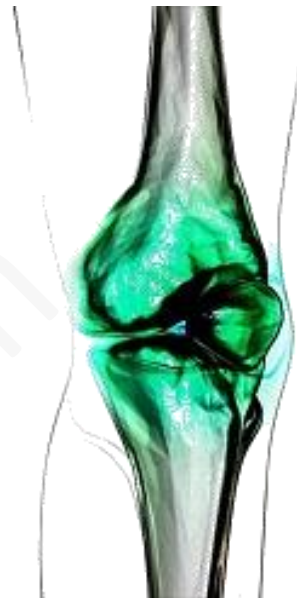
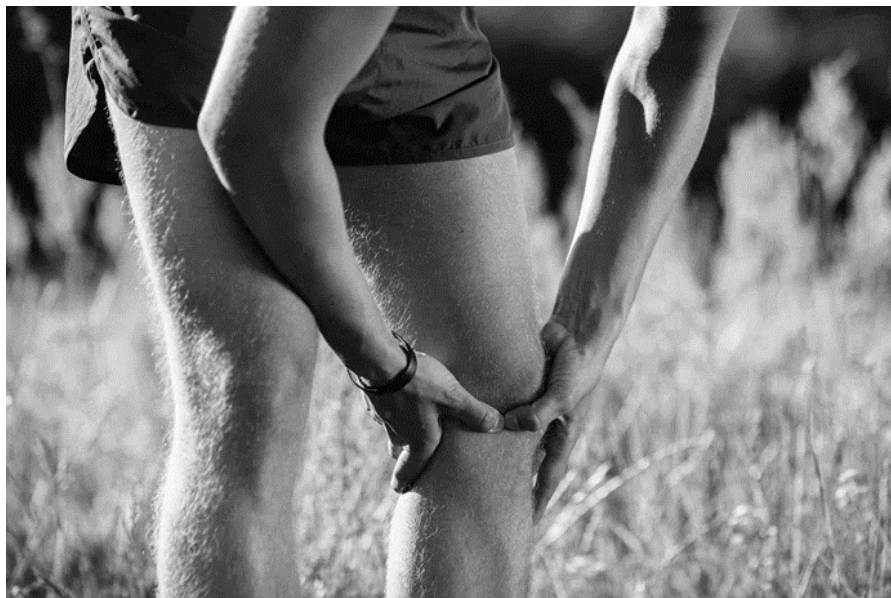


# “A FIBROUS RESPONSE FROM DOWN UNDER”

## ORTHOPAEDIC PRESENTATION



Dear colleagues and interested parties,

This document is part of a series of Orthopaedic Papers and Presentations drawn from the past 40+ years of medical practice I have enjoyed, primarily focused on the treatment of knee injury and degeneration.

The series includes a mix of conference papers presented over the years, as well as general knee injury management reference documents covering some of the challenges and solutions developed during this time.

We needn't reinvent the wheel too often, so I hope these documents prove useful to my fellow surgeons and those interested in the treatment of knee injury, degeneration, recovery and patient care.

Thank you for taking the time to read these papers, and please do not hesitate to reach out to discuss any of the issues covered further.

Iain

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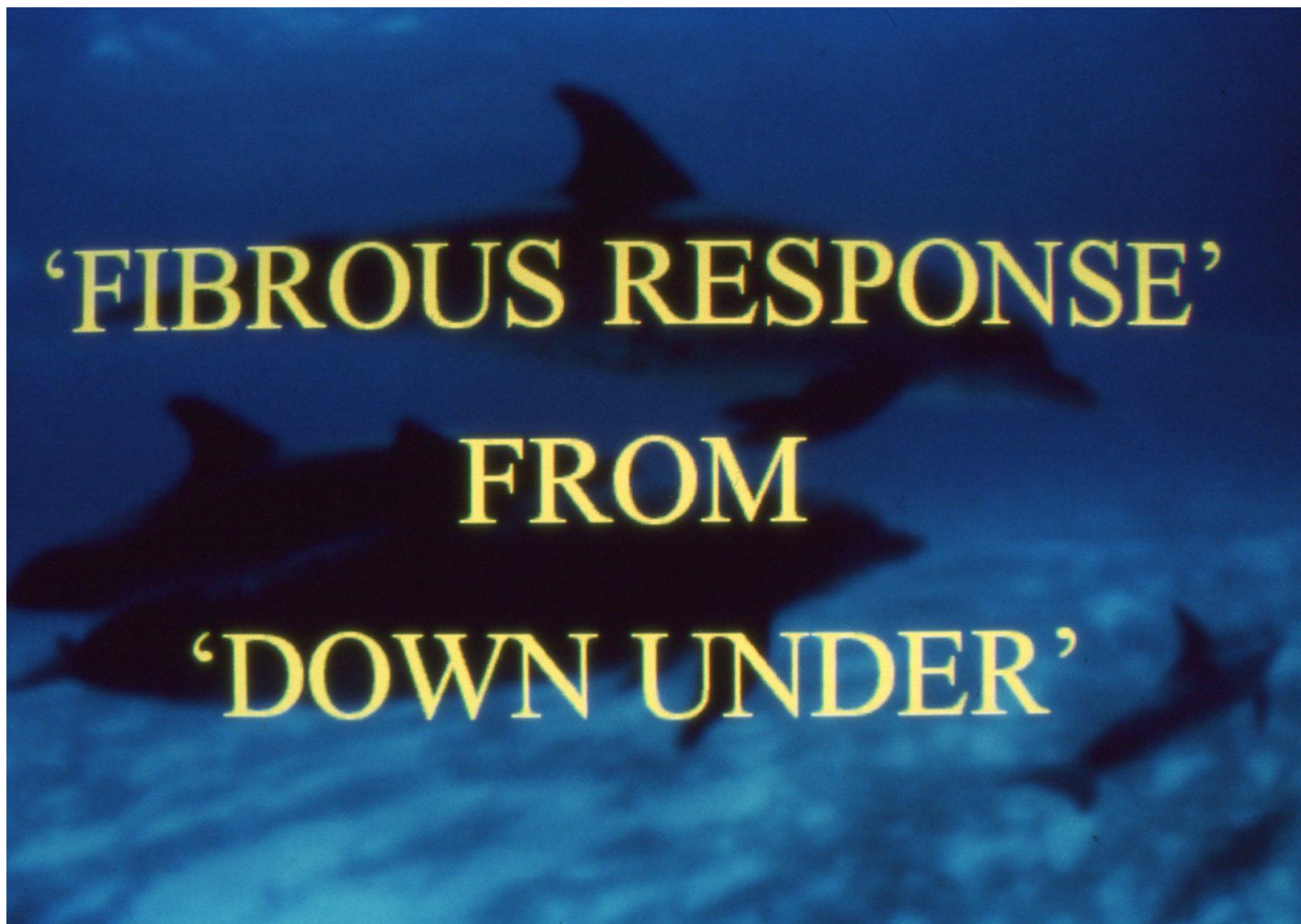
Title: “A Fibrous Response from Down Under”

