Factors Contributing to an Unstable Patella

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Via our online work - websites, online courses and eBooks - we are trying to help patients ensure that their own knee problems are not missed. We explain key diagnostic issues directly to patients, in language that is easy to understand, so that they feel empowered to challenge the doctor when they feel something has been missed. To make things easier for readers, we also take pains to create clear simple explanatory drawings, and where appropriate we may also include video discussions or animations.

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Section One

A Nerdy Topic

Our topic here is a little bit ‘nerdy’ to most, but a very important topic if you happen yourself to have a loose or unstable kneecap or patella.

By understanding the factors that can upset the stability of the kneecap, you can then get an idea of the prognosis if you have had such an episode of your own kneecap going out. Will it happen again? Will surgery help?

And if you are going to have surgery, it it of huge importance that the surgeon understands why the kneecap went out, because that is what the surgeon has to fix somehow.

What do we actually mean by an unstable patella?

Figure 1.1 The knee from the side, showing the kneecap or patella snug in the underlying groove of the femur bone (trochlear groove).
An unstable patella is one that somehow goes out of its underlying groove; either it *dislocates* and jumps right out it *subluxes* or nearly goes out. And this can happen once, or more than once.
I would say that patellar instability is a continuum, starting with anterior knee pain.

Anterior Knee Pain is not actually an unstable patella - however, many of the factors that underlie anterior knee pain are nearly the same as in those people with patellar instability.

Some patients may just experience a ‘giving way’ situation, where somehow the kneecap moves a little bit wrongly in the trochlear groove and this causes pain and muscle inhibition and the knee gives way.

Then there is real subluxation, and that means that the patient feels that the kneecap somehow is about to leave the groove. It doesn’t actually leave the groove completely, however it nearly goes out and this can be extremely uncomfortable.
Then there is a *one-time dislocation*. Naturally it is unpleasant to experience your kneecap jumping out to sit on the outer side of the knee, however some of these patients will experience this once in their life and then they will never have any more symptoms from the knee.

In many that have a first dislocation, however, they will continue to have either subluxation or even a new dislocation. If you have several dislocations you call it *recurrent dislocation* - and for those having recurrent dislocation there are a variety of symptoms as well. Some patients find that the kneecap goes out and then goes back, and naturally that’s unpleasant but then there can be years without any symptoms at all from the knee, and then the kneecap goes out again. Then there are those patients who just have to do a little twisting in the knee and the kneecap goes out again and again - this is a bad situation.  

*Habitual dislocation* means that the kneecap goes out every time the person bends the knee.  

*Permanent dislocation* means that the kneecap is on the outer side of the groove all the time and never goes back. At the end of this book I will demonstrate a situation like that.
Section Three

Normal Anatomy

Before we talk about the factors that cause this instability we need to say what is actually normal anatomy.

Somehow humans diverged or separated from apes and other mammals since we are walking upright. Nature has made it so that in order to walk fast, run and move in an optimal way we humans are structured a little bit knock-kneed. That means when you put your feet together this automatically happens. However, this also gives a little ‘Q-factor’ - and if you look at the picture on the right you will see the red arrow going left, meaning that these normal knock-kneed forces tend towards pulling the kneecap out of its groove. Moreover, we have actually a ‘lateralised tibial tubercle’ so that the patellar ligament acts on the tibial tubercle and the tibial tubercle tends to be towards the outer side. Well this is simply a construct so that avoids putting too much force on the inner side of the knee. We are all prone to develop osteoarthritis on the inner side of the knee, and to avoid having huge forces
on the inside of the knee we are constructed with a tibial tubercle sitting a little bit on the outer side.

So these factors together makes the kneecap go out. In order for this not to happen humans have developed this bony wall on the sides of the groove, which wall is higher on the outer side of the knee giving some bony stability for the patella.

This is a smart construction and for most people that works pretty well. However 1 in 25 will nonetheless experience a patellar dislocation. That means for every school class there will be one individual having this problem. Of those about 25-35% will unfortunately experience a re-dislocation, and this re-dislocation normally will occur within a year or two. That means that one can actually have a long period without having any symptoms - and then the dislocation happens again.

There are scoring systems for evaluating an unstable kneecap - such as the Banff score from Canada and the Norwich score from the UK. They are very helpful in saying something about how patients with this problem are actually doing, and unfortunately they are doing pretty badly, in fact doing worse than those patients who have had an anterior cruciate ligament (or ACL) tear.

A new thing we have found, and quite surprisingly I would say, is that if you have had a one time dislocation you actually have just as severe symptoms as those having recurrent patellar instability.

