgical intervention needed but this did not affect the final results as there was no statistical significance in the patient subjective scores. In the study by Raikin et al. where patient satisfaction and pain level were evaluated, arthrodesis supersedes hemiarthroplasty. There were fewer complications with arthrodesis as seen in the other two studies. The study by Erdil et al. also revealed that fewer complications were seen in the arthrodesis group, although the biomechanical functionality is decreased. The total joint and hemiarthroplasties were also successful procedures in this study so they suggested that arthrodesis be considered a salvage procedure if functionality needs to be preserved.
In conclusion, arthrodesis in cases of advanced hallux rigidus is the most successful and reliable procedure when every criteria is taken into consideration. Besides low functionality and maintaining the integrity of the joint, it provides fewer overall complications, lower revisional rates, and higher patient satisfaction. Nonetheless, hemi-arthroplasty and total joint replacement are also viable options that need to be considered in every case, specifically for patients that are less active and wish to maintain their first MTPJ motion.

References