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Hypermobility; is it Detrimental or Advantageous to Today's Dancer During Training?

Being hypermobile is a term used to describe someone whose joints appear to articulate beyond the normal range of motion. For a dancer this may be thought of as a positive asset due to the nature of the aesthetic demand in dance. Long elegant leg extensions and the ability to create interesting body positions and shapes is a sort after commodity for today's contemporary choreographer, striving to create different and innovative dance pieces. It has also been stated that 'hypermobility may act as a positive selection factor for entry into ballet school' (Graham, Jenkini and McCormack in Kerr, R and Grahame, R: 2003:4), this will be discussed later on in this work regarding its relevance to today's dance institutions. Hypermobility would not be deemed problematic if a dancer could perform on stage, or during their training, whilst in control of their mobile joints. It can become a problem, however, if the dancer does not have adequate control as they may increase the risk of injury.

There are many different aspects of being hypermobile that affect a dancer's ability to perform at their best. The main points that will be examined within this essay will be the significance of the higher prevalence of injuries amongst hypermobile dancers than in those deemed to have normal range of motion. Some of the reasons as to why this may happen, such as poor proprioception, joint instability and overloading will also be looked at, with particular reference to the knee joint. The psychological issues involved with injury will be discussed as this could be considered to have a negative effect on a dancer during their training. Other areas that will be addressed include the relevance of the different tests used to identify hypermobility, as well as the different ways in which hypermobility may be controlled so that a dancer can continue their training and go on to have a career in dance.

Before all this can be examined, the causes of joint hypermobility need to be discussed so that the main issues can be better understood. One of the major causes of hypermobility is a defect in the connective tissue system.

This system is responsible for holding all the cells, tissues, organs and joints of the body together. The defect arises from a fault or mutation within the gene that encodes for the protein collagen, the other proteins that make up the connective tissue system being fibrillin, elastin and tenacin. If there is a low concentration of collagen, the tensile strength of the connective tissue is compromised, giving it a more elastic property,

> *It has been suggested that the abnormalities in general hypermobility…are due to a collagen processing defect or an irregularity in another part of the connective tissue protein complex that causes increased elasticity of ligaments, joint capsules, tendons, skin and blood vessels.*
>
> (Desfor, F, 2003 Vol 7: No. 1)

Ligaments are the connective tissues responsible for connecting bone to bone via the periosteum, the layer covering the bone, and are there to act as stabilisers. The random criss-crossed layering of fibres within the connective tissues structure, such as the tissues surrounding the heart, does not occur, as such, in ligament tissue. Instead the collagen fibres become uniform, decreasing the tissue's elastic quality (see appendix 1). However, with a defect in the connective tissue make-up, the ligaments will not have the same tensility, allowing an increased amount of 'give', 'Genetic aberrations affecting these fibrous proteins distort their biomechanical structure and impair their tensile physical properties, resulting in tissue laxity, fragility and, ultimately, mechanical failure' (Kerr, R and Grahame, R: 2003:15).

The same may apply to the hyaline tissue surrounding the joints, often referred to as the joint capsule. With defective collagen, the hyaline tissue will be more elastic, possibly adding to the increased instability of the joint. Some of the chief visual indications of someone having hypermobility would be the appearance of swayback legs, pronated feet or elbows that bend the

'wrong way'. This may be the result of years of 'hanging of their joints' (Simmonds, J, seminar 3, 2006), mainly due to the laxity of these ligaments and joint capsule that surround the hypermobile joints. In extreme cases, a defective connective tissue system can result in a number of Heritable Disorders of Connective Tissue. Within this group are various conditions, such as Ehlers-Danlos Syndrome, Marfan Syndrome and Benign Joint Hypermobility Syndrome.

Sometimes a joint may be rendered hypermobile due to its structure. Some examples of this can be found in ball and socket joints. If the bowl-shaped depression in the pelvis, known as the acetabulum, is too shallow, then the head of the femur cannot be securely slotted deep enough inside. This may increase the risk of dislocation, as the hip would have to rely solely on the surrounding ligaments to retain the integrity of the joint. This too may apply to the shoulder joint. However, if the head of the femur is too small, it may also decrease the stability of the joint, as there will be too much space surrounding it, allowing more freedom of movement within the socket. This may be problematic for a dancer during training due to the vast numbers of repetitive *Grande Battements,* where the dancer will throw the leg, straight up in the air as hard as they can, to increase their power and flexibility, or during floorwork in a Graham class, as the technique requires lots of movement within the hip socket.

In her article *Flexibility in Dance,* Martine Deighan states that 'since joint factors are largely hereditary, the potential for young dancers to achieve optimum flexibility and aesthetic purposes is probably constrained by their genes', (Deighan, M, 2005, Vol 9: No 1). However, hypermobility can be acquired. When this occurs, relatively normal joints with average mobility are constantly stretched to increase the dancers flexibility. When this happens, the ligaments may not necessarily be the tissues under pressure. It occurs through the lengthening of the fascial coverings of the individual muscle

fibres. The fascial system is part of the connective tissue system, described as our 'organ of shape' (Carter, G, seminar 2, 2006), and acts as a net or matrix supporting the cells of the body. When a muscle is stretched or lengthened, the muscle fibre itself is not affected; it is the fascial covering that gives way to allow the flexibility. One joint that may have become hypermobile during dance training may be the hip, due to increased hamstring, quadricep, adductor and abductor flexibility. Even so, this is seen not to be a problem, as the stability of the joint has not been compromised,

> *Those with 'normal tissues' can increase range of movement by stretching, and this is typically seen in ballet dancers and gymnasts. It is probable that individuals who have joints of average flexibility have better protection from injury by their 'normal tissues', and those who have developed a hypermobile range from specific training enhance the stability of their joints through good muscle strength and control.*
>
> (Kerr, R and Grahame, R: 2003:52)

It may be important to acknowledge here that during childhood, the body is generally more mobile. This mobility however diminishes as the child goes through adolescence and on into adulthood. General mobility in childhood can sometimes be maintained if the individual continues to stretch and lengthen their joints and muscles during training such as in dance, 'there is evidence that over the age of 11-15 years, female dancers retain the level of joint laxity that they enjoyed at an earlier age, while non-dancer controls show a significant reduction in Beighton hypermobility score over the same period' (Poul, et al. 1988 in Beighton, P, Grahame, R and Bird, H: 1989:127). It may be said that in this case, hypermobility is not acquired as such, but is preserved and maintained through continued dance training.