Date: July 1996 (original presentation)

## “A Fibrous Response from Down Under”

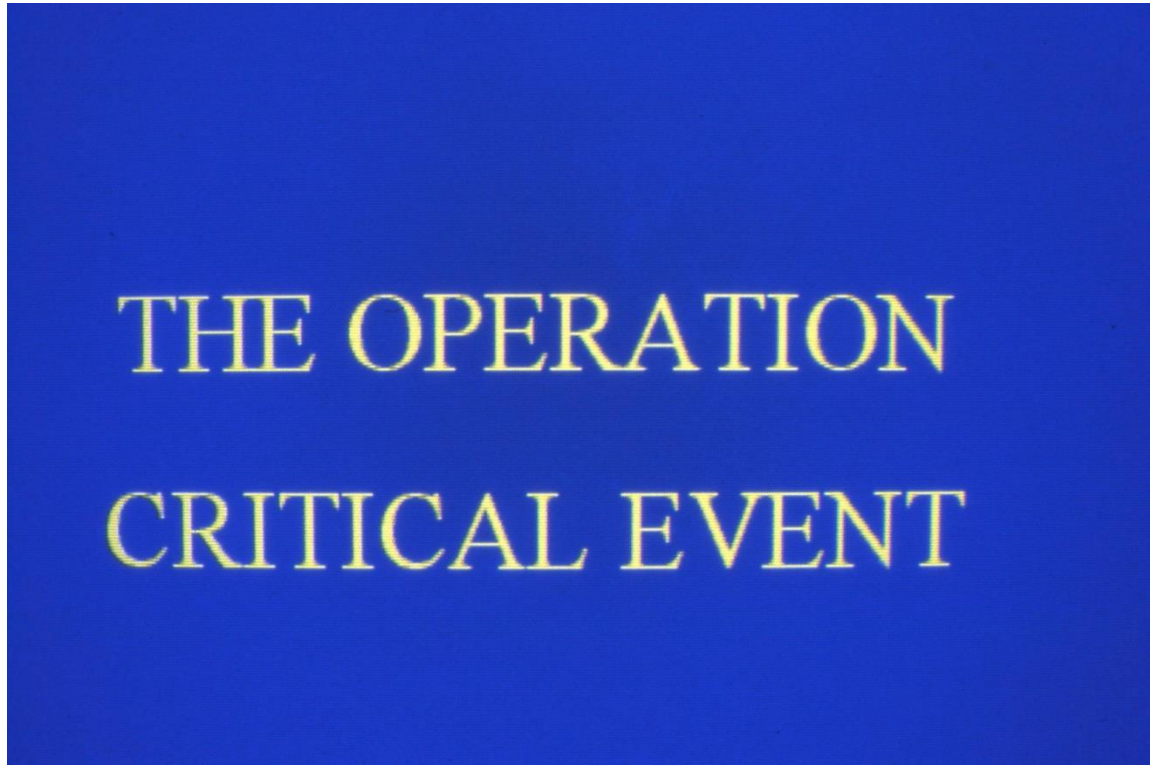
### PRESENTATION DETAILS:

Location: COE Hamilton Island, July 1996  
Title: Knee Injuries: “A Fibrous Response From Down Under”  
Author/Presenter: Iain D McLean, Melbourne, Australia



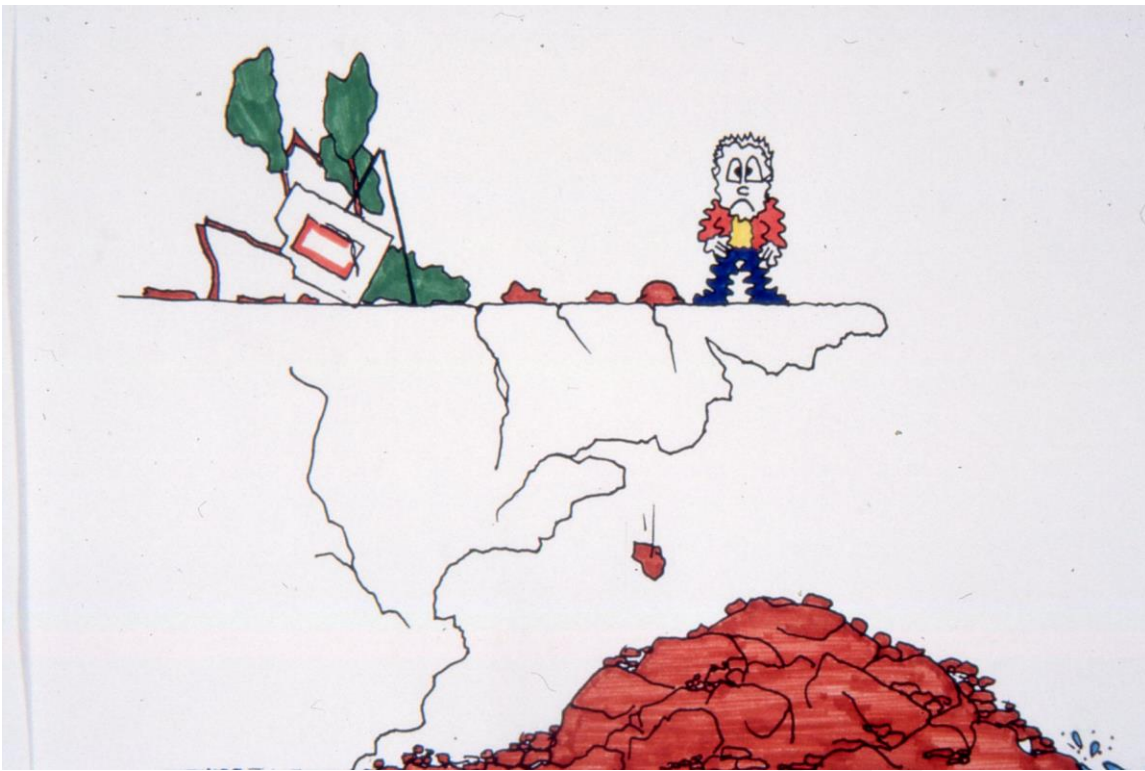
**A. AIM**

1. My aim is to look at and review some of the other factors that affect the outcome of knee injury and ligament surgery. These are not excuses for bad surgery or bad management, but other factors to consider.

**B. POINTS TO MAKE**

2. **The operation is a "critical event"** that will either set up the **sound mechanically basis**, starting point, or possibly doom the knee to failure right from the start – unless we pay attention to the factors we have considered over the last few days such as the **graft strength, its isometrical-physiological-anatomical placement, firm fixation to a raw bone surface, and attention to angles and edges.**
3. We need to consider not only the primary ligament or damage, or the primary surgery, but also the secondary responses to this, and the subsequent complications.

