Clinical Case Report Competition

West Coast College of Massage Therapy

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Third Place Winner

Liz McLaughlin

The effects of myofascial release on scar tissue formed at the knee joint as a result of a total knee arthroplasty
Abstract

Objective: This study investigated the efficacy of specific massage therapy techniques as treatment for scar tissue build up, which decreased active range of motion at the knee joint after a total knee arthroplasty.

Case Selection: A 61 year old male, diagnosed with end-stage lateral compartment osteoarthritis of the left knee, further lead to a total knee replacement (arthroplasty).

Methods: A protocol of five sixty minutes treatments over a period of fifteen days was adhered too as well as a homecare plan. Massage Therapy techniques were applied. The majority of each treatment was comprised of manual myofascial techniques and frictions. The focus of the treatments was on the 9” scar running longitudinally over the left knee. Osseous, capsular, muscular and superficial tissues in the area were also affected.

Results: Patient experienced an increase in active knee flexion, easier extension of the knee (straight leg) as well as regained strength and stability of the entire knee complex. Pain and stiffness subsided accordingly.

Conclusion: It was found that massage therapy techniques in combination with a rehabilitative program and hydrotherapy are effective at increasing range of motion (flexion/extension) at the knee after a total knee arthroplasty. Further research is required to validate this report and establish possible long-term effects of myofascial release techniques on scar tissue.
The Effect of Myofascial Release on Scar Tissue
Formed at the Knee Joint as a Result of a Total Knee Arthroplasty

John F. Barnes said “Healing is not an event, it is a process”. Understanding the healing process in any circumstance is important for the therapist. In this case report, the effects of massage therapy on the formation of scar tissue, following a total knee arthroplasty, will be investigated.

**Background**

The formation of scar tissue (fibrosis) can develop as a result of trauma, surgery, prolonged immobilization or progressive chronic joint diseases (Hertling and Kessler, 2006). A scar is an anatomic barrier that limits soft tissue releases and will prevent an end-feel from being reached during range of motion of a joint (Manheim, 2008). This restriction is present in this case report, where the patient’s superficial, visible scar extends to deeper structures and is preventing normal tissue movement.

Normal tissue is dense, regular elongated fibers running in the same direction (tendons/ligaments), or dense irregular loose fibers running is multiple directions. When tissue becomes damaged it heals in a haphazard pattern (scarring – a fibrous build up of tissue) and results in restricted motion and very often pain. “Scar tissue” involves a “re-absorption of excess collagen, realignment of collagen fiber orientation and changes in
the intermolecular cross-links within the collagen tissue” (Hertling and Kessler, 2006). This formation will have effects on fascial tension, causing restrictions in soft tissues and therefore postural changes in the body.

Fibrosis is a normal development in post-operative patients affecting both men and women of any age. The primary objective of this case is to determine the effects of specific massage therapy techniques when applied to scar tissue, formed, as a result of a total knee arthroplasty. The goal of this study is an increase in range of motion, and a decrease in knee stiffness with a complete return to a pain free, active lifestyle.

**Anatomy of Fascia**

To comprehend the complexity of the fascial system, it is important to understand structural concepts and anatomy of the fascia.

Fascia is the most pervasive tissue in the body, representing a three-dimensional network from head to toe (Manheim, 2008). Fascia is a mobile connective tissue, derived embryologically from mesoderm and composed of an elasto-collagenous complex (Schultz and Feitis, 1996) that surrounds and infuses every organ, muscle, bone, nerve and blood vessel all the way down to the cellular level. This connective tissue is responsible for the continuity of movement through the body (Schultz & Feitis, 1996). The fascial connections and pathways through the body contribute to balance among structures. No one part of the body moves or functions without interaction with all other body parts (Schultz & Feitis, 1996).
Fascia is divided into three layers; superficial fascia (hypodermis), deep fascia and subserous fascia (Manheim, 2008). The superficial fascia lies beneath the dermis and consists of loose connective tissue and adipose tissue. It is attached to the underlying tissue and organs. Deep fascia is a dense band of fibrous connective tissue that separates the muscles into functioning myofascial groups. It compartmentalizes the body, separating and surrounding visceral organs (Manheim, 2008). The deepest layer of fascia is the subserous layer, which surrounds and lubricates the internal viscera, as well as encasing the central nervous system and brain (Schultz and Feitis, 1996).