Other factors that may increase the dancer's chance of being hypermobile would be their gender or possibly their ethnic background. During a test of

9275 patients at a rheumatology clinic in 1986, it was discovered that 2% of these patients were deemed to be hypermobile, of which 85% of these were women (Kerr, R and Grahame, R: 2003:71). Dr. Alan Hakim, who is supported by a Clinical Research Fellowship from the Arthritis Research Campaign (A.R.C.), states that 10-30% of the adult population have generalised hypermobility with a female to male ratio of 3:1 (www.rheumatologyonthebeach.com). This may be due to the higher levels of relaxin in the female body. Relaxin plays an important role during pregnancy by relaxing the ligaments and tissues around the pelvis to allow for childbirth. Testing for hypermobility amongst people from different racial groups have shown that people of Asian origin have a higher prevalence of hypermobility than of Afro-Caribbean origin, which sequentially have a higher prevalence than people of Caucasian-European origin (Simmonds, J seminar 3, 2006). In one study of university students between the ages of twenty to twenty-four in Iraq, hypermobility was found in 39% of females and 25% of males, (Hudson, N, Fitzcharles, M, Cohen, M, Starr, M and Esdaile, J, 1998:37). These results may appear to be quite high, however, it is not mentioned which test has been used and what score was deemed to indicate hypermobility. As mentioned previously, the importance and relevance of accurate hypermobility testing will be discussed further on in this work.

Now that some of the many causes and reasons for the occurrence of hypermobility have been explored, the important issues of why this may affect a dancer during their training will be discussed. Perhaps one of the most frequent worries of a hypermobile dancer would be the higher prevalence and recurrence of injury. A dancer goes through specific training in the hope to fine-tune their body and improve their technique, often in a number of different dance disciplines, in order to gain a successful career in dance, either in performance, choreography or teaching. If a dancer is frequently injured, then their training will be interrupted due to temporary withdrawal from class and possible rehabilitation.

There is an abundance of evidence that suggests that there is a direct correlation between hypermobility and injury. In a letter written by Katherine Watkins, the physiotherapist for Laban Contemporary Dance School in London, she mentions that she 'feels that hypermobility does predispose injury' (Watkins, K, 24/2/06, personal correspondence), as does the authors of *Joint Hypermobility: An Information Booklet* published by A.R.C. A hypermobility study in ballet dancers produced evidence that within the hypermobile group 'injuries were significantly more common compared to controls' and more importantly that the researchers behind the study 'regard hypermobility as a liability to the ballet dancer' (Klemp, P, Stevens, J and Issacs, S, www.ncbi.nlm.gov). The significance of this statement will be discussed further on in regards to the main issue of this work.

Another statement also supports a link between the higher incidence of injuries amongst hypermobile dancers, especially injuries affecting the knees, lower back and feet (Kerr, R and Grahame, R 2003:52). The different types of injury sustained and the possible reasons as to why they may happen will be presented next, followed by an in-depth study into common injuries of the knee joint, possibly caused by hypermobility.

The first group of injuries to be examined are collectively known as soft tissue lesions, which include overuse injuries, muscle tears and micro-traumas. The fragility of the body tissue, due to defective collagen, may probably be one of the main reasons for this outcome, 'a feature of hypermobile tissues is that they are less resilient, so that muscle tears and tendon-osseous attachment lesions occur with greater ease', (Kerr, R and Grahame, R, 2003:52). Shin splints can be thought of as an over-use injury, the main characteristic being painful areas along the medial or lateral borders of the tibia, often hard to pinpoint exactly where. It is generally agreed that the pain is caused by micro-traumas in the soft tissues within that area, such as the muscles, ligaments, tendons, periosteum to name but a few. After repeated weight

bearing movements, these tissues may struggle to retain the integrity of the lower leg and may eventually tear. Significantly, out of sixteen dancers studying at Middlesex University deemed to be hypermobile by using the Beighton test, twelve reported the development of shin splints during their intensive training (see appendix 2). More research and wide spread investigations need to be done in this particular area to ascertain if this high prevalence of shin issues exists in other dancer populations.

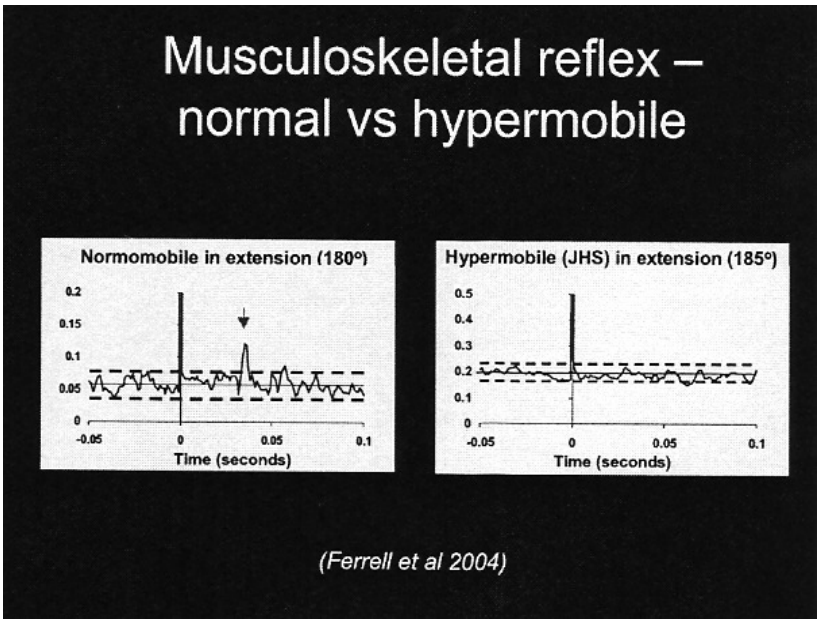
Another form of injury that is commonly linked to hypermobility is termed a dislocation or sublaxation. This is where the ends of the bones within a joint become either partially or fully separated. Dislocations during training may happen through poor landings, affecting possibly the ankle or knee, or through general floor work, maybe putting the shoulder or hip at risk. Other incidents may happen during choreography, improvisation or contact work, possibly due to the reality that a lot of the movement is new to the dancer and has never been previously attempted. If a movement is performed incorrectly, then the lax ligaments and joint capsule may not be able to take the strain and therefore the stability of the joint will be compromised, perhaps becoming displaced on impact or sudden dynamic movement, 'On the debit side generalised laxity of ligaments can pose problems for the dancer. Hypermobile dancers are vulnerable to all the ailments to which loose-jointed persons are susceptible, but because of the greater physical demands imposed by dancing they are at an even greater risk' (Beighton, P, Grahame, R and Bird, H: 1989:128)