Why is that? It is that if you feel like your kneecap is nearly going out you change your activities. You get fearful doing recreational activities and therefore you avoid this, and the same with twisting activities and you maybe stop walking on uneven ground or you have just got concern when you do it, you will have uncertainty climbing stairs and some of these patients with patellar instability will have anterior knee pain - typically after prolonged bending.
Section Four

The important factors

Now for what this ebook is all about - we are going to look at the factors that contribute to an unstable patella and as you see from the list below there are a quite a lot of possible factors:

1. Trochlear dysplasia
2. Patella alta
3. Increased tibial external torsion
4. Valgus deformity
5. Externally-situated tibial tubercle
6. Medialised trochlear groove
7. Lateralised tibial tubercle
8. Combination of above

Figure 4.1 Factors contributing to an unstable patella

I will go through each of these factors, starting out with *trochlear dysplasia* because this is the single most important factor for having an unstable patella. If you have trochlear dysplasia there will be a risk of about 60% of your kneecap going out again, and this fact might influence you to choose surgery from the beginning.
So what is trochlear dysplasia? It means that there is a flat groove and thus poor lateral (or outer) wall support for the patella.

In the two illustrations below you see a normal groove in the left hand one, and then on the right you see a dysplastic one - and what we say to patients is that it can be “difficult to balance a tennis ball (‘the patella’) on a football (the flattened groove)“.

Figure 5.1 A normal groove on the left, and one with trochlear dysplasia on the right

Lateral Trochlear Inclination Angle (LTI)
To assess the adequacy of the lateral wall, someone developed what we call the lateral trochlear inclination angle which this describes the support.

If the LTI is 20-22 degrees we say it is normal. However, if it is below 11 degrees we will say it is dysplastic. For some severely affected people it can be even zero or less.
We conducted a review, and we contacted experts from different areas of the globe and asked each - “What single factor do you believe is most important for describing trochlear dysplasia?” Everyone agreed upon that this was the lateral trochlear inclination angle. We looked at 33 different measurements and the lateral trochlear inclination angle came out as the most important.

Figure 5.2 Normal (left) and dysplastic (right) Lateral Trochlear Inclination Angle

$LTI = 21^\circ \text{ (normal)}$  \hspace{1cm} $LTI = <11^\circ \text{ (dysplastic)}$
Section Six

**Patella Alta**

Another factor contributing to an unstable patella - and which I consider to have huge importance is *patella alta*.

**Camel Sign**

Actually you can spot those patients with patella alta just by looking for the *camel sign* - this is a two-humped camel because you will see a bump where the patella is and then a bump where the Hoffa fat pad is.
When you are going to look for the patellotrochlear index on MRI or x-rays, you are looking for something about the overlap between the trochlear cartilage and the patellar cartilage. It is very simple to calculate. However, most measurements used globally and in scientific papers are what we might call ‘old measurements’ such as the Insall-Salvati and Caton-Deschamps indices, and they are measurements that are calculated in relation to the tibial tubercle. I think these indices should nowadays be avoided because it is not the tibial tubercle that is at issue.
Here you can see that the patella is high-riding, and there is only a small overlap of the cartilage in the trochlear groove and the cartilage on the undersurface of the patella. You can see this more clearly in transparent X-rays. This small area of cartilage becomes overloaded and can soften (chondromalacia) and stress the underlying bone and this might eventually lead to Anterior Knee Pain.

Figure 6.4  Patella alta with only a small area of cartilage overlap
Section Seven

Rotational abnormalities

A little nerdy topic, however a very important topic in respect to having a loose kneecap are rotational abnormalities, especially *femoral anteversion*.

Femoral Anteversion
In femoral anteversion there is somehow a rotational abnormality in the femur bone. This can be seen by examination and confirmed by MRI and CT scans.

External Tibial Torsion
Often when you have increased femoral anteversion you will have compensation by increased external tibial torsion and this can also be calculated by MRI and CT scans and can be seen by clinical examination.

Miserable Malalignment
You can have isolated increased femoral anteversion and you can have isolated increased tibial external torsion - but often they are combined.

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Figure 7.1  Miserable malalignment - a combination of femoral anteversion and external tibial torsion
If they are combined you call it Miserable Malalignment - and that means that you have ‘squinting’ patellae - and this is actually very often overlooked.

We know that this situation has some importance because if you look at those patients who have had an unstable kneecap - and then had MPFL ligament reconstruction that didn’t go that well - we find that many of these have underlying increased femoral anteversion. However we don’t know precisely what the risk is of having recurrent patellar instability if you have increased femoral anteversion because there are so few studies on this.

Figure 7.2 is a 3D scan of a patient who had experienced recurrent patellar instability, and you see her left femur is rotated too much compared to the right femur. This causes the kneecap to tilt and sublux laterally. You can also imagine that if you rotated the femur outwards the kneecap would be completely centred.

Figure 7.3 shows what I mean by ‘squinting patellae’ - when the feet are straight the kneecaps turn inwards. The patient on the right also has Miserable Malalignment and she also had squinting patellae, and when I
asked her to turn her kneecaps to face them forward then her feet looked like Chaplin’s – outwardly rotated and this is classical.