Fascia contributes contour to the body and provides lubrication between structures for movement and nutrition (Manheim. 2008). It allows the body to retain its normal shape and maintain the vital organs in their correct positions. This avascular structure organizes itself along lines of tension imposed upon it, and thus can create unrelated clinical results elsewhere in the body (Rao, 2010). Along with tension lines, adhesions can develop and in this case, specifically scar adhesions, which have been formed as a result of a total knee replacement (surgery). An extensive amount of scar tissue has been laid down affecting soft tissue, from the skin to the subcutaneous tissues, the superficial and deep fascias and the muscles. The scar adhesions have been a source of chronic pain for this patient. These restrictions have produced impaired mobility of soft tissues and motor dysfunction, leading to movement restriction at the knee joint.

There is often a tendency for connective tissue to wrap a joint as stress within the joint increases (Schultz & Feitis, 1996). This will call for more stability. A well-balanced
joint will have full range of motion, and the wrapping will be sufficient to stabilize the joint and flexible enough to ease off when the joint is not active (Schultz & Feitis, 1996). When a joint is unbalanced or shortened it accumulates excess tissue. The knee complex can shorten and thicken and can be wrapped by fascia is such a way that it is held in a bent position, unable to lengthen out (Schultz & Feitis, 1996). This immaturity in the joint will create contraction in the connective tissue structure. A tightly bound joint will create tissue irritation resulting in chronic joint pain. A total knee arthroplasty will produce this immaturity in the joint resulting in an absence of ease and full range of motion.

**Case Introduction:**

The case study participant is a 61 year old male who works in construction administration. He had an open lateral menisectomy over 30 years ago on his left knee and has had no problems until 7-8 years ago, when the knee became more symptomatic and debilitating as a result. Pain in the lateral knee was his major complaint after a minor twisting injury. He tried Glucosamine and anti-inflammatory as well as bracing without any benefit. He was only able to walk 30 minutes at a time and walked with a limp. There were no complications around the time of his lateral menisectomy.

In January 2007, the patient was referred to an orthopedic surgeon for further management of the knee. On examination, the patient stood with slight valgus alignment of the left knee and walked with an antalgic gait, favouring the left side. A well-healed
scar longitudinally over the lateral aspect of the knee was present from the open meniscectomy. There was slight swelling at the knee and thickening of the surrounding tissues. Tenderness was primarily along the lateral joint line and to a lesser degree medially. Patellar grind test was negative. Range of motion was reasonably good with flexion to 125 degrees. The knee was stable ligamentously with slight pseudolaxity resulting in correction of the valgus malalignment. X-rays demonstrated tri-compartment Osteoarthritis with the most severe involvement of the lateral compartment. There was almost no remaining joint space laterally. Significant subchondral sclerosis and osteophyte formation was seen as well.

With the knee becoming more and more symptomatic and debilitating the subject has become more sedentary and thus gained weight and activities of daily living (ADL’s) have decreased.

In summary, this patient had a history, physical findings and x-rays consistent with advanced degenerative arthritis, primarily affecting the lateral compartment of the left knee resulting in a valgus deformity. The only definitive treatment option at this point was a total knee arthroplasty.

In February 2007, the patient went in for surgery (total knee arthroplasty). Postoperative results included pain and significant swelling through the knee and distal thigh. Range of motion was quite stiff at this early postoperative stage with 85 degrees of knee flexion. Conservative measures were instructed including Advil and icing as often as possible.
Nine weeks postoperative, the patient still presented with increased knee stiffness, but a significant decrease in the swelling. He experienced improvement in mobility but the range was still restricted from 2 to 92 degrees of knee flexion. A decision was made to proceed with a manipulation under general anesthetic with Cortisone and a local anesthetic injection at the same time.

To begin with the knee had near full extension and passive flexion of 90 degrees. After the manipulation the subject had 115-120 degrees of flexion. There was some good crepitus during the manipulation, indicating a breakdown of scar tissue.

At this point, the subject was left with a postoperative plan to see a physiotherapist and work at increasing range of motion as well as strengthening of the knee joint.