These injuries can happen for many reasons, possibly down to tiredness and lack of concentration due to the high physical demand of the training schedule. There are, however, other ideas as to why injuries are more common in hypermobile dancers that focus mainly on the neuromuscular system. Nerve fibres, just like muscle fibres, are also bound together by connective tissue; a defect within the connective tissue system may indicate a

defect within the nervous system. Proprioception is a term used to describe the awareness of the body in space. If the arm is lifted above the head, the brain should receive nerve signals from the arm to tell it where it is. Proprioception is also responsible for balance and control and the ability to detect how flexed or extended a joint is. People with hypermobile joints seem to have poor proprioception, possibly increasing the risk of injury,

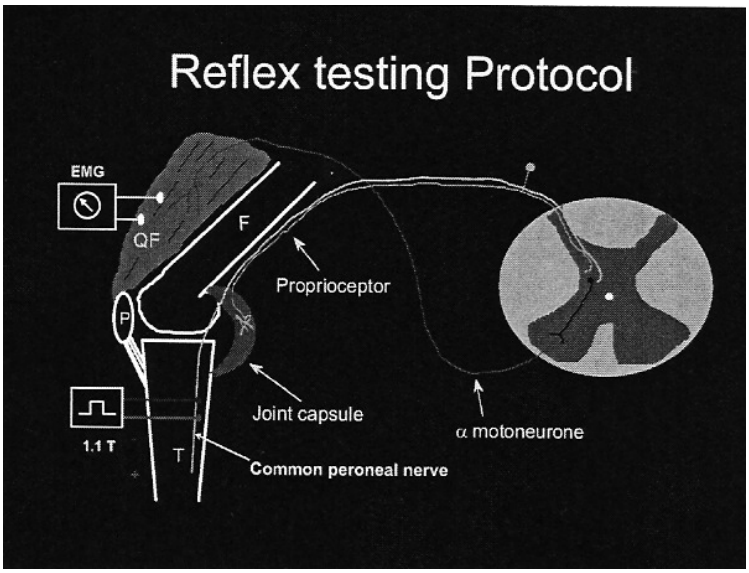
> *Reduced neuromuscular feedback and ligament laxity may lead to 'biomechanically unsound' limb positions, with the joint being in a much more extreme position than the person perceives. Proprioceptive deficit in the dancer, combined with faulty technique and inadequate strength, may lead to chronic, abnormal loading on articular surfaces.*
>
> (Desfor, F, 2003 Vol 7: No. 1)

During a seminar presented by Jane Simmonds, a senior lecturer at Middlesex University, it was suggested that the poor proprioception might have something to do with the nerve receptors on the surface of the skin. The skin of a hypermobile person may be more elastic than a non-hypermobile person as it possibly lacks sufficient collagen. This may in turn hinder the neuro-feedback to the brain by dissipating the information across the more flexible skin fibres, resulting in a loss of proprioceptive information. The same may apply to the nerve receptors and neural messages in and around the joint capsule that may result in the 'problem with end of range proprioception', (Simmonds, J, 2006, Seminar 3). This view is also supported by Dr Alan Hakim and is demonstrated on the graph below in figure 1, taken from his presentation (documented on www.rheumatologyonthebeach.com).



(Figure 1)

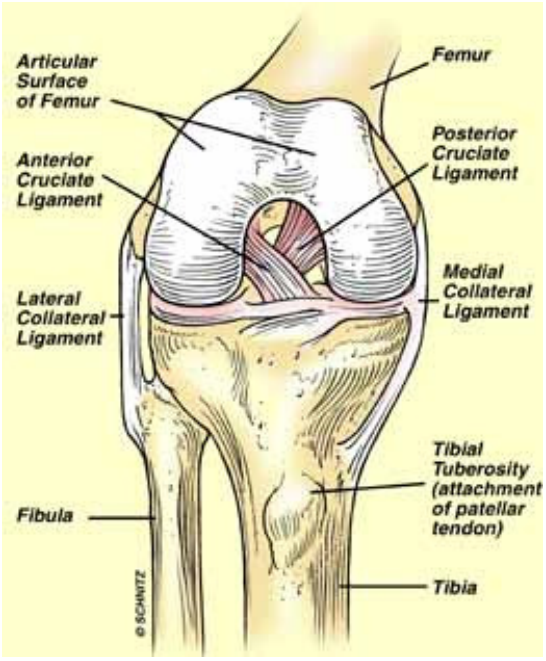
It is possible to see more activity or 'noise' on either side of the peak in the non-hypermobile person than in the hypermobile person. The 'noise' is the result of the neurons firing within the motor nerve in the quadratus femoris and propriocepter nerve attached to the posterior aspect of the joint capsule (see figure 2 below).



(Figure 2)

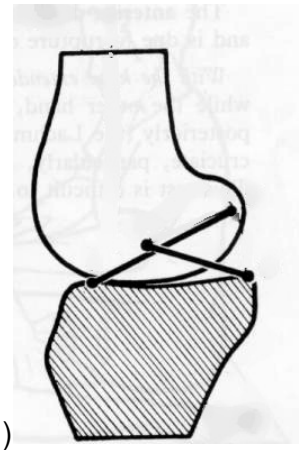
It may be interesting to mention here that other neurological factors are now being linked to hypermobility, 'symptoms such as palpitations, light-headedness, dizziness or fainting, which are similar to those experienced by people with automatic nervous system dysfunction', (Kerr, R and Grahame, R 2003:9).

