**Osteotomy about the Knee**

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Osteotomy is an operation whereby one of the bones about the knee is cut in order to correct an alignment problem. The usual reason for doing this is to unload a damaged (or arthritic) area on one side of the knee, moving the load to the other side of the knee. For this to be successful, the other side of the knee needs to be normal, with no evidence of wear. If this is the case, then this procedure can provide good function and pain relief for many years. When successful, which is 80 - 90% of the time in appropriate cases, the result is not only better than a knee replacement, but can delay replacement for 10 - 15 more years in most cases.

**What is osteoarthritis**

As discussed in our sheet on osteoarthritis (available on the website listed below), osteoarthritis is a mechanical wear and tear of the lining (hyaline) cartilage of the joint. It can come on because of an injury, because of meniscal failure such as a loss of meniscus on that side of the joint, or because of degenerative change. In any of these situations, if there is an underlying mal-alignment, then this will aggravate the situation by overloading that part of the joint where the weight is concentrated. Initially, osteoarthritis begins as straightforward wear in what is otherwise a normal joint, with a normal range of motion. With time however, what started out as a normal joint with some wear in it, starts to become a diseased joint where the capsule starts to become tight, leading to a loss of motion. As a consequence of this progression, the varus or valgus (bow legged or knock knee) deformity which may have initially been correctable, slowly becomes uncorrectable.

As this process further progresses, a point is reached whereby, the only treatment option is that of replacement of the joint. Up until then however, if the wear is localised to just one part of the joint, and if the other half of the joint is normal, then an osteotomy to move some of the weight bearing load to the good side of the joint, maybe an option. This not only preserves the existing motion of the joint, it also relieves pain by unloading the damaged compartment.

**What is an osteotomy**

An osteotomy is a procedure in which one of the bones about the knee is cut, and an alignment change is made, at the level of the cut, in order to transfer weight away from a damaged compartment, to a normal compartment (see opposite). By unloading the damaged compartment, pain will be significantly reduced, the rate of further wear will be diminished, and the life of the joint will be prolonged.

When the deformity is varus (bow legged), then, in most cases, that deformity is in the tibia. For this reason, any correction of that deformity, should be made in the tibia. By doing this, the joint line will remain at right angles to the weight bearing line stemming from the hip. This is important because, it means that the forces across the joint will pass directly across it, and will not cause shear forces: something...
Varus Deformity

In a straight leg, the line of force should pass from the centre of the hip to the centre of the ankle. Here the deformity is mostly in the tibia. The joint line is almost parallel to a line drawn at right angles to the line from the hip to the centre of the femur. The joint line is quite angled to a line drawn from the centre of the knee to the centre of the ankle. This shows that the deformity is in the tibia in a varus knee, hence, this is the bone where the correction should be made.

Who is suitable for osteotomy

1) The wear needs to be confined to, either the medial compartment, or to the lateral compartment, and the other compartment needs to be normal.

2) The underlying deformity, or the deformity resulting from the wear, needs to be such that, the weight-bearing line passes through the damaged compartment.

3) The patellofemoral joint needs to be relatively asymptomatic, or needs to have wear on just one side, something that can be corrected at the time of osteotomy by moving the patella. This correction may just happen as a result of the osteotomy but, where correction of the osteotomy will make this worse, separate realignment of the patella may need to be undertaken.

4) The knee joint needs to have a good range of motion and, most importantly, it needs to be able to go fully straight. If the arthritic process has progressed to the stage where motion restriction is occurring, and if that is becoming progressive, then that progression will not be halted by an alignment change. This restriction is in the joint itself, and therefore, it will still be present after osteotomy. For this reason, any significant contracture becomes a contraindication to this procedure.

5) Osteotomy requires that the cut bone goes on to solid union. Accordingly, age is a factor in this. This does not preclude osteotomy in older individuals, however, over the age of 55, particularly in women, the union rate of femoral osteotomy seems to be decreased. Similarly, in this age group, in both sexes, the union rate of tibial osteotomy seems to be decreased as well. Therefore, if osteotomy is considered the most appropriate procedure for someone in this older age that would happen if the joint line was not at right angles to the weight-bearing line.