Patient’s current complaints are decreased range of motion of the knee joint in flexion, and occasional stiffness through the lateral left knee. The patient experiences relief with heat, ice and rest. The patient is not seeking any other medical treatment during this trial. Patient is currently taking 10mg of Atacand once a day to maintain and regulate his blood pressure (normally high BP). He takes an oral dosage of Metaformin (500mg) twice a day for his Diabetes. He takes 81mg aspirin once a day. Patient’s goals are to increase active flexion of the left knee, and regain strength and stability.
Subjects XRAY: End Stage OA of knee 2007, pre-operative
Subjects X-RAY: post-operative - 2008
Subjects XRAY: post-operative – 2008

Baseline & pre-treatment photo of left knee - 2010


Literature & Research Review

Total replacement of the knee complex has become a common and worthwhile procedure for patients suffering with end-stage knee osteoarthritis (OA). Zeni, Axe, and Snyder-Mackler (2010) suggest that knee replacements are effective in managing pain and disability associated with OA. When function and mobility is compromised and pain has progressed to significant levels (severe pain on walking, pain at rest, or nighttime pain), a joint replacement will be recommended (MTABC, 2002). It is important to note that the success of a surgery relies heavily on a patients’ rehabilitation post-operation. While more than 90% have successful recoveries, complications may still arise such as infections, deep vein thrombosis, limitation of motion requiring manipulation, patellofemoral arthritis, heterotopic bone formation, deformities, and fractures (Lovelock, Griffiths, Silverstein and Anson, 1984).

Another development associated with knee replacements is arthrofibrosis, clinically defined as “abnormal scarring of the joint in which the formation of dense, fibrous tissue and tissue metaplasia prevent normal range of motion” (Freeman, Parvizi, Della Valle and Steinbeck, 2009). Characterized by synovial hypertrophy and capsular thickening (Boldt, Munzinger, Zanetti & Hodler, 2003)), arthrofibrosis is diagnosed on the basis of reduced range of motion, knee pain, palpable synovial thickening, hemarthrosis and extraarticular abnormalities (Boldt et al., 2003)). Numerous tissue changes, inflammatory factors, increased cell proliferation and increased matrix deposition all contribute to this condition (Freeman et al., 2009). Post-operative patients will ultimately
go through an intense healing process as the body begins to repair itself after surgery. The healing response results in the migration of inflammatory cells (neutrophils and monocytes) to the site of injury (Freeman et al., 2009). The recruitment of fibrocytes undergo proliferation, differentiation and ultimately deposition of matrix. A balance between cell proliferation, matrix production and tissue remodeling must occur for normal healing. For restoration of the tissue to a functional state with the prevention of fibrosis, a resolution of the inflammatory response is critical (Freeman et al., 2009).

In Freeman et al.’s (2009) journal article on arthrofibrosis following a total knee replacement, it investigated whether a “dis-regulated production of reactive oxygen species (ROS) and nitrogen species (RNS) mediates matrix protein and DNA modifications, which result in excessive fibroblastic proliferation”. There was a direct correlation between intensity of inflammation and the ROS/RNS to the amount to heterotopic ossification. They found increased numbers of macrophages and lymphocytes in arthrofibrotic tissues compared to their control tissues. Based on the findings of this study by Freeman et al (2009) they suggest that reactive oxygen and nitrogen species initiate and sustain the arthrofibrotic response driving aggressive fibroblast proliferation.

Fibrosis is the repair and replacement of inflamed tissues or organs by connective tissue (Tabers, 2001). Normal healthy cells are being replaced by fibroblasts and eventually the replacement of normal organ tissue by scar tissue. This process of laying down ‘scar tissue’ is what causes restriction and often a decrease in functional mobility early on after surgery.
Early post-operative functional activity levels of patients after total knee replacements vary tremendously. Bakirhan, Unver and Karatosun (2009) compared functional activity levels of patients having undergone unilateral and bilateral total knee arthroplasty (TKA). Patients having undergone a bilateral TKA decreased more in functional activities than those who experienced a unilateral TKA. There were improvements in both groups post-operative however improvement in walking speed was significant only in the unilateral TKA group.