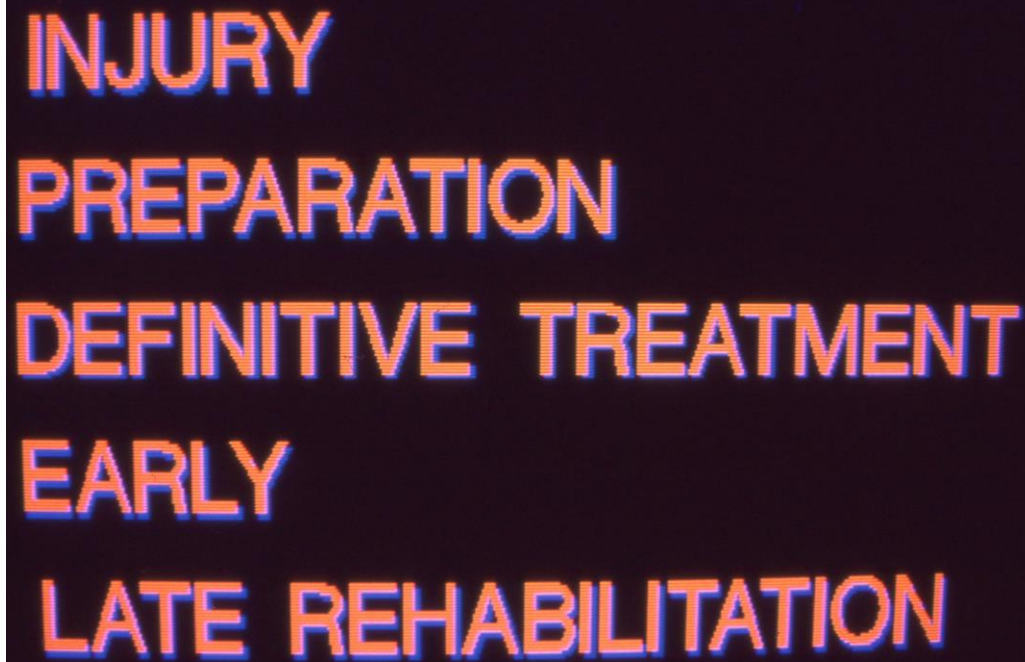




4. This injury and response can be likened to being on a cliff, with an explosion blowing the knee or person apart. The primary damage and the secondary structures are represented by the cliff face.

### C. PATHOLOGY

5. I will quickly review the basic biology and the **concept of initiating synovial fibroblastic response**.
6. And finally, we will look at the difference between the elite level traumatic sportsman and the weekend warrior.
7. We know that injury to menisci, articular surfaces, and to ligaments **heal by a fibrous repair/scar tissue – and not by replication**.
8. **Our clinical and animal studies show us that the tendon graft and "repair" tissues will undergo change in their characteristics and functional adaptation, if subjected to a physiological/Wolff's Law load or stress and given time for "maturation".**

**D. APPROACH**


INJURY  
PREPARATION  
DEFINITIVE TREATMENT  
EARLY  
LATE REHABILITATION

9. In order to reduce our complications and sequelae of injury, our treatment, or surgery, we need to have an approach to the problem.

First off is to assess the injury as a whole and not just focussing on the tissues damaged in the knee, while also looking at the associated problems from intra-articular and peri-articular haemorrhage and CONSIDERING THE RESPONSE TO THESE.

10. A careful history, examination and adequate plain x-rays are fundamental in determining the primary ligament damage, but also the associated injuries to capsule, collateral ligaments, menisci, and articular surfaces.

Most of these injuries can be diagnosed by suspicion over the telephone and confirmed by careful physical examination.

11. The knee is never too swollen or too painful to examine carefully, this in itself does not justify immediate arthroscopy or other surgery.

12. Only by initially recognising and treating the **responses or reactions to injury** can we determine when and if surgical intervention is indicated. The initial response to injury is that of **pain, anxiety, limited range of movement, disability and quadriceps inhibition**. The key is gaining quadriceps control, with co-contraction and proximal patellar movement.

13. There is a **biological repair response** to the injury that may be minimal, inflammatory in nature, or a strong fibrous reaction.

And whenever considering this response to injury or surgery, we need to look at not only the knee but the muscles, the mind, and the 'whole patient' ...as discussed by Don Shelbourne.

14. The **preparation for our definitive treatment commences right from the initial injury**. We are all familiar with the FIRST AID – RICE TREATMENT of rest, ice, compression, elevation; or RICE I treatment.

Patients are so often seen with a swollen, painful knee – they are told to ice the knee, rest, and keep it bandaged until you see the specialist. **They sit, afraid to move, because it may hurt, and cause further damage.** They leave the tight compressive bandage on, causing venous obstruction and oedema, and the risk of producing DVT. They rest and do not attempt to use the muscles, but have their parent, or spouse, lift, or move the limb for them.

RICE I treatment can and does lead to problems of anxiety, quadriceps inhibition, stiffness and Deep Venous Thrombosis.

15. A haemarthrosis or blood is like having **"glue"** in the knee.



16. The KNEE – needs to move to gain full range of movement, so as to lubricate, and for nutrition of the articular cartilage, preventing synovial adhesions, stretching any early adhesions, and aiding the absorption of blood products.
17. **The MUSCLES need to contract.** The quadriceps need to move the patella proximally, so as to prevent fat pad fibrosis in the notch, and reduce patellar compression, and stretching the patellar tendon.
- This should be a co-contraction, noting proximal patellar movement.
18. The MIND – needs to come to terms with the problem. Initially this means controlling the pain and anxiety, so as to prepare for a rational treatment program.
19. The MASS – needs to be sorted out. Such as problems of immobility and the ability to use crutches, and all those factors that "weigh us down" and cause added **problems if we are disabled for any length of time** – such as work, study, family and other commitments.
20. Physiotherapists and trainers need to be aware of **RICE II**;

- a. **Remove bandages**
- b. **Inspect /Instruct**
- c. **Crutches**
- d. **Exercise/ Educate**

21. Whereby they take off the compressive bandages, encourage range of movement, inspect the knee and any calf swelling; showing them how to use crutches to gain mobility, and part weight bearing; and explanation and education, as to how and why the knee needs full range of motion, the muscles need to co-contract, the mind needs to be relieved of pain and anxiety, and the mass needs to be organised.

22. **The big painful knee is not a surgical emergency in the vast majority of cases.** After checking the **neurovascular status** and x-rays, along with considering cruciate ligament and **lateral complex injuries** (but may be an indication for good quality MRI studies), so as to assist with appropriate initial treatment and planning.

**Failure to recognise the response to injury and its inadequate treatment will lead to early problems and this then sets the pattern for "late complications".**

The knee, the tissues, and the patient, need to lose their "irritability" before proceeding with definitive treatment.

SURGERY  
INAPPROPRIATE  
Type  
Timing  
= DISASTER

23. The definitive treatment may entail purely a progressive exercise and rehabilitation program. It may require an arthroscopy and then an exercise program, or leading on to ligament reconstruction with appropriate meniscal or capsular repair.