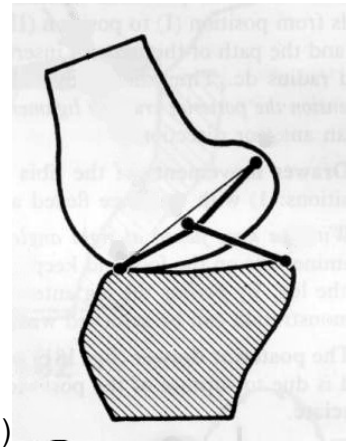
For this next section the structure of the knee will be looked at, comparing an 'ideal' knee alignment and a knee that has been pushed back and locked, having to rely heavily on the internal ligaments for support. Hyperextended knees go beyond their normal extension limit causing them to lock back and look as if they are bending in the wrong direction. This is a common occurrence in dancers, especially ballet dancers, as they will often stand on one leg which will be supporting all of their body weight, so when the leg starts to tire, instead of pulling up, the tendency will be to 'sit back' into their knees. Figure 3 below shows the basic anatomy of the right knee during flexion.



(Figure 3)

It has been stated that 'the standard posture is one that demonstrates maximal efficiency and involves the minimum amount of stress and strain on the body' (Kendall et al. 1993 in Kerr, R and Grahame, R 2004:76) and that 'hyperextension at the knee is a common finding…and can cause other faults around the knee' (Kerr, R and Grahame, R, 2004:93). As mentioned above, lax ligaments are primarily responsible for allowing the joint to articulate beyond its ideal range of motion. There are four main ligaments involved in stabilising the knee joint, two cruciate ligaments and two collateral ligaments. The role of the cruciate ligaments will now be examined with reference to figure 4 and figure 5.

(Figure 4.) 

(Figure 5.) 

The posterior cruciate ligament and anterior cruciate ligament lie in a groove between the femur and tibia, forming a crossed connection. During ideal alignment, as illustrated in figure 4, both cruciate ligaments are working together to help maintain the integrity of the joint. However, when the knee becomes extended the anterior cruciate ligament becomes more active as it will have to bend around the under side of the femur. If the anterior cruciate ligament is more elastic, as may be the case with a hypermobile dancer, the ligament will stretch even further causing the knee to bow backwards as in figure 5, clinically termed genu recurvatum. If a dancer is constantly 'hanging off' the anterior cruciate ligament then it is likely to become more and more stretched over time,

> *When a dancer 'locks back' into the hyper-extended position, the weight of the body is no longer transferred through the centre of the knee joint. Instead, it is directed towards the back of the knee joint. This can further stretch the knee ligaments and weaken the stability of the joint.*
>
> (Watkins, A and Clarkson, P.A, 1990:117)

Dancers with sway back legs will frequently hyper-extend since an ideal straight leg will feel bent and not stabilised, the only option, if not corrected, is to over extend their knees to feel secure. This may become problematic when the knees support structure is called upon during a particular movement, the risk being that the anterior cruciate ligament will not be able to function correctly and may either tear or come away from the periosteum, causing painful damage and possibly allowing the knee to dislocate.

The anterior cruciate ligament and posterior cruciate ligament are also responsible for limiting the forwards and backwards sliding motion of the femur on the tibia. Due to the positioning of both ligaments, it can be possible to acknowledge that the anterior cruciate ligament limits the forwards slide of the tibia and the posterior cruciate ligament limits the forwards slide of the femur. As with hyperextension, if these ligaments are more elastic than those found in the non-hypermobile population, the knee joint is less stable. During a dance class, this instability may cause problems during travelling sequences that involve a series of forward moving actions, triplets and leaps for example, that rely on the knee for stability. An injury may occur when a dancer is performing a succession of leaps, landing repeatedly on the same leg with the momentum of the body pushing forward. If the posterior cruciate ligament is overly lax then the femur will slide forwards with the body's momentum during landing, and may tear. The same may apply to the anterior cruciate ligament during a backwards-travelling sequence as the body's backwards momentum may slide the femur backwards, off the tibia,

especially if the anterior cruciate ligament has been overly stretched due to continued hyperextension during standing.

As mentioned previously there are two collateral ligaments, the medial collateral ligament which runs down the side knee joint between the femur and tibia, and the lateral collateral ligament that runs down the other side of the knee joint between the femur and fibula. Both these ligaments are the transverse stabilisers of the knee joint whilst the joint is in extension. The medial collateral ligament and lateral collateral ligament can be damaged during a dance class if a hypermobile dancer does not properly engage their leg muscles during a *Grande Battement* or a leg kick with a straight, turned-out underneath leg. When the dancer throws the leg into the air, the muscles surrounding the femur and knee need to work together, along with the hip stabilisers, to stop the standing turned-out leg from bowing sideways with the body's momentum. When this happens the dancer is said to be 'swinging off their leg'.

During a *Grande Battement* to the front, the medial collateral ligament will be facing forwards due to the turned-out positioning of the underneath leg. As the leg is thrown upwards, the pelvis may tilt, pulling the standing leg with it. As the dancer tries to maintain a straight underneath leg, the medial collateral ligament is stretched as it struggles to maintain the alignment. The same may apply to the lateral collateral ligament during a *Grande Battement* to the back. Being hypermobile could mean that these collateral ligaments may not be able to maintain the required tension to keep the knee from bowing sideways and may become vulnerable to tears.

Both sets of ligaments are important for maintaining the correct knee alignment during turnout. The cruciate and collateral ligaments and outward rotator muscles of the hip, work together to maintain the correct knee alignment with the foot. If a dancer forces their turnout, with out muscular

assistance, they become reliant on their cruciate and collateral ligaments to stop the femur from inwardly rotating away from the tibia. The lax ligament tissue of a hypermobile dancer will not be able to sustain the alignment of the leg with out the thigh muscles aid. The stability of the ankle may also be compromised, as the feet could possibly be prone to 'rolling in', pushing the ankle joint forwards. The weight of the body will now be dangerously hanging of the ligaments and connective tissues of the ankle and not through the centre of the foot and into the floor.

Along with tissue laxity, there is evidence that hypermobility may be linked to low bone mass. During a research project, twenty-five pre-menopausal hypermobile women and twenty-five age-matched controls had their bone mineral density tested in their greater trochanter and femur. The results indicated that the hypermobile group had 'significantly lower' bone mineral density scores than in the control group. There were also 'significant negative correlations between the Beighton scores and trochanteric bone mineral density', meaning the higher the score on the Beighton hypermobility test, the lower the bone mineral density result. The study concluded that 'hypermobility was found to increase the risk for low bone mass by 1.8 times', (www.springerlink.com). Low bone mass may lead to an increased risk of fractures within the bone tissue which could affect a dancer during training.

