** An Original Paper**

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**Cartilage erosion and outcome predictability in hallux valgus**

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Cartilage mapping might offer some prediction in regard to long-term outcomes of first toe pathology or so Thomas Roukis (2005) suggests. This paper considers the evidence that might support this hypothesis. All clinicians desire to help patients and there are no reasons why earlier interventions should not be the goal to prevent surgery being required.

Not every patient with a hallux valgus or hallux rigidus requires surgery, if symptoms can be allayed. The primary question relates to the prediction of a strategy related to the location of osteochondral lesions. Are specific criteria such as hallux valgus angle and the articular angle of the metatarsal head together with long or short metatarsal lengths useful as criteria for intervention? Often unstated, the metatarsal-sesamoid joint relationship creates the highest focus when studies start to analyse zones affecting this joint complex. To exclude the sesamoid apparatus from assessment could lead to some patients being disappointed.

# http://consultingfootpain.co.uk/wp-content/uploads/2018/11/clinical-factsheets-300x150.jpg****Introduction****

Many papers on hallux valgus concentrate on surgery with little evidence on conservative care. Deformity plays less of a role in why patients come to us (Tollafield 2019).  Dayton (2018) cites others suggesting that pain arises from the medial eminence (70-75%) and from intractable plantar keratoma (IPK) and metatarsalgia (40-48%). Secondary features generally drive patients to seek assistance (**Table 1**).

Deformity and arthritis of the first toe joint did not determine joint pain as much as general health, educational attainment and level of physical activity (Hurn el al, 2014). The statistics covering pain (62%) and deformity (37%) were derived from the database PASCOM-10, a tool used by the College of Podiatry covering 1030 responses with 571 statements. The data is skewed toward surgical consultations. Referrals arise in the main from medical practitioners with the purpose of surgical discussion in mind. Pain, discomfort and difficulties with walking and wearing shoes are placed into the 60% group of the complainants for this first toe condition (Tollafield 2019). The idea of using RICE, the mnemonic for rest, ice, compression and elevation, might appear ideal but this is not always practical for patients who do not have acute pain, except maybe for gout or turf toe injury. But what of pain associated with the chronic condition? RICE can still be applied but managing pressure and stabilising the joint forms the key management strategy. Metatarsalgia can be arrested depending upon patient footwear considerations in relation to orthoses and insole prescriptions.

# What are the objectives of treatment?

There is probably little doubt that surgical papers predominantly refer to cartilage damage in passing without meaningful conclusion. One should ask, does it matter? The podiatrist needs to know how to use the information reliably to inform patients of prognosis.

##### **Should a patient have an intervention and what intervention is best?**

Protecting soft tissue should be paramount as in footwear, local padding or devices suited to protecting the first toe prominence. Splints and taping all have a part to play but no-one has studied the effect on hallux valgus degeneration emanating from erosions within the conservative arena. It is only once patients present for surgery that the evidence becomes observable.  When considering the paucity of information on conservative care, the best insight into the effect of treatment comes from Grice et al (2017). This paper helps identify the concept of timeline by recording limitations from steroid injections. The problem with Grice’s steroid injection study is that it is specific for hallux rigidus. The conclusion that one must draw is that more questions remain unanswered than answered. We need to bear in mind that the time of treatment in the scheme of symptoms and progressive pathology cannot be ignored.

## **Evidence from Imaging**

##### **X-rays**

X-rays are the primary diagnostic tool for most practices in considering first MTP joint pain. They are relatively cheap and safe due to modern safety regulations. A report that comes from a medical doctor (and sometimes extended scope radiographer) may contain the word ‘arthritis’. Radiologists train to consider the joint space and small changes around the joint to rely on such a diagnosis. There have been a number of different grading methods and for the most part these have not been tested for reliability, specificity or validity.