24. Some patients with varying degrees of ligament laxity can cope (after explanation that they will need to compensate) with straight line activities and a modified activity program.

25. While others are not happy with this restriction of recreational and work activities.



26. While others deny or try to ignore the episodes of instability, pain or swelling that lead to progressive meniscal chondral damage ("**knee abuser**").
27. The vast majority of ligament surgery is elective surgery; – when the patient is "**adequately prepared**" for this, and aware of the demands of the early and late rehabilitation program, and with "realistic expectations".

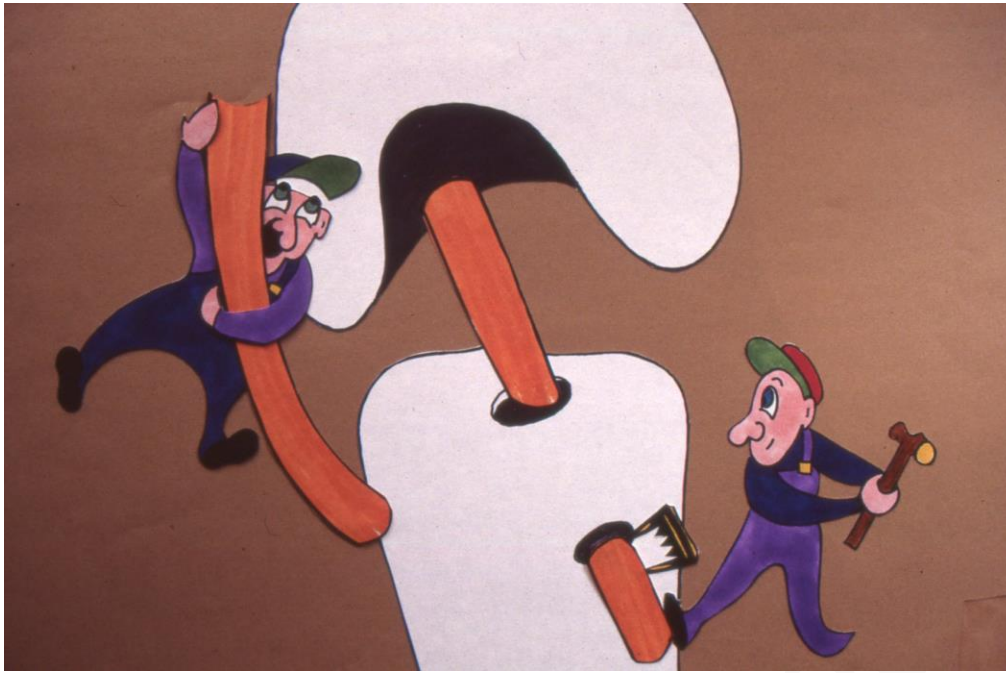
**Quadriceps activation: Recognising contraction with proximal patella movement and ability to perform a sustained straight leg raise is the key to progress, with failure to attain this leading to ongoing problems.**

Surgery may therefore be indicated – maybe in three days, three weeks, three months, or it may never be appropriate.



28. **The OPERATION** – we have seen various ways of technically placing and anchoring a primary patellar tendon or hamstring graft (these acting basically/primarily as a "**collagen scaffold**") within the knee.
29. For those that fail or are re-injured, we have a further selection of various graft materials and fixation devices.  
**The important thing is not so much which graft is used, but that it is anatomically placed and firmly fixed to a raw bone surface.**
30. Whether this is technically done through one incision or through two incisions should be determined by the surgeon's ability to produce these primary mechanical factors, and not purely on cosmetic grounds or..  
**Further consideration may need to be given to peri-articular repair and/or lateral tenodesis.**





31. The operation then will have produced surgical trauma, both in the knee and at the donor site.

The initial mechanical strength of the reconstruction will depend on some technical aspects of harvesting, passage and fixation of the graft, but will also **depend on the quality and quantity of the patient's tissues, with the maximum size of useful graft being determined by the intercondylar notch dimensions.**



**After completion of the technical masterpiece, or otherwise, we need to release the tourniquet and awaken the patient. We then have a "whole new ball game", similar to that of injury.**

32. With adequate preoperative preparation, pre-emptive analgesia and anaesthesia, and expert supervision, progress will hopefully be in the right direction.

The initial problem again is that of pain, anxiety, quadriceps inhibition, decreased range of movement, and disability.

33. Treatment is directed at these responses in the knee, muscles, mind and towards ignoring the MASS of inappropriate advice and comments from the multiplicity of experts who have their opinion.

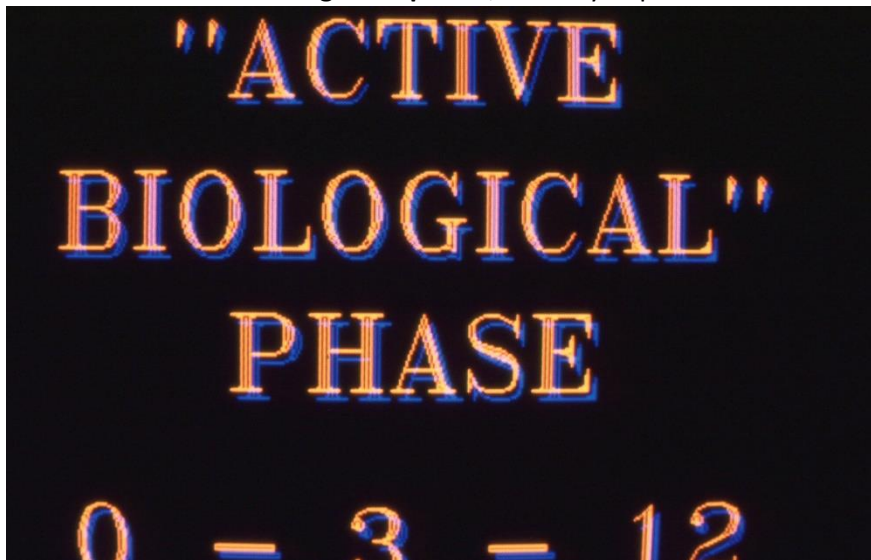
34. **ACCELERATED REHABILITATION** is dependent on the **pre and peri-operative preparation** to treat these individual responses; and surgical trauma.

This can be divided into the early, or biological response period; and into the late, or maturation, phase.