When the deformity is valgus (knock knee), then, in most cases, the deformity is in the femur. Most people who go on to wear out the lateral side (the outside) of the knee, start life with a valgus deformity which is due to the lateral femoral condyle being hypoplastic (under-developed). When this is smaller than the medial femoral condyle, the leg is valgus.

If the tibia is normal, the joint line will be at right angles to the tibial axis. Hence, when the deformity in the femur is corrected, the joint line becomes parallel to the ground, and therefore at right angles to the weight-bearing line: that being a line which comes from the centre of the hip and passes to the centre of the ankle.

In some instances, where the deformity has arisen from trauma (such as a broken leg) the correction may need to be either at the sight of that deformity, or in the bone containing that deformity. Although uncommon therefore, correction is occasionally undertaken somewhere other than in the traditional places.

A Varus Knee

Correction of valgus deformity

As the deformity is in the femur, this is where correction takes place. Just like in the tibia, a cut in the bone is opened and filled.
group, then special considerations may need to be given to the technique used, in order to enhance the rate of union.

Originally, when these procedures were first described, a wedge was taken out of the bone and, the thus created defect, was then closed, bringing together the healthy ends of bone. Whilst this is still a valid technique, the current trend is towards an opening wedge procedure, rather than closing wedge procedure. The main reason for this, is that it is much more accurate, with the degree of correction being more controllable. When an opening wedge is performed however, the resulting defect has to either heal across by itself, or it has to be filled with bone or bone substitute. Perhaps the best filler is bone from the pelvic crest (pelvic brim), however, this does involve surgery to this site. Accordingly, numerous bone substitutes which contain tri-calcium phosphate (TCP - the same crystal as is in bone), have been tried. These act as a scaffold for the healing bone but, unfortunately, some of these tend to slow union down rather than help it. More recent trends have been to use bone from the bone bank (allograft) rather than the artificial substitutes. This then avoids the problems of harvesting bone from the pelvic crest, but of course the bone is dead (it is tested for all sorts of infections, including AIDS and Hepatitis C, and then irradiated with x-rays to make sure that the bone is completely sterile). Whilst this will act as a scaffold, and will still heal, we now enhance that healing by adding bone growth factors to it. So far, whilst these seem to be helping union, this can never be guaranteed: and unfortunately, nothing that has ever been used, guarantees union in every case.

If union does not occur in a reasonable length of time, then the osteotomy site may need stimulating. This is usually done with pelvic crest bone because it contains marrow cells which, being stem cells, help union. In addition, other techniques such as ultrasonic stimulation, can be added.

The advantage of osteotomy

The big advantage of osteotomy is that it is performed outside the joint, in the bone: hence, it does not, in itself, add any further restriction of motion to the knee. When successful therefore, the knee feels very much normal, and it allows moderate activity. Nevertheless, high impact loading activities, such as running, are strongly discouraged given that, such activities, will hasten the day when a replacement becomes necessary.

Unlike knee replacement, most people can kneel, squat, climb stairs easily, and so forth. In addition, the joint is not metal and plastic, and hence, it does not have a specific lifespan. Clearly therefore, it is the operation of choice in the younger age groups. If it fails, then a replacement can still be undertaken: and, particularly in opening wedge osteotomies, the procedure does not seem to compromise the eventual replacement. If a knee replacement fails however, and if the metal components become loose, then revision can become difficult. Such revisions necessarily lead to loss of bone stock, and the lifespan after a revision involving a change in the metal components, is known to be significantly less than the lifespan of the initial replacement, partly because of this. This law of diminishing returns with each replacement therefore, necessarily means that, if there are multiple failures, then eventually, further revision may not be possible. The aim of all arthritis treatment therefore, is to try and to delay replacement as long as possible, whilst still maintaining good function.

Longevity of osteotomy

Current figures would suggest that most people can expect 10 to 15 years of good function from their osteotomy. There are however, a good number who function to well past 20 years, and some who never end up with a replacement. On the other hand, there is also a smaller group who do not get significant relief from their osteotomy despite good correction of alignment. This group, representing about 10% of all osteotomies, come to premature knee replacement because of this.