LEFT - cartilage damage in a young person. RIGHT -schematic with x-ray with loss of joint space

Bock et al (2004) looked at the reliability of x-rays against two methods of recognised evaluation. The Kellgren-Lawrence scale 1-4 showing different levels of deterioration by radiographic interpretation, and secondly, the International Cartilage Repair Society scale (ICRS; 1998). In an ideal world there should be reasonable comparison, but 54% (144) underestimated the presence of degeneration and 11% (29) overestimated the presence of degenerative changes. Around 35% (92) agreed with the intra-operative scale using the ICRS. [**Table 2**](http://consultingfootpain.co.uk/wp-content/uploads/2021/01/Tables-1-to-3-Erosive-cartilage-mapping.docx) shows the Kellgren-Lawrence scale for radiographic interpretation of damage in hallux valgus

##### **Magnetic Resonance Imaging**

The use of **M**[**agnetic Resonance Imaging**](https://en.wikipedia.org/wiki/Nuclear_magnetic_resonance)(MRI) is still in its early stages of use for hallux valgus. This is clearly due to cost and access even in strong health economies. The MRI however is the ‘go to tool’ in orthopaedics (Choi et al, 2018). Of the MRI they state;

‘considered the most suitable tool to observe soft tissue structures including tendons, ligaments, menisci, and articular cartilages. However, MRI is not usually performed before correcting hallux valgus deformity.’

It is always more ideal to use recent papers but Choi cites Schweitzer M.E, 1999 and says the study was limited by numbers;

‘The most common findings observed in hallux valgus were hypertrophic medial eminence (95%), sesamoid proliferation (90%), and adventitial bursitis (90%). They also found that osteophytes (77%), subchondral cysts, and bone marrow edema were commonly found with hallux rigidus.’

The use of MRI for sesamoid degeneration suggests that increasing lateral shift of the medial sesamoid bone is associated with worsening degenerative change within the medial sesamoid-metatarsal complex, Katsui et al (2016). Choi (South Korea) believes that MRI would provide accurate and valuable information about the arthritic changes. MRI in fact is not as useful after surgery because any metal work will degrade the accuracy of the joint site depending upon its proximity. Computerised tomography might offer a better choice.

##### **Arthroscopy**

The use of intra-articular investigation or [**arthroscopy**](https://www.nhs.uk/conditions/arthroscopy/) is probably still in its infancy compared to knees and ankles. Fibre-optic cameras are now small enough to insert into the mtpj as recorded by Lui (2008) cited by Villas (2012).

#### **Objectives of studies**

Roukis et al (2005) set out to consider the predictive aspect of analysis between clinical, radiographic and intra-operative findings. Roukis’ paper was published a year later than Bock (2004). Bock cited the presence of lesions in terms of the ICRS grading but did not look at mapping. In terms of validity or observer validation the ICRS was reviewed by Van den Borne et al (2007) for 7 observers, while Smith (2011) considered the ICRS for 2 observers reporting on first toe joint erosive mapping. [**Table 3**](http://consultingfootpain.co.uk/wp-content/uploads/2021/01/Tables-1-to-3-Erosive-cartilage-mapping.docx) International Cartilage repair society grading for erosive changes based on depth.

### http://consultingfootpain.co.uk/wp-content/uploads/2021/01/cartilagemap-300x221.jpg

### **Mapping cartilage lesions**

international cartilage repair society score 1-4 as in first toe joint

Roukis et al (2005) provided the first mapping exercise on live patients rather than falling back on cadaveric studies. Such studies may have predominated previous work on cartilage defects (Scranton & Rutowski,1980) where sesamoids were blamed for erosive changes. Roukis cites Dereymaeker (1996), where erosive changes existed under the first toe joint in cadaveric studies. Such studies tend to use subjects that fall into an older age bracket. Broadening the subject’s age offers a fresh view and a wider age perspective but living subjects are preferred.

The top layer of cartilage, the pearly white material (lamina splendins) accounts for 5-10% of the thickness of cartilage. However, the chondrocyte content is low (0.4-2%) relying on the specialised effect of collagen fibres, proteoglycans and water. The deeper two zones do not play an immediate part in dealing with stress. Any replacement that does arise will repair with fibro-cartilage, Walsh et al (2007).  Adaption to cartilage and bone is seen in hallux rigidus around the dorsal elements of the first mtpj anatomy. Roukis et al (2005) suggested erosive cases existed in a 100% over the age of =/>50 in a study of 166 feet affecting one or other part of the mtpj. Jastifer et al (2014) found 91% in his patient cohort had osteochondral lesions in 56 consecutive feet. The numbers may appear low when compared to a study by Bock et al (2004), Austria, who reported 73% of their 265 joints (196 patients) had erosions.