35. The early biological response as seen clinically, does correspond to what we see in the animal studies.

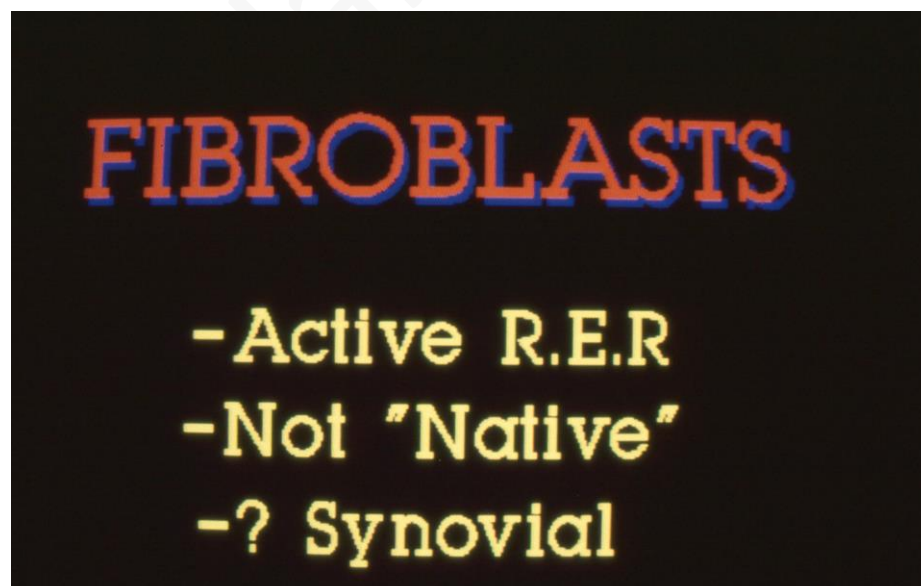
We see –

- i. **The initial reaction to surgery;**
- ii. Then the **"active biological" period**, usually up to around 10 or 12 weeks (**3 months**).

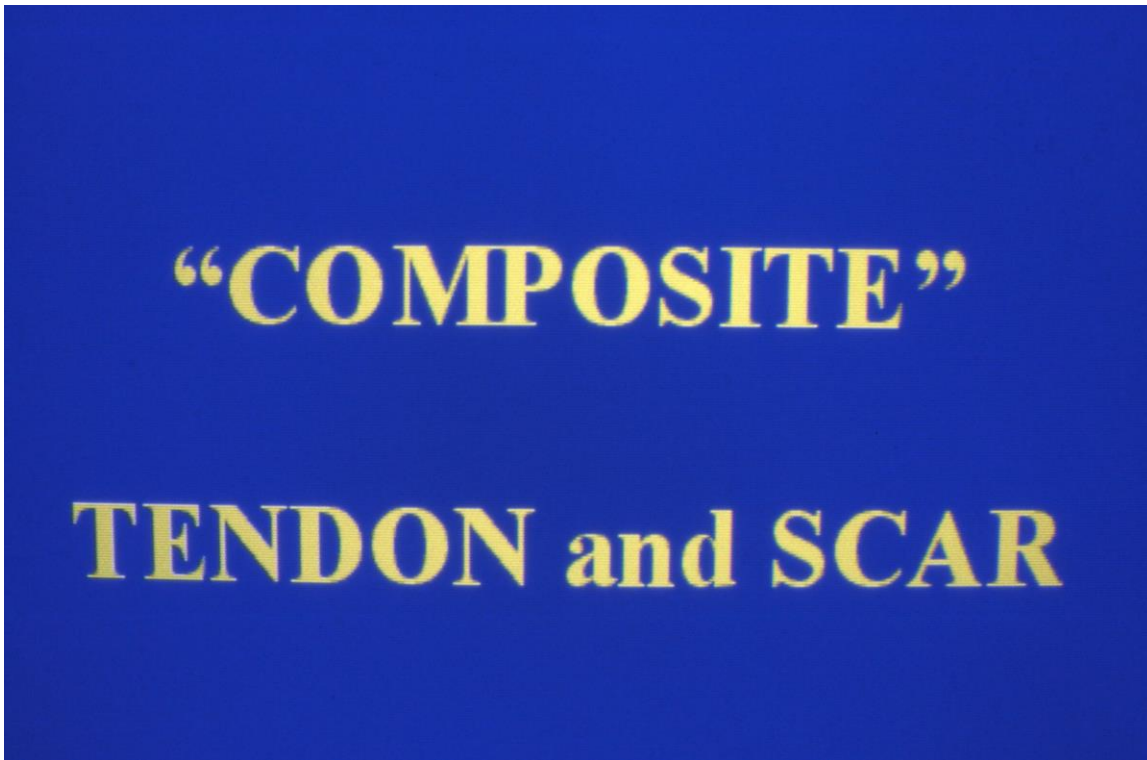


The tendon graft is undergoing change within the joint, and gaining biological fixation to the raw bone surfaces.

36. Our clinical and animal work suggests that within the knee, any injury or exposure of tissue, foreign to the intra-articular environment of the knee – such as the graft, or injury to the ACL exposing its fibres, or any capsular injury – provokes a variable inflammatory response, with rapid cellular invasion, and a repair response. The repair appears to be **initiated by synovial fibroblasts, or other stem cells**, capable within the environment of the knee of producing only small diameter collagen fibres.



37. The result of that response, both in the intercondylar notch and throughout the knee, is dependent on the balance between cellular activity and the fibroblastic production of collagen.
38. We see this fibrous response into, onto, and around the graft; forming a "composite" of graft, tendon; and scar tissue. This undergoes progressive change in material and mechanical properties ("moulding of biology").



39. Clinically we see a spectrum of biological or tissue healing responses.
40. Some knees show –
- (1) **NO RESPONSE** – to injury or surgery – with very little pain, minimal haemorrhage, almost immediate muscle control, rapid range of movement, but with progressive stretching and laxity of the knee (creep). The graft arthroscopically is flimsy, loosely bound and lax. This is seen more commonly in the young hypermobile with recurvatum.
  - (2) **DRY FIBROUS RESPONSE** – results in a synovial fibroblastic activity and collagen deposition into, onto, and around the graft; and into intra-articular blood and fibrin clot; throughout the knee.
    - a. **WITH QUADRICEPS INHIBITION** – and lack of patellar and joint movement, we have poorly organised deposition of collagen and scar, in the intercondylar notch, suprapatellar pouch, and lateral gutters. The fat pad fibroses and the patellar tendon may contract, leading to patella infra and a block to extension, with secondary patellofemoral problems and degeneration; and in less extreme, to the origin of Cyclops formation.

This is more commonly seen in the acute knee, with arthrotomy or associated surgery, patellar tendon grafts and particularly in the anxious, apprehensive patient, who has had no previous experience of significant injury, surgery or pain.

Pain may potentiate this fibrous response by a sympathetic type reaction.