Timing of osteotomy

Osteotomy is a procedure designed to preserve the life of the joint, and to provide good function. As such, it is not a procedure of last resort. It is not knee replacement. Like tyres on your car therefore, you should not wait until they are worn right down to canvas, before considering rotation. Once the wear is this bad, the point of rotating tyres is lost. Similarly with osteotomy, this procedure is best done earlier rather than later. Obviously, symptoms have to present to a sufficient degree to make it seem worthwhile but, if the joint is wearing out on one side, this is the only thing that will slow that wear down.

If the joint is bad enough to be borderline for re-alignment, but not bad enough to consider replacement, then some will elect to sit it out and go directly to replacement. This is a reasonable option if function is still reasonable, and if you are old enough to consider replacement an option.

Technique of osteotomy

This is done as an open procedure, with the bone being directly exposed and cut. The cut is then opened to create a triangular defect, thereby changing the alignment of the leg. In order to achieve the desired correction, the computer is used in conjunction with an alignment system. This means that 2

Bone graft at 9 months. The bone has healed and any foreign graft is being resorbed.

Tibial Osteotomy

The bone is cut and opened. It is then filled with bone or bone substitute, and a plate applied to maintain correction until healing takes place.
rods, with a tracker attached, are placed in each bone (femur and tibia), and the computer then analyses the relationships between the bones, in order to determine alignment.

When the correct alignment has been achieved, a plate is applied to the outside of the bone, using a series of screws. Along with the initial cut, the plate and screws are applied with the aid of the image intensifier (portable x-ray machine). This helps determine the level of the cut, the angle of the cut, the position of the plate, and the length of the screws; thus making the procedure more accurate.

The procedure takes approximately 75 minutes, and this includes an arthroscopy to both clean up the joint, and to inspect the good half of the joint, making sure that it is good enough to continue with the procedure. Sometimes, despite an MRI scan suggesting that the other compartment is normal, an arthroscopy may show unsuspected signs of wear on that side of the joint. In this instance, a decision then has to be made in regards to proceeding further with the procedure. Such a decision will be based largely on the degree of wear in the good side of the knee and the age of the patient, noting that, in very young patients, the option of knee replacement may not be a good one.

**Time to union**

In general, the tibia unites more quickly than the femur, possibly because it is a slightly smaller bone. X-rays will be taken at six weeks, three months and six months, and usually, full healing occurs sometime between the three and six month mark. Rarely is much seen in the first six weeks, but early signs of union should be seen by three months. When union is deemed adequate, the plate may be removed, and this always improves both the residual symptoms and the function of the knee. Removal of the plate within 12 months is thought to be important because the bone can grow solidly into the screws. This can then make removal very difficult. In addition to this problem, the plate and screws need to be removed in order for a knee replacement to be performed. Ideally, this should be done well in advance of that replacement, thus allowing time for the bones to strengthen, and for the holes to heal. Our preference therefore, is to get all the metal work out as soon as healing has occurred, and preferably in the first year.

**Recovery**

This is a moderate sized procedure to do and most people will require five nights in hospital for it. It is important, not only in this period of time, but also for the next couple of weeks, to keep the leg up, preferably at waist height, in order to get the swelling down as quickly as possible. Although the plate is strong, the screws can break if the leg is overused. Accordingly, most people should stay on crutches for 5 to 6 weeks, albeit that they can usually stand and put weight on the leg within the first week.

The biggest problem in the first few days is swelling, most of which is due to bleeding from the bone. If the swelling and bleeding are not too bad, then this procedure is usually not as sore as most expect it will be. Nevertheless, for the first couple of days, an intravenous pain pump will be used. This will then be followed by oral analgesic tablets, which will be increased until healing begins, that anti-inflammatory tablets such as nurofen, voltaren, celebrex, naprosyn etc., are not used. This is because all of these drugs can significantly decrease bone healing, and therefore lead to an increased risk of delayed union, or non-union, of the osteotomy. Other drugs such as paradole, panadine, panadine extra, or tramadol, are all fine.

By six weeks, most can walk reasonably well on the leg with just a mild limp. By three months walking should be fairly easy, and there should be no limp. Most people know when the bone heals because, it suddenly feels significantly better, and they can walk much more easily.

It is important to realise that the osteoarthritic part of the knee is still present even though it may have been largely unloaded. This means that it can take some months for the pain from that side of the knee to disappear. For the same reason, it is not unusual to have to inject the knee with cortisone, sometime in the first year, to fully settled it down. Similarly, if the knee continues to swell, then a cortisone injection can be very helpful in this situation as well.