#### ***Schematic features studied***

Jastifer et al (2014) used the ICRS scale for observation damaged and also followed 79% patients for two years. It is only by following patients for any length that we can work out the of the timeline effectapplied to treatment.

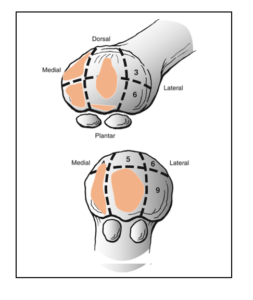


Figure 1.  
Common areas of erosions across all papers. Adapted by author from Jastifer et al (2014)

# ****Are we better informed?****

Bock (2004) looked at the comparison between radiology and cartilage damage with the backdrop of x-rays. Roukis considered the principle 13 zone map and concluded the common zones affected. Roukis also considered measurable parameters such as angles between common joints and bone relationships hoping to provide indications of which presentation might afford a greater predisposition to an erosion. This included the proximal articular set angle (PASA), hallux angle (HA), intermetatarsal angle (IMA 1-2) and tibial-sesamoid position/joint (TSP)/TSJ). Roukis felt that such angles could help predict the incidence of likely lesions but this was speculative. Jastifer (2014) does not wholly agree with Roukis on the angles of deformity and relationship with erosions. Improved imaging is likely to help the clinician without recourse to surgery. The involvement of the TSJ relationship is still unclear but, on balance, will require more work in regard to affecting the range of movement and joint pain.

Although 6 years old, Jastifer’s paper (2014) is the latest in a small series on first MTP joint erosions. Their conclusion however suggests that the grade of the cartilage lesion and extent of lesions do not have a strong correlation with the severity of the deformity. And yet we know that as the deformity increases, the number of lesions found do increase. Jastifer found similar findings for the most frequent locations. The medial inferior and superior zones held the greatest frequency but this was not universally found between all authors. Medial wear was considered due to compression forces, rotation of the metatarsal head as the deformity increases and the effects of medial ligament strain.

As the deformity leads to subluxation, could the loss of the integral lubrication system lead to desiccation and easier tangential wear? Disuse atrophy is widely recognised alongside the medial sagittal groove. Dayton et al (2013) consider the medial eminence rarely requires resection because it is part of (eversion-valgus) frontal plane rotation and yet we know this is routinely performed by foot surgeons. If this is corrected the medial prominence is minimised.

#### http://consultingfootpain.co.uk/wp-content/uploads/2021/01/axialviewssesamoid-300x178.jpg

#### Metatarso-sesamoid articulation

relationship of sesamoids and metatarsal

Sesamoid displacement is easy enough to assess from x-rays, but the correlation with actual erosive changes is less robust. The confounding features of erosive changes in the first MTP joint are compounded by the fact that two sesamoids articulate with the remaining first MTP joint. Males showed more erosive zones when a demarcating map drew 13 different locations, Roukis. As the age of the participants increased, the number of zones involved increased as well as the incidence of a lesion. A long toe (66%) was considered more likely to be involved when compared to a second, shorter toe, but this only related to one of the zones; at the inferior medial surface. Conversely fewer erosions were seen when the toe in relation to the second digit was shorter, Roukis et al (2005). Medial erosions predominated while the lateral side was spared more often (Figure 1).

The proximal articular set angle or PASA, was associated with the inferior central zone erosions. This is an angle of the head of the cartilage cap upon the first metatarsal. It has been considered to have been adapted in shape and position over time as well as being part of development. Breslauer et al 2001 used cadaveric studies and applied these to patients to show that the metatarsal rotated to increase sesamoid impingement against the crista. They believed that capital osteotomies to correct the PASA angle increased the risk of metatarsal-sesamoid joint damage creating stiffness. Rounded joints fared better than ridged and square joints although the relevance of joint shape still remains unproven by a number of previous authors. There is a suggestion that an increase PASA (norm = 0-8) above 8 degrees is likely to lead to more erosive changes.