The low bone mass may be due to the tissue structure of the bone, as it too relies on connective tissue for support as well as acting as a framework for the minerals that give the bone its toughness. It may be that the more lax the connective tissue within the bone, the less likely it is to be able to store the minerals as the flimsy structure possibly may not be able to accommodate the minerals securely. Low bone mass can lead to premature osteoporosis, a condition that is often linked to the Female Athlete Triad (see appendix 3). Osteoporosis is a debilitating condition where the internal structure of the bone begins to break down. There have been various studies to support the

view that being hypermobile can 'increase the risk of osteoporosis later on in life' (Simmonds, J, seminar 3, 2006).

There are also suggestions that hypermobility can increase the risk of premature osteoarthritis. In this instance, it is the people rendered hypermobile by their 'abnormally shaped bone surfaces or (by) an abnormal sense of joint position' rather than those who have fragile tissues. In osteoarthritis, the cartilage that covers the ends of the bones within a joint, acting as a shock absorber, starts to thin out causing 'pain and stiffness in the joint' (A.R.C. information booklet). Both these conditions may not necessarily affect a dancer during training; however a hypermobile dancer can prepare themselves for the higher possibility of developing the condition in the future.

Now that some of the physical issues of hypermobility have been examined, including defective connective tissue make-up and higher injury rates, the psychological issues that may affect a hypermobile dancer will be discussed. After sustaining an injury, a dancer may have to limit the amount of workload in order for the healing process to begin. Working at a lower impact or 'marking' out a movement can have a negative affect on the dancer, especially if it is a common occurrence. Some of the main psychological issues a dancer may have to deal with may include frustration within themselves, jealousy of others, guilt, if depended on by other dancers for their choreographies and possible withdrawal and avoidance from the classes.

The reasons as to why a dancer may feel these anxieties are due to the long-term affects of these injuries. One of the main problems with 'sitting-it-out' would be that the dancer might incur a drop in their levels of fitness, possibly leading to weight gain. This in turn would mean that instead of slowly easing their way back into class, the dancer may not give themselves enough time to recover and start back too early, increasing the risk of re-injury. Along with the drop in fitness levels, their technique may also suffer, especially if the

injury requires a longer recuperation period, causing probable impatience within the dancer to get back to their normal routine. Having to watch their fellow students train and improve may also have a negative psychological effect on the injured dancer, also prompting them to ignore professional advice and join in classes too soon (Holder, T, seminar 1, 2005). Due to the fragility of the soft tissue structure within a hypermobile body, the dancer may have more then one injury at the same time.

If an injury is not fully rehabilitated and recovered, then an early return to class may increase the risk of re-inuring the same area. Sometimes a dancer can develop a fear of re-injury and may start to avoid certain movements that involve the recently recovered part of their body. This fear of re-injury could be classed as a form of kinesiophobia, defined as the 'fear of pain induced by movement' (Kerr, R and Grahame, R, 2003:15). An example of this may be when a dancer has a fear of performing a *pirouette* on a particular side. This may be due to a previous attempt where the dancer may have lost balance, fallen down and sustained an injury. The same may apply with kicking up a particular leg to the back or, perhaps, during a dynamic floor routine that involves rolling onto the shoulder.

There are a number of examinations that have been devised to test individuals for hypermobility; however the Beighton scoring system seems to be the most commonly used test during clinical research. This system has a maximum score of nine, four being the usual indicator of general joint hypermobility, however, it can sometimes be five (Simmonds, J, seminar 3, 2006). It tests the knees and elbows for hyperextension, awarding a point for each joint that hyperextends, points are also awarded if you can bend the thumb forwards to touch the wrist and can lift the little finger back into a 90° angle. An extra point is added if you can bend over and place your palms flat on to the floor (see appendix 4).

Although the Beighton scoring system is more commonly used, due to its relative simplicity to perform, it does however only test five joint areas. For a dancer, forwards flexion with the palms on the floor may have been acquired, as with the knees, during training, 'Some authors using the Beighton method to assess hypermobility in dancers…have found that the forward flexion manoeuvre is an invalid test for global hypermobility in dancers since it can be acquired through training', (Desfor, F, 2003 Vol 7: No. 1). These findings were confirmed during a test conducted on ballet dancers, the main conclusion was that a 'direct relationship was found between forward flexion and both the duration of dance training and age. This suggests that forwards flexion is acquired' (Klemp, P, Stevens, J and Isaacs, S, www.ncbi.nlm.gov).

Another hypermobility test, the Bulbena scoring system, looks at additional joints for hypermobility, this time with a possible score of ten. The joint areas and criterion are displayed in table 1 below.

Thumb	Apposition to forearm
MCP Joint (little finger)	Hyperextension > 90°
Elbow	Hyperextension > 10°
Shoulder	External rotation > 85° with elbow at side
Knee	Hyperflexion: prone heel to buttock
Patella	Excessive lateral mobility
Hip	Abduction > 85°
MTP Joint (big toe joint)	Dorsiflexion > 90°
Ankle/Foot	Excessive dorsiflexion and eversion
Ecchymoses	Ecchymoses after minimal trauma

Table 1 (taken from Desfor, F, 2003 Vol 7: No. 1)

It is possible to see that in the Bulbena test, hyperflexion has replaced hyperextension of the knee and hip abduction has replaced forwards flexion. However, the criterion does not state how the leg should be placed, whether

the knee is flexed or extended or whether the leg is turned-out or in parallel. It can be assumed that if in correct anatomical alignment the leg should be in parallel and will be abducted laterally. In this case flexion or extension of the knee would not make any difference. However, if the leg were turned out, the placement of the knee would affect the outcome, as an extended knee would imply that the hamstrings would have to be involved, rather than just the hip joint. It can also be argued that increased mobility of the toe joints and ankles may be acquired during training, as well as the knee hyperflexion, commonly used in a warm-up to stretch the quadricep muscle group and, if extended at the hip joint, the hip flexors.