The primary goals of a total knee arthroplasty (TKA) are pain relief and improvement in function and range of motion. It is possible however for complications to arise, as with any surgery. Kim, Nelson and Lotke (2004) investigated the prevalence of stiffness after total knee arthroplasty. Stiffness was variably referred to as arthrofibrosis and limited motion resulting in a disabling complication. Stiffness after a TKA was attributed to many factors, including a biological pre-disposition, limited pre-operative motion, intra-operative technical problems, poor patient motivation and inadequate post-operative rehabilitation (Kim et al., 2004). Revision treatments for these complications have been reported quite successful and include; manipulation under anesthesia (which this case study participant had to undergo), arthroscopic debridement of scar tissue, release of the posterior cruciate ligament and arthrolysis and exchange of the tibial insert (Kim et al., 2004). Stiffness was found to be an uncommon but disabling problem after total knee arthroplasty.
The degree to which scar formation interferes with a patient’s recovery and rehabilitation depends significantly on their early post-operative work. The age of a scar does not affect its potential for being released (Manheim, 2008). However, a newly formed scar is easier to release than an older scar (Manheim, 2008). A layer by layer approach to scar release is essential in working through the superficial scar and into its deeper adhesions (Manheim, 2008). Alternating between releases of surrounding tissues and the scar itself will lead to a final end-feel and free tissue movement. The scar releases need to be repeated in multiple treatments until a maximum availability and movement have been achieved. This ongoing process will allow the entire body to accommodate the increased freedom of movement.

Myofascial Therapy facilitates the mechanical, neural, and psychophysiological adaptive potential as interfaced via the myofascial system (Manheim, 2008). The prolonged stretching and soft tissue mobilizations can effectively maintain and facilitate fascial restrictions in the body. “The human organism is incapable of upright posture without myofascial tension” (Manheim, 2008). This gives us an understanding of the strength of the fascial sheath. It has been estimated that if every structure of the body except the fascia were removed, the body would retain its shape (Rao, 2010). Malfunctions of this fascial system will create dysfunction in the body and dis-ease with movement.

Direct and indirect treatment of the fibrosis formed after a total knee arthroplasty will effectively breakdown scar tissue, creating a greater ease and fluidity of movement,
increase in range of motion, decrease in pain and stiffness and therefore allowing complete return to functional activities of daily living.

**Assessment & Methods**

Functional data from one, male subject (61 years of age) previously diagnosed with end-stage OA of the knee and further underwent a total knee replacement, was obtained during an initial assessment. The subject was referred to an orthopedic surgeon for a total knee replacement. The subject had radiographic evidence of OA in all three compartment of the knee, with the lateral compartment affected most severely.

Functional evaluations were completed and consisted of measuring quadriceps strength, hamstring strength, active and passive knee range of motion, functional squat (functional knee flexion), screw home mechanism (terminal extension of knee), patellar apprehension test, capsular end feel, capsular pattern of restriction, girth measurements of the knee and length of the visible scar.

Quadriceps strength was determined by the ability to produce force during unilateral isometric knee extension, from a seated position. Hamstring strength was determined by the ability to produced force during a unilateral isometric knee flexion, from a prone position. Active and passive knee flexion and extension range of motion was collected in a supine position using a standard long arm goniometer. Measurements were recorded with respect to full extension being 0 degrees (straight leg) with positive numbers indicating a more flexed knee. During knee extension, the subject’s heel was placed on
an elevated towel to allow clearance of the thigh and calf. Range of motion was
recorded. During knee flexion, the subject was instructed to maximally flex the hip and
knee and draw the heel toward to buttocks. The range of flexion was recorded. A
functional squat was performed by the subject with both feet comfortably, shoulder width
apart. The degree of the squat was measured with a goniometer. The screw home
mechanism was used to determine if the subject had complete terminal extension of the
knee complex. When the knee moves into extension, the tibia externally rotates roughly
20 degrees on the fixed femur. Within the last 20 degrees of extension of the knee,
terminal rotation will occur (Magee, 2008).