# Hypotheses and paradigms

Dayton et al (2013/2015) provided evidence to support a hypothesis that lack of frontal plane correction reduced the ability for the tibial sesamoid relationship with the crista to recover from a higher displaced position in the transverse plane (TP). Correction of the TP and sagittal plane (SP) deformities alone were reasons for failed surgery. The importance of using an axial, often called skyline, view comes into play to help understand the sesamoid position. This x-ray view depends on the expertise within the radiology department.

### **Getting closer to the answer?**

While we cannot make an assumption regarding the incident of erosions in clinic, we have to rely on imaging, or intra-operative findings.

One question we must ask is, do erosive changes make a difference to treatment outcome?

The problem with this question is that unless you open up a joint, or, technology willing, place an arthroscope into the joint, you have to rely on MRI or CT scanning. The latter has the disadvantage of producing larger radiation doses. The means might not justify the ends if the risks are seen to outweigh the benefits.

As far as erosive lesions, we can say that it is more likely than not that patients with pain associated with the first MTP joint will have erosions above 50% of cases. What of those without painful symptoms? With insufficient data available on the subject of pain alone, our joint-related research must continue to look for more evidence. We need numbers and we need controls, but we also need reliable diagnostics. Current research tends to use smaller numbers than older research for therapeutic activity. Ethical consideration and tighter criteria will limit active cohort participation.

#### **Informing the patient**

Jastifer makes an important statement;

‘Patients should be counselled about the prevalence of these lesions when discussing expectations from surgery but no less the role of the sesamoid articulations.’

**The problem lies in what to say to the patient?**

The significance of lesions remains unclear and yet it is reasonable to suggest that some lesions exist in critical locations and those critical locations have not been identified reliably. That the TSJ plays a part must hold some truth, especially where sesamoid pain can be identified. Jastifer followed patients for 24 months and those with 21 degrees of hallux valgus returned a good outcome in 83% of cases. Those under 21 degrees were 100% satisfied. This seems surprising when Jastifer found in 51 of 56 feet a mean score for 50mm2 surface area damage using callipers. Grades 2 and 3 for depth prevailed across most studies. And yet the general view is that surface area and depth of lesions do not contribute toward the outcome after treatment.

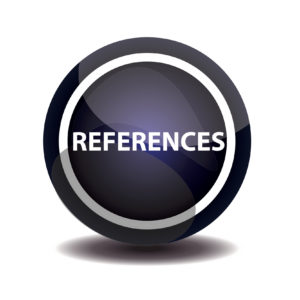
***But how much TSJ degeneration arises before symptoms arise?***

At present foot surgeons take steps to [**fuse joints**](http://consultingfootpain.co.uk/arthrodesis-definition/) or [**replace joints**](https://www.google.com/search?q=integra+silastic+toe+implant&client=safari&rls=en&tbm=isch&source=iu&ictx=1&fir=LwbxYyF_selP8M%252CNpCxVr93YcxYfM%252C_&vet=1&usg=AI4_-kQvGLL22Q2MhchJdMaj_sHhNfYgjQ&sa=X&ved=2ahUKEwic8LPry4ftAhUXQEEAHSUnDWoQ9QF6BAgKEA4#imgrc=LwbxYyF_selP8M) wholly or use resurfacing techniques. The rational for selecting surgical procedures remains inaccurate except that we can identify with Dayton’s view about the frontal plane contribution to the subject of TSJ degeneration. At best we can advise patients of the risk they might encounter from surgery based on the sesamoid involvement. As far as mapping is concerned at best it is an observation rather than a reliable prediction of which procedure and who fairs best. Of course this article covers hallux valgus not hallux rigidus and the difference seems to come down to the position of damage. Hallux rigidus has more damage in the dorsal-superior aspect while hallux valgus relates more to the plantar-inferior position.

As Dayton says,

*‘The gap between clinical sciences and bedside medicine is quite substantial.’ Dayton (2018)*

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