The Nicholas test, however, was designed to be more relevant for screening hypermobility in dance, measuring five different positions;

1. **Palms touching the floor with extended legs**
2. **Palms on the floor with shoulders and elbows externally rotated, elbows hyperextended**
3. **Hyperextended knees, equal to or beyond 15°**
4. **180° turn-out at the feet with knees flexed no more than 30°**
5. **Sitting in lotus position ('frog's legs') with legs flat to the floor.**

Even though this test may have seemed more appropriate to dance, it was found that when the manoeuvres that involved lower leg turnout and putting the palms on to the floor were taken out, the dancers were not deemed to be hypermobile. This implied that the ability to perform the omitted criteria was

acquired and ‘not accurate indicators of inherent hypermobility in a dance population’ and that ‘assessment tools used in the dance population must be able to distinguish acquired versus inherited hypermobility, taking into account type and level of dance training’ (Desfor, F, 2003, Vol 7: No. 1).

A test for hypermobility needs to be devised for all sports and arts that rely on the body to be able to cope with increased ranges of motion. Athletes and performers, such as gymnasts, ice skaters, synchronised swimmers, rhythmic gymnasts, acrobats, as well as dancers, all use their bodies to display impressive and dynamic positions and movements that rely heavily on their control of the limbs. Movements that should be measured and monitored could include hip abduction and circumrotation, eversion and inversion ranges of the ankles as well as the flexibility of the wrists. Being as modern dance training often involves floor work, the ability to stabilise the body, putting pressure through the hands and onto the floor, may be a problem to dancers with hypermobile wrists and elbows. Wrist and elbow hypermobility may also become problematic to gymnasts who depend on their arms to be able to perform movements such as those performed on the vault, and during tumbling sequences on the floor. Therefore a valid multidisciplinary hypermobility test should be devised in order to assess the wide range of physical sports and activities.

Measuring rotation, extension and lateral flexion in the torso may also be helpful in monitoring dancers with hypermobility. It could be argued that flexibility in the torso can be acquired through training; however, looking for obvious pivot points along the spinal column may indicate an area of instability and possibly a future injury site. In her letter, Katherine Watkins states that 97% of the first year dancers at Laban ‘had the criteria for a hypermobile lumbar spine’, but concluded that the hypermobility was

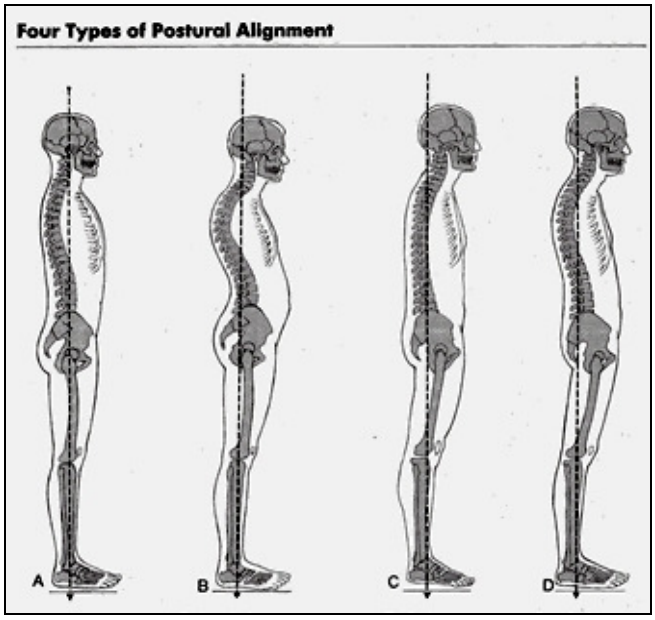
'acquired and so not of much use in the measurement of hypermobility in dancers' (Watkins, K, 24/02/06, personal correspondence. The main objective for a hypermobility test would be to ascertain which joints are overly loose and to then design a program for increasing the local stabilising muscles to prevent possible injury.

Due to the number of different tests, research into hypermobility within various populations around the world should be approached with caution. It is evident that finding accurate figures for hypermobility within various demographics can be difficult due to discrepancies within the scoring systems. As it may not be known which test has been carried out on each group, the data may be deemed unreliable. As mentioned previously, Dr. Hakim stated that hypermobility appeared between 10% and 30% of the adult population. This is an extremely vague result, as it does not mention how many people were tested or whether or not the same test was used throughout, nor was the age, sex or racial background mentioned and which score they used to indicate hypermobility.

The importance of testing dancers specifically for hypermobility as mentioned previously, is too look for possible future injury sites. It will be explored in this section what can be done to ensure that hypermobile dancers can continue training safely and go on to a possible career in dance. Firstly, being able to recognise that a dancer may be hypermobile at the beginning of their training, may help to stop bad postural habits from forming. Making sure that the young dancer doesn't 'sit in their hips', push back into hyperextended knees or over-pronate their feet whilst dancing, may perhaps help them to create a good muscle memory, enabling the dancer to gain better technique by continually practicing the moves in the correct way. The dance teacher should have knowledge of the issues involved with hypermobility, as it is their responsibility for coaching the young dancers. As mentioned at the beginning of the essay, having hypermobility is not a problem as long as the dancer has

control over their body, control that should be encouraged when they first start dancing.

If hypermobility is only detected when a dancer begins their post-sixteen intensive training, then the dancer must try to re-train their body to attain sufficient control. This is important as at this stage the dancer may possibly be doing more classes than previously, probably becoming more and more fatigued and therefore more susceptible to injury due to a decrease in the levels of concentration. Basic stance should be the first issue that the training dancer should look at. It is said that ‘‘postural alignment in hypermobile patients frequently exhibits an attempt to gain more stability through resting at the ends of range of hypermobile joints’ and that ‘hypermobile patients frequently demonstrate a sway-back or a kyphosis-lordosis posture’, (Kerr, R and Grahame, R, 2003:76). In a typical sway-back posture it is possible to notice that the knees are hyper-extended, the pelvis is pushed forward, the thoracic shows signs of kyphosis and the neck is jutting forwards as in posture D in figure 6 below.