These patients will, most of them, also have an increased TT-TG distance, and I will come to this topic in a later section.
Section Eight

Angular abnormalities

Besides the rotational deformities discussed above, patellar stability can also be compromised by the angular deformity of ‘knock knees’, which is known medically as ‘valgus’ deformity.

Valgus Deformity (knock-knees)

Then there is Valgus deformity: That means that the patient are too knock-kneed.

The normal ‘Q forces’ and big abnormal inwards angulation combine to make the patella want to go laterally.

Figure 8.1 shows you an example. If you look at the long-leg X-rays and you simply draw a line between the centre of the femur and down to the ankle (green dotted line) you can see that it goes on the outer side of the knee in...
the affected knee. That means that there is a huge Q factor for taking the kneecap out to the lateral side.

This patient had a femoral osteotomy and the leg became straight and her symptoms disappeared. She had to have the plate removed a year after but her subluxation stopped.

Figure 8.2 Showing how the knee was straightened with a wedge osteotomy.
Section Nine

Increased TT-TG distance

Then there is increased TT-TG distance, which can also affect the stability of the patella. A lot of surgeons talk about this distance - it has huge importance, however we need to see the TT-TG in a new light and I will talk about that shortly.

The TG (or Trochlear Groove) point is the centre of the trochlear groove in the upper part of the knee joint. The TT (or Tibial Tubercle) point is just where the patellar ligament attaches to the tibial tubercle. You make a line from here and then measure this distance between them.

It gives an idea of how well in line the forces are between the ligaments and muscles pulling on the patella, and the bony constraints at its side.
If the TT-TG is about 20mm or more there will be a risk of re-dislocation of about 40%.

Our team just finished a study that looked at this TT-TG distance to determine if an increased TT-TG reflected an externally rotated tibial tubercle or a medialised trochlear groove. Our results showed that in most of the patients having an increased TT-TG distance the problem was not caused by an outward rotated tibial tubercle but rather that the trochlear groove was medialised. This means that a surgical solution that involves medialisation of the tibial tubercle does NOT normalise the anatomy!

When you have trochlear dysplasia for some reason the trochlear groove goes medially, and that means that for many patients who have increased TT-TG distance they actually have some degree of trochlear dysplasia.

So what about those cases who do indeed have an external rotated tibial tubercle? This is a situation where it is a very good idea to do Fulkerson osteotomy or similar procedure and thereby reduce the Q factor, or if is that the externally situated tibial tubercle is caused by external rotation of the tibia one can do a tibial de-rotational osteotomy.

There are measurements for this, this is one measurement, the Muneta method, you see it on the left picture, this angulation and that can give you an idea how the tibial tubercle is rotated. There is another way to measure this, when you do a measurement between the PCL or posterior cruciate ligament and the tibial tubercle.
Section Ten

A brief mention of the MPFL

Now I have mentioned the most important factors for having a patellar dislocation I haven’t even mentioned the MPFL - the medial patellofemoral ligament.

The MPFL is a normal structure, and in itself it does not contribute to patellar instability - in fact it is a passive stabiliser of the patella and has huge importance. However, once there has been an initial patellar dislocation the MPFL may tear and become incompetent, so the kneecap loses the stabilising effect of this ligament and re-dislocation becomes easier.

I believe that this structure is always torn when the kneecap dislocates completely, and in my practice I do a lot of MPFL reconstructions.
Before I close, I just want to mention that there are those patients that have combined factors contributing to their patellar instability. For example, they may have both patella alta and trochlear dysplasia, or they have patella alta and increased tibial external torsion. One can find any combination of the factors we have already discussed.

This really makes things very complicated, and there is absolutely no agreement between orthopaedic surgeons with an interest in this topic how to deal with this. There is no algorithm of what to do first. So I will say it is up to the surgeon to say what factor has most importance in this situation - how many combined surgeries should I do if I am going to correct it? And if I am not going to go and correct it in one surgery which surgery am I going to take first? So this is really complicated.

Figure 11.1  Showing how the knee was straightened with a wedge osteotomy.

Take for example these images. This girl she has severe increased femoral anteversion, and she also has severe trochlear dysplasia, and she has
permanent patellar dislocation on both her knees. You see in the picture on the left, that means the right knee, she actually has developed a new kind of groove for the kneecap because she was born like that. But she is dancing and running! She has only some crunching sensation in her knees. She is 17, and is a little bit worried about what is going to happen in the long run but she doesn’t want to have surgery now.

The surgeon in these complicated situations has to take into consideration the whole clinical situation, and then make decisions together with the patient.
My take-home message is that there are a number of clearly identified factors that may contribute to patellar instability, and it is critical to determine the underlying cause or causes of a patient’s unstable patella before committing to surgery. Too often an inappropriate procedure is undertaken and the patient’s problem is simply made worse.