The knee will continue to improve out to about 12 months when, hopefully, it will be fairly much asymptomatic. By that stage, the plate will have been removed, and the function should be good.

**Time off work**

This will depend on the nature of the job, whether it is sedentary or otherwise, and whether it involves lots of walking, lifting etc. This is a moderate sized procedure, and most, even those in very sedentary jobs, should allow at least 4 weeks before contemplating return to work. If standing all day is required, then this may take 3 or more months, depending on how quickly the bone unites. When the bone does finally heal however, it does allow much more normal activity.

**Prolonging the life of the knee**

Even if the knee has been rendered asymptomatic, and even if there is a full range of motion present, it is important to realise that the arthritic side still takes some weight. In addition, the normal side of the knee has been deliberately overloaded in order to take some weight off the arthritic side. This means that the arthritic side will continue to wear, albeit at a slower rate than previously, and that the normal side may prematurely wear, because it has been overloaded. For this reason, the knee still needs to be looked after in order to get the maximum number of years of benefit from the procedure. To achieve this, it is better to do non-impact loading type exercises, rather than activities that involve impact loading. This means that activities such as bike riding, rowing machines, cross trainers etc., are preferred to running, power walking, prolonged walking and so forth.

The aim is this procedure is to prolong the life of the knee with ongoing good function, is not designed to enable return to demanding activities such as football.

**Complications**

**Bleeding and bruising** are relatively common because the bone is living, and it does bleed when cut. Despite this, significant bleeding is uncommon, even though, for most people, a low dose anti-coagulant is used to try and prevent DVT's from occurring. Elevation in the first week or so is very helpful to reduce this problem but, in contrast, hanging the leg down will make it bleed and swell more, thus making it sore.

**Swelling** is largely related to bleeding, but muscles and other soft tissues are stretched a bit when this procedure is performed. Accordingly, some soft tissue swelling is normal for this procedure. Occasionally however, the swelling is such...
that blisters develop on the skin. These so called ‘fracture blisters’ do resolve with time and are not in themselves harmful. Nevertheless, they are a sign of moderate swelling, and may require some treatment in their own right.

**Compartment syndrome** is a complication of all tibial surgery that is uncommon but possible. It is due to excessive swelling in the muscle compartments around the tibia, leading to increased pressure in those compartments, to the extent that it cuts off the blood supply to the muscles. To counter this, elevation of the leg and foot movement (pulling the foot up every hour to stretch the calf) are important. It can also be helped by cortisone, which helps decrease the swelling and the pressure. If it continues to progress, the muscle itself is at risk of damage, ultimately leading to permanent injury with contracture. If necessary therefore, the leg may have to be opened to relieve the pressure for a few days. It can then, subsequently, be closed up again.

**D.V.T.’s** (deep venous thromboses) also occur but are uncommon (less than 5%). These represent clots in the deep veins of the leg, usually the calf. They may occur at the time of surgery, or sometime over the next few weeks. Most commonly however, it is in the first 10 days. If noticeable, it is usually as an ache in the calf at the back of the leg. If this is occurring, then a doppler (ultrasound) scan can be used to detect it, and appropriate treatment organised.

Usually, some mild thinning of the blood will be organised for every osteotomy, most commonly being clexane injections. In general this is ceased upon hospital discharge, but can be extended when a patient is at a higher than normal risk for this complication (e.g. a significantly positive thrombophilia factor like Factor V Leiden). Rather than extending the clexane regime, low dose aspirin will sometimes be used depending on risk and the degree of bruising.

The at risk period for getting a DVT is generally regarded as being the first two months, albeit that the majority occur within the first 10 days. For those who travel in that period of time however, consideration of further anticoagulation should be given and, depending on distances travelled, prophylaxis may be indicated even out to the three month mark. This can be done using clexane (or similar) injections, and usually by self injection. A newer alternative however is to use oral anticoagulants, which may not be on the PBS listing yet, but are not overly expensive. Different tablets are taken as per their recommended dose regime. For rivaroxaban, 10mg taken 1 - 2 hours before travelling, and repeated at 18 hours if still travelling, will provide good prophylaxis, especially if combined with flight socks or flight stockings. Such travel would include plane flights, long-distance car journeys and long train journeys. Note that all forms of prophylactic anticoagulation does not seem to change the incidence of pulmonary embolism, almost as if it is a separate disease entity: and therefore not directly related to a DVT. For those at high risk of PE therefore, more substantial anticoagulation is required, and this may involve substantial, and prolonged, anticoagulation with warfarin or similar agents.