(Figure 6)

Re-organising the body into a more neutral and ideal alignment may be difficult as the sway-back posture is the result of years of overcompensation by the body's own sense of balance and would have become habitual. It would mean having to retrain not only the dancer's body but also the way the dancer thinks. Things that may be regarded as simple, for example, imagine being suspended from two hooks that are attached to the ears, may encourage the person to bring their head back into alignment and lift up out of their usual slumped position. Many people use the benefits of imagery to improve their posture or alignment, one such person being Eric Franklin. Franklin uses imagery as a tool for helping dancers overcome problems that occur during their training such as improving pirouettes, increasing flexibility or core stability,

> *When you develop your intuitive imagery, you have a dialogue with the cells of the body. Through detailed attention to the body, the mind of the cells becomes a felt reality, and the intelligent support system behind every tissue and movement becomes available to you. You can fully use the inner resources of the body to improve technique*.
>
> (Franklin, E, 2004:20)

Controlling the hyperextension within the knee joint is a major issue, especially for dancers. Simple alterations in training, such as standing closer to the ballet *barre* during class will force the dancer to pull up and engage the hamstrings, adductors and quadriceps instead of sitting back into their knees. When coming up out of a *plié*, focusing on the inner thigh adductor muscles, such as magnus, longus and brevis, and stopping just before the knees begin to hyperextend will help with the dancer's proprioception of that joint. By repeating this movement often, in the correct way, the dancers muscle memory may eventually acknowledge this change, and will hopefully become the new habit.

Improving core stability and postural control will also help the hypermobile dancer improve their proprioception. The dancer may be encouraged to participate in extra training outside of their usual timetable in disciplines such as Pilates. The inventor of Pilates, Joseph Pilates, was said to have believed that,

> *Imbalances in the body and habitual patterns of movement cause injuries. He observed the links between weak areas of the body and overcompensation (if you are weak in one area the rest of the body has to support the imbalance), and the exercises he devised were based around re-education and the re-alignment of the body.*
>
> (Smith, J, Kelly, E and Monks, J, 2005:51)

By doing Pilates, the dancer will be able to focus on their deep stabilising muscles rather than the superficial muscles, and will hopefully be able to incorporate it into their dance training. By improving core stability, the hypermobile dancer will become increasingly more reliant on the deeper muscles rather than on their ligaments to retain their posture and individual joint structures. Being able to maintain postural control whilst the body is moving is one of the key goals of both Pilates and dance.

Other things that could be incorporated during training may be the use of strapping or support bandages, especially if used during a class where the dancer has been previously injured. This may also help the dancer with their fear of re-injury; however they must not become too reliant on them and work on maintaining control physically. Taking nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen may help to control swelling after intensive repetitive work. However NSAIDs should only be used when necessary and not taken regularly.

Now that the relevant issues involving hypermobility and the training dancer have been presented, including connective tissue structure and the higher rates of injury, the question of hypermobility being detrimental or advantageous will now be explored. Firstly, the claim that 'hypermobility may act as a positive selection factor for entry into ballet school' (Graham, Jenkini, 1972 and McCormack, 2002, in Kerr, R and Grahame, R: 2003/4) will be discussed. After writing to various different dance schools, including ballet schools, contemporary schools and performing arts schools, it was discovered that this statement might not be as relevant in today's modern and contemporary dance institutions. Three letters were received, including one from Dr. Druanne Roberts, physiotherapist at Byrd College in Kent, and one from Katherine Watkins who, as mentioned previously, is the physiotherapist for Laban Contemporary Dance School, confirming that they do screen their dancers for hypermobility.

Watkins mentions in her letter that 'from our screening it is evident that a very low proportion of our dancers are hypermobile' and from that it 'seems to imply that hypermobility is not a necessary factor' (Watkins, K, 24/02/06, personal correspondence). It is mentioned that the Brighton Test was used to determine hypermobility. The main aim of the Brighton test is to screen for Benign Joint Hypermobility Syndrome rather than generalised joint hypermobility, as it takes into account both the Beighton hypermobility score as well as the individuals history of injuries. This information supports the notion for an all round hypermobility test for multidisciplinary activities, to makes comparisons between dance populations more straightforward.

Janet Briggs, the physiotherapist for the Royal Ballet School at White Lodge had responded by sending a recent paper documenting the research that she and others had done, which looked into the relationship between joint laxity,

Benign Joint Hypermobility Syndrome and professional ballet dancers. It was concluded that, 'the prevalence of hypermobility, judged by the Beighton score, was the same in the Upper School and the Company, suggesting that positive selection on grounds of hypermobility occurs early in a ballet career', (McCormack, M, Briggs, J, Hakim, A and Grahame, R, 22/02/06, personal correspondence). In fact it was discovered that 95% of female dancers in the Company and 94% of female dancers in the Upper School had a Beighton score equal to or greater than four. Even if hypermobility had been acquired through training, the majority the dancers were able to control their mobile joints. It was also revealed that the prevalence of Benign Joint Hypermobility Syndrome decreased from 47% in the Lower School, to 46% in the Upper School to just 26% in the Company,

> *However, the prevalence of Benign Joint Hypermobility Syndrome appeared to decrease in the transition from the student to the professional classical ballet dancer and was also underrepresented in the highest grades of professional dancer in both males and females, suggesting that Benign Joint Hypermobility Syndrome may impede a young dancer's chance of becoming a Soloist or Principal.*
>
> (McCormack, M, Briggs, J, Hakim, A and Grahame, R, 22/02/06, personal correspondence)

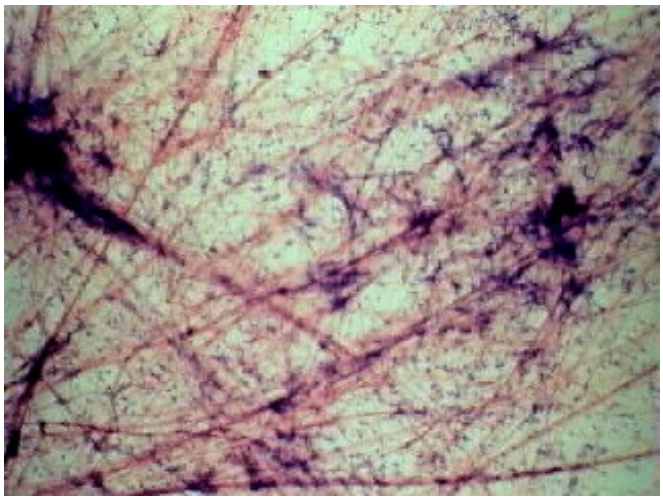
The main debate of aesthetic versus injury is one that can have many outcomes. Long elegant lines and high leg extensions do look more exiting from the audience's point of view. Dance is an art form, not a sport, and is judged on a number of factors such as the style or dance genre, the ease of movement, relationship with the music or whatever preference the viewer has. A dancer needs to be consistently in good condition to be able to cope with the demands placed upon them, whether during training, performing or teaching. A hypermobile dancer needs to take responsibility for their own