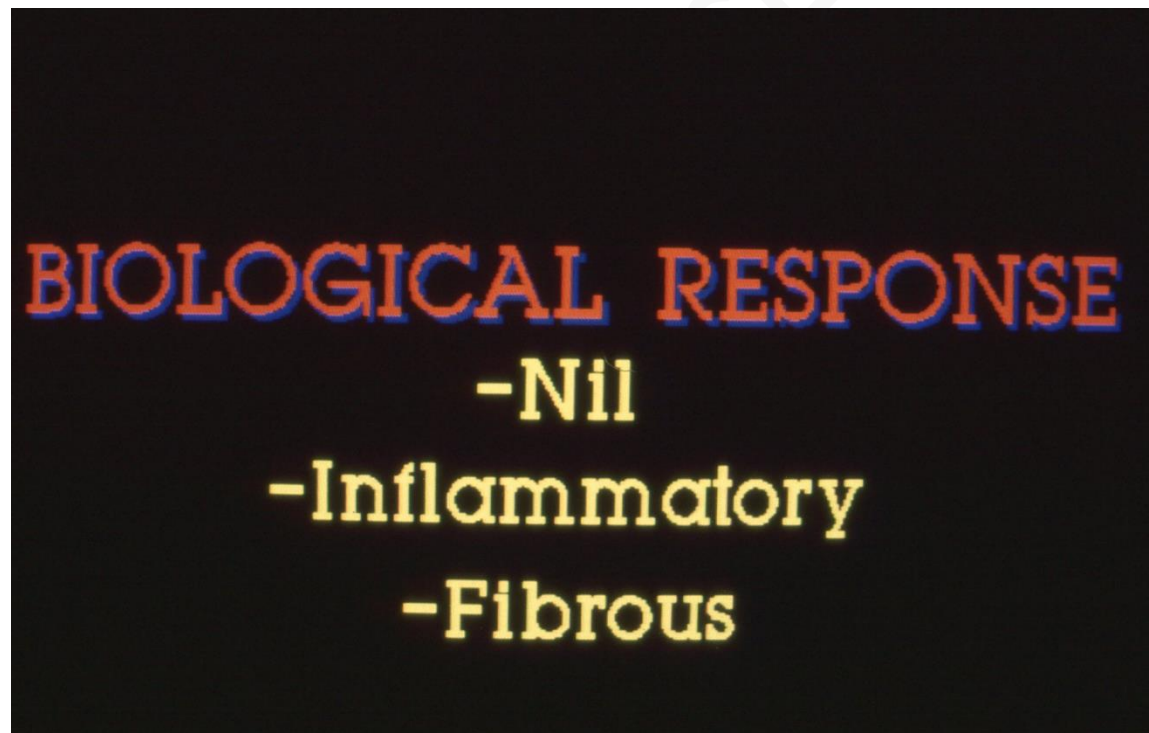
- b. If, on the other hand, we GAIN QUADRICEPS FUNCTION – with proximal patellar movement and quadriceps hamstring co-contraction, early full extension and knee flexion, the collagen deposition is "moulded" in the:
  - i. intercondylar notch to form a firm, tightly bound replica of the original ACL
  - ii. and in the suprapatellar pouch and lateral gutters.

This occurs more commonly in the **adequately prepared** competitive and elite athlete.

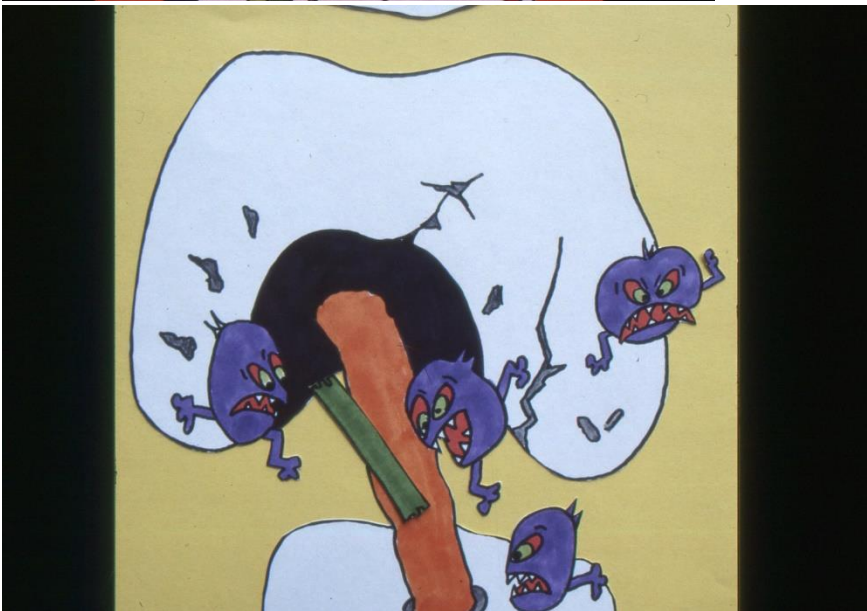
(3) **INFLAMMATORY RESPONSE** – if we have a significant inflammatory response, as a result of:

- a. primary inflammatory predisposition
- b. secondary to a
  - i. haemarthrosis, or
  - ii. internal derangement of meniscochondral lesions, or
  - iii. because of doing "too much too soon".

There is persisting joint effusion – with increased cellular activity – "inhibition of" collagen synthesis, organisation and maturation occurs – with soft, boggy, stretchable tissues – and the articular surfaces are at risk from lysosomal activity.







**The quadriceps and VMO activity is inhibited**, with failure to improve, in the presence of an effusion.

This inflammatory response often leads to a weak, flimsy graft, at risk of "creep" or rupture, particularly if the muscles are inadequately rehabilitated.

We need to be aware, and advise our patients, of these responses, but recognising that generally there is a spectrum.

**If the patient does nothing the knee may stiffen and the muscles waste.**

**Yet on the other hand, if attempting to do too much too soon with inappropriate exercises/activities, the knee will become sore and swollen after the activity.**

We need to **find the appropriate "individual" level of activity in this phase.**

This period goes through to approximately 10 to 12 weeks from surgery – when we start to see less reactivity and irritability to the knee. The soft tissues and ligaments appear to be maturing by losing the soft, boggy look.

**LATE – MATURATION PHASE** – after this 10 to 12 week period that corresponds to decreasing cellularity in the animal model – we can begin to (with a graduated, progressive and appropriate program) push for **STRENGTH, ENDURANCE AND PROPRIOCEPTIVE TRAINING**.

This is dependent on –

- a. the original "injury" or pre-existing meniscochondral pathology or lesions;
- b. progress through the early rehabilitation period without problems; and
- c. time, effort and commitment; over a minimum of 8 to 18 months



41. It needs emphasising to the patients before considering ACL reconstruction that they will need to undertake a consistent progressive exercise routine, becoming **"fitter than they have ever been"**, otherwise they could be "worse off" following surgery than if they had been treated conservatively.

42. This particularly applies to the under 18 years and the over 30 year olds – those with heavy study, work or family commitments, and those who have not been committed to a regular fitness routine in the past.

Specific caution with regard to third party/WorkCover.

43. The biggest problem of practising knee surgery in Melbourne is that the press has educated people to think that no matter what the problem is; following arthroscopy, one is back to normal in two weeks.

44. And, with a "knee reconstruction", will be playing better than ever in three to six months.

45. The statement "but what about the League footballers", follows almost any attempt to explain any joint pathology.

Whether to a 20 year old or a 50 year old, overweight, degenerative "athloid" individual.