**Superficial Infection** involving the skin is not all that uncommon in tibial osteotomy, perhaps because the wound is near the bone, perhaps because this area of the body has a poor blood supply. Either way, it is usually easy to diagnose because the skin gets red and sore. This is usually treatable by antibiotics, although sometimes it is necessary to use intravenous ones, rather than tablets. It is less common in femoral osteotomy, perhaps because the skin in the thigh has a much better blood supply than that of the shin. Perhaps also, because the femur is totally covered in muscle which, in itself, has an excellent blood supply.

**Deep infection** is very uncommon, perhaps because prophylactic antibiotics are always given for these procedures. If it occurs, it can be difficult to treat, often requiring a washout, intravenous antibiotics and so forth. Rarely would the plate and screws have to be removed.

**Non-union of the osteotomy** can occur. It is more likely in the femur because it is a bigger bone. It is also more likely in the older patient (55 years and older). It is also more than twice as likely to occur in a smoker than a non-smoker. As mentioned above, all anti-inflammatory drugs can also cause delayed and non-union, hence they should be avoided until it is clear that union is well advanced.

If there is a substantial delay in union, then stimulation of the osteotomy site by bone grafting may help. Similarly, techniques such as ultrasonic stimulation, may be helpful.

**Loss of correction** can occur but, with the current generation of plates, it is uncommon. When it does occur, it is usually due to soft bone (osteoporosis) which do not support the screws adequately. This allows the screws to gradually migrate by expanding the holes they are in, ultimately leading to a loss of correction and loosening of the plate. The other only cause of loss of correction, is screw or plate failure.

**Screw breakage or plate failure** are very uncommon. Usually these events happen because the bone is not healing, and the plate is under too much stress. For this reason, protection of the osteotomy with crutches is beneficial in the first 5 - 6 weeks. Even after that however, care needs to be taken not to overdo walking and weight bearing activities. The plate and screws are made of titanium alloy to provide extra fatigue strength but, given enough force, over enough time, they can fail. Treatment will then involve re-plating and bone grafting, with the aim of regaining any lost alignment, and getting the bone to heal.

**Pain over the plate** is common, both in the femur and the tibia. The plate is quite large and is prominent. As soon as the bone is healed therefore, it should be removed. This is relatively minor to do, and mostly can be done as a day case procedure.

**Pain in the knee** can persist despite the re-alignment. The arthritis is still present, even though unloaded. This can be treated by an injection of cortisone if necessary, and the knee will continue to improve for up to a year following surgery. If it does not, then replacement may be the only option available.
**Patello-femoral pain** can occur if the patella is already a bit worn out. When an osteotomy is performed, the patella alignment usually changes. This is taken into account at the time and, if a re-alignment of the patella is needed, it can be done as part of, or with, the osteotomy. Despite this, the patella may still give on-going problems, thus requiring further treatment: albeit that this is uncommon. Generally, some specific physiotherapy for this, usually with VMO (vastus medialis obliquus - the inside part of the quads muscle near the patella) strengthening, will settle this down.

**Progression of the arthritis** is inevitable despite re-alignment. The unloaded area still takes some weight, and will always continue to wear. It is likely however, that this will be slow, and may take 10 - 20 years to be significant. When bad enough however, replacement may be necessary. Similarly, if the loaded up area (the good side of the joint) starts to wear, then this will also ultimately lead to replacement.

**Numbness on the outside of the wound** used for tibial osteotomy is normal. The superficial skin nerves come across the scar area, and are cut when this procedure is done. This largely recovers over about a year, but the feeling is never quite normal. The superficial nerves do not supply any muscles however, so there is no associated weakness. Although initially bothersome, by a year, most people no longer notice this.

**Questions and concerns**
Please contact Dr Holt’s office

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**Further information** can also be obtained on this and other related topics such as:
- Knee arthritis
- Knee replacement
- Patello-femoral pain
- Patello-femoral surgery