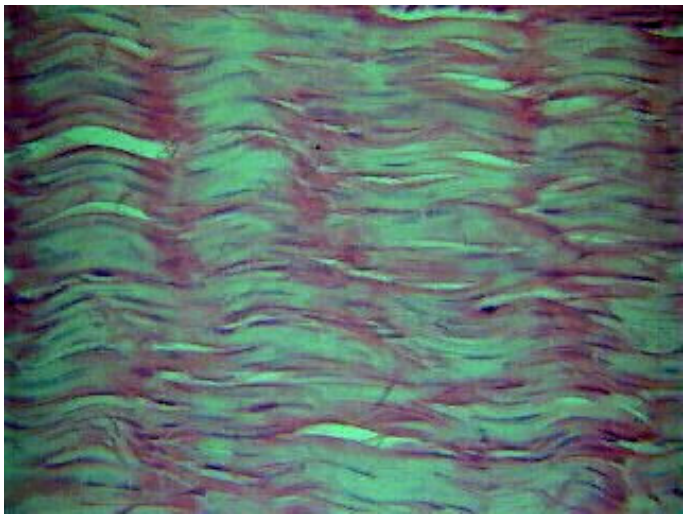
development, acknowledging that without working on their core stability and re-programming their muscle memory to eradicate bad postural habits, they increase their risk of sustaining an injury. If hypermobility has been inherited, knowledge of the issues that have been discussed throughout this essay may help the dancer understand why they are more vulnerable to soft tissue injuries such as shin splints and ligament tears, and possibly more dramatic injuries such as dislocations.

Hypermobility can be deemed advantageous to a dancer as long they have the strength and control needed to cope with the demands of full time training. However, if the hypermobile dancer does not have sufficient body control, they may become more susceptible to injury, thus disrupting their training, leaving them less prepared for a full time career in dance; in this case hypermobility would be deemed detrimental.

Appendix

1) Comparisons between connective tissues, the first picture demonstrates elastic connective tissue, the second demonstrates strong, collagenous tissue.

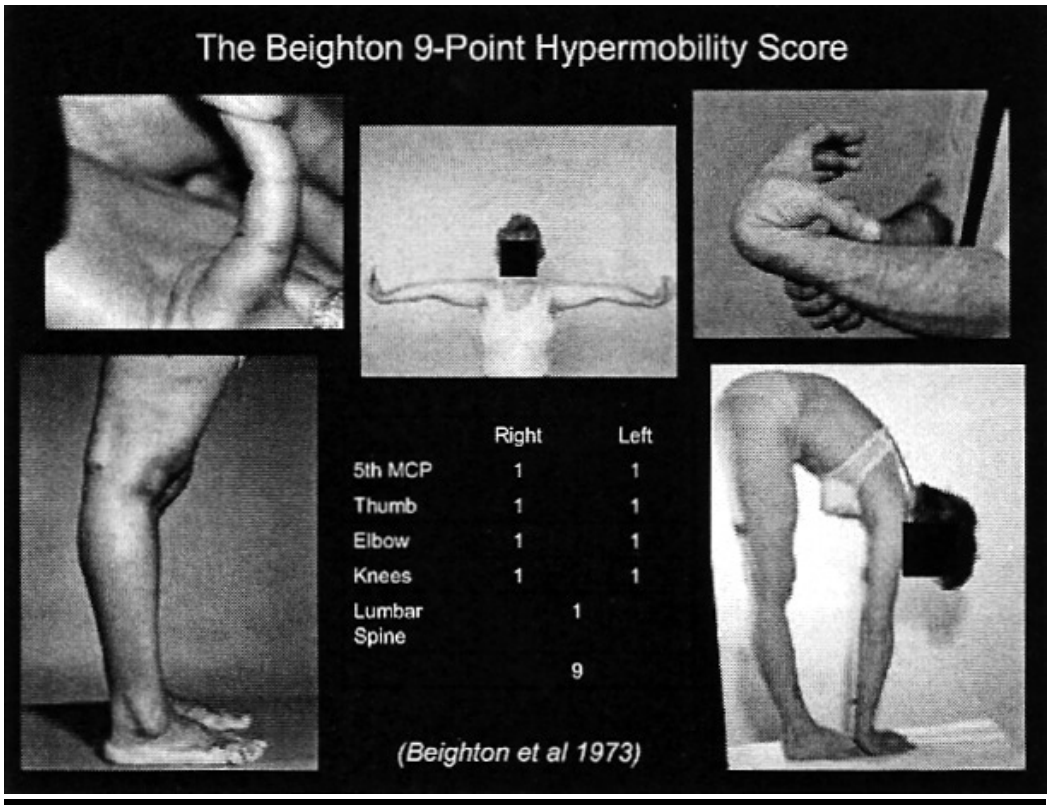




2) Questionnaire

3) The Female Athlete Triad- a condition involving osteoporosis, amenorrhea and disordered eating.

4) The Beighton Test.



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- ***"A Guide to Living With Hypermobility Syndrome for Children and Teenagers"*** Information leaflet produced by the Hypermobility Syndrome Association (HMSA)

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3. Simmonds, J, February 2006, ***Hypermobility*** lecture.

Pictures and diagrams

Figure 1. www.rheumatologyonthebeach.com

Figure 2. www.rheumatologyonthebeach.com

Figure 3. www.yoursportsdoc.com

Figure 4. Kapandji, I. (5th Ed) 2002 ***The Physiology of the Joints: Volume Two, Lower Limb***

Figure 5. Kapandji, I. (5th Ed) 2002 ***The Physiology of the Joints: Volume Two, Lower Limb***

Figure 6. Kendall, F, McCreary, E and Provance, P. (4th Ed) 1993 ***Muscles, Testing and Function***