**The difference between an "elite" athlete and a "couch potato" is usually obvious to everybody except the "couch potato" himself!**

# THE PROTOPLASM 'MATERIALS' ARE DIFFERENT

46. The **"protoplasm" is not the same**. The surgery from the technical aspect is the same, whether done in an elite sportsman or other, but the materials we are working with are "different".

The public often has the impression that the elite athlete has better or preferential treatment – and want or demand the same. They want to see the surgeon who had "what's his name..." back playing so soon after injury.

47. It can be like comparing the servicing of a new Mercedes Benz car by a "selected" mechanic with the servicing of an old Toyota or FJ Holden, by the same "selected" mechanic, and expecting that all those cars will perform the same after their service/repair.

48. Our "elite" surgical colleagues have presented results of their elite athletes.

In my practice a **review of 200 ACL reconstructions that included a high percentage of associated lateral tenodeses** –from 1991 and 1992 – showed that 25% were Grade I athletes (professional and top level amateur athletes), 49% were Grade II (regular highly competitive athletes), 24% were Grade III (regular recreational sportsperson), and 2% Grade IV (no regular sporting activity, but with occupational demand – tradesmen).

49. 80% of Grade I sportsmen, following a primary ACL reconstruction, returned to the same level of activity after 12 to 18 months, but taking over 2 years to attain their previous performance levels.

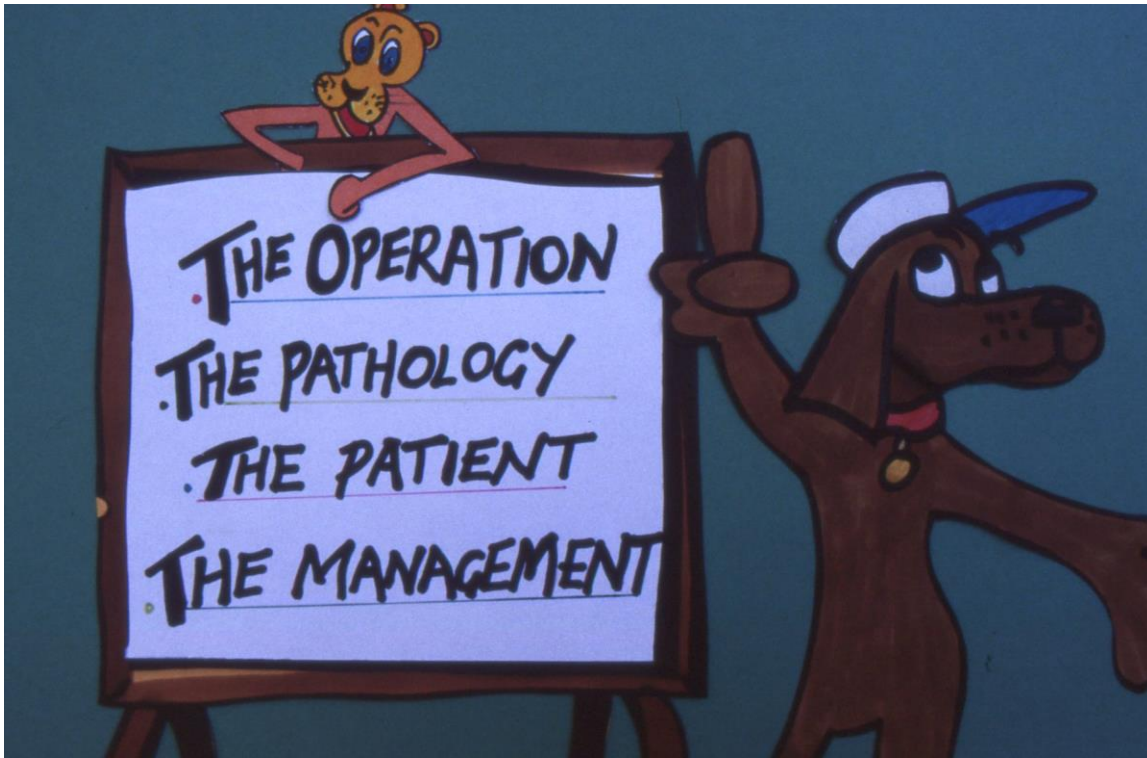
Whereas 50% of Grade II and 30% of Grade III dropped a level – for a multiplicity of knee and other reasons – usually work, study, family, and being worried they may "do it again".

50. Despite this seeming high rate of reduced activity levels, the overall patient grading or subjective rating of their knees showed that the majority (85% to 90%) rated themselves as **good to excellent for the lifestyle they had adopted** – with 94% stating, in retrospect, they would undergo the same course of action.

**Note: all of these are carefully selected, prepared and followed-up for a minimum 8 to 18 months post-surgery; and may reflect on my practice location and the type of sports undertaken.**



There was **no real difference between those reconstructed in the first three weeks**, or those reconstructed after three months, which is little different to some of the recent reported literature; but all **having gained quadriceps function, range of movement and "come to grips" with the problem preoperatively**. But, what is statistical success and is it meaningful?



51. The conclusion from this study was that the most consistently good functional results (maybe in the relatively short-term), occurred in the Grade I – elite level – contact or traumatic sportsperson – almost despite the degree of injury, and despite, or maybe because of, undergoing acute surgery.

From this, there are a number of factors relative to these groups of sportspeople that do have a bearing on the clinical outcome, and certainly worthy of note when we are faced with the statement – "what about the footballers".

These athletes are:

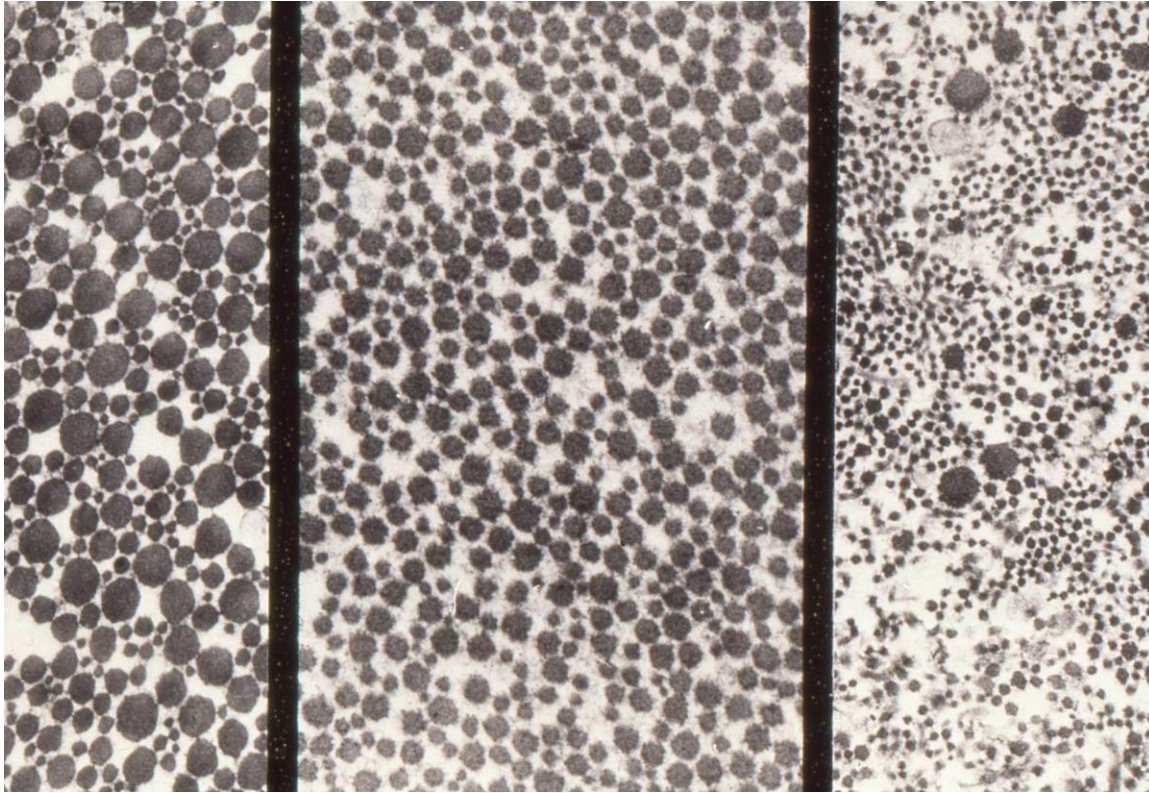
- Aged 18 to 30 years (in their prime)
- Physically fit and developed, with trained soft tissues
- Excellent proprioceptive and neuromotor function, with body awareness
- Tissue type – with ability to heal soft tissue injury
- Experienced to overcome pain, with previous injury and/or surgery
- Determination – the psyche and motivation to overcome setbacks
- Time, equipment, and trained personnel to devote to appropriate preoperative and post-surgical rehabilitation – and to complete the required program.

52. This is a select group of elite athletes who "generally" have a soft tissue capacity to undertake that level of traumatic sport or otherwise they would not have reached that level (not been eliminated in the junior ranks).



But what about the vast majority of patients who are anxious, non-trained, with a first-off injury? They require greater attention to: indications, preparation and timing of surgery, if necessary. They then need more guidance, reassurance and motivation so as to prevent the problems of ACL injury and surgery.

**53. In summary – our clinical and animal studies show us that our intra-articular tendon grafts will undergo changes in their characteristics with time. The normal ACL ultra structure and biomechanics has not been replicated.**

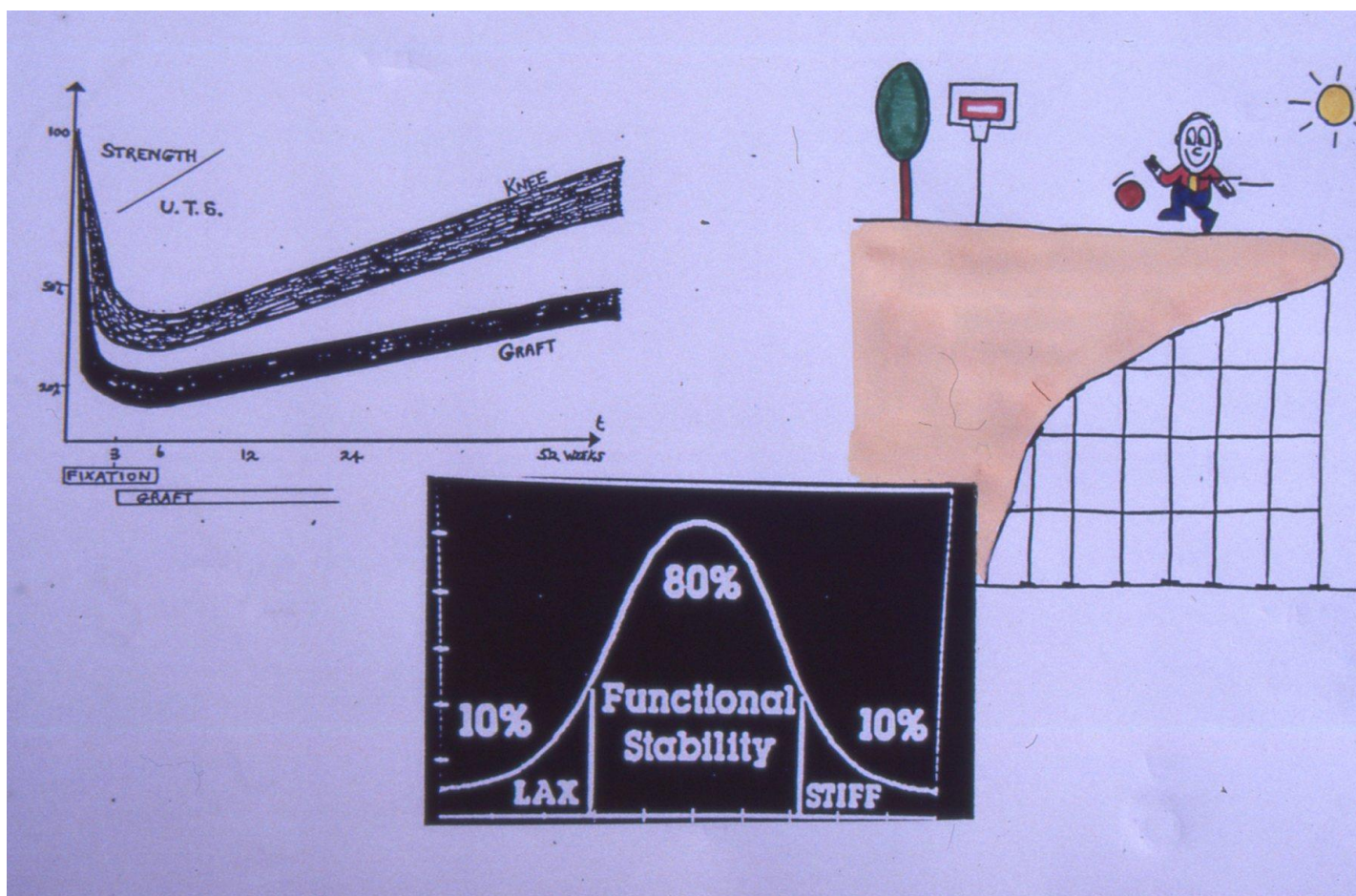


**54. Functional stability may result, by**

- i. eliminating or reducing the size or speed of the pivot shift; or anterior translation of the lateral tibia on the femur
- ii. dealing with any IDK, and
- iii. preventing secondary patellofemoral problems of pain, swelling, crepitus.

**55. In conclusion – if the basic parameters of current surgical techniques are followed, it is the belief of the authors that:**

***The biological response and our ability to control it, is as vital as the surgery and the primary mechanical properties of the graft; and may be the major factor in determining the clinical success or failure of such procedures.***



56. I leave you with these flow diagrams as illustrating the major components and points discussed.





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Iain D McLean