Table 1 on page 18 shows all baseline assessment results.
## MYOFASCIAL RELEASE ON SCAR TISSUE

### Table 1: Baseline Assessment Results

<table>
<thead>
<tr>
<th>TEST</th>
<th>LEFT KNEE</th>
<th>RIGHT KNEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Squat</td>
<td>75 degrees</td>
<td>75 degrees</td>
</tr>
<tr>
<td>A - ROM in Degrees of Flexion</td>
<td>102 degrees</td>
<td>115 degrees</td>
</tr>
<tr>
<td>P - ROM in Degrees of Flexion</td>
<td>106 degrees</td>
<td>120 degrees</td>
</tr>
<tr>
<td>Screw Home Mechanism</td>
<td>Full Terminal Extension: NO - 2 degrees</td>
<td>Full Terminal Extension: YES</td>
</tr>
<tr>
<td>Capsular End Feel</td>
<td>Flexion: Adhesions &amp; Scarring Hard End Feel</td>
<td>Normal: Tissue Approx.</td>
</tr>
<tr>
<td>Capsular Pattern of Restriction</td>
<td>Flexion &gt; Extension</td>
<td>None</td>
</tr>
<tr>
<td>Patellar Apprehension</td>
<td>Medial glide - 1/2 width of patella</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td>Lateral glide - 1/3 width of patella</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Superior/Inferior Glide - no movement</td>
<td></td>
</tr>
<tr>
<td>Muscle Test: Hamstrings</td>
<td>4 - Good</td>
<td>5 - Normal</td>
</tr>
<tr>
<td>Muscle Test: Quadriceps</td>
<td>4 - Good</td>
<td>5 – Normal</td>
</tr>
<tr>
<td>Girth Measurement</td>
<td>16.5&quot;</td>
<td>15.5&quot;</td>
</tr>
</tbody>
</table>
Treatment Protocol

The treatment plan consisted of five massage therapy treatments, each sixty minutes in duration over the course of three weeks. A specific homecare plan was given for the patient to adhere too. Each treatment session consisted of direct and indirect scar release techniques, including skin rolling, fascial shearing, bowing, lifting and cross hands over the 9”, vertical scar crossing the knee complex. One of the most important tasks in recovery is mobilization of the soft tissue over the incision and in the surrounding muscles and ligaments (Brugioni and Falkel, 2004). This was addressed with myofascial release techniques to the quadriceps and hamstring muscle groups. Cross-fiber and longitudinal frictions were applied at the scars’ incision sites (at either end of the scar). Contract/relax of hamstring and quadricep muscle groups were performed at the end of each treatment to help reset the muscles crossing the knee complex. The use of hydrotherapy was applied prior to the treatment techniques. A hydrocollator was placed on the anterior thigh, over the scar and quadricep muscle group of the left leg for 10mins, prior to applied techniques. General Swedish massage was applied as an accessory technique to help blend and mold the soft tissue respectively.

Remedial Exercise

With the primary goal of increasing knee flexion, the patient was instructed to actively stretch hamstring and quadricep muscle groups twice a day, along with one step lunges to build strength and stability in the knee complex. Static stretches were held for 30-60 seconds in a low intensity, pain free position. Patient completed 8-10 one-step lunges, unilaterally (one leg, then the other), 3 times a week.
**Hydrotherapy**
Patient was asked to apply a hot pack to the hamstring muscle group of both legs prior to his daily stretch and strengthening routine for ten minute duration. This was to warm up the tissue prior to stretching to avoid any tearing or over-stretching of a cold muscle.

**Results & Analysis**
Patient showed a substantial increase in flexion range of motion at the knee complex through the goniometric measurements.

The overall increase in functional range of motion (functional squat) was 10 degrees of flexion. Active flexion of the affected (left) knee improved by 18 degrees, while passive flexion improved 14 degrees. Two degrees was gained in knee extension. The patient went from 3 degrees of flexion in a straight leg to 1 degree in the affected (left) leg. A consistent progression of increased knee flexion presented throughout the five treatments.
The graph below demonstrates the progression of active & passive left knee flexion as well as a functional squat throughout the five treatments:

With the steady progression of increasing knee flexion, patient did experience some stiffness and pain throughout completion of his homecare. Stiffness in the left knee was felt after the first set of homecare stretches, but this decreased within a day. After the third treatment patient expressed signs of pain along the medial side of knee after the quadricep stretches were performed. This was addressed by having the patient perform the stretch under therapist supervision. There was a slight deviation occurring during the stretch which was putting strain on the medial knee. This was adjusted promptly. By the fourth and fifth treatment patient was experiencing some achiness and fatigue in the
muscles that cross that knee complex. However, more control was felt and shown by the patient when lunges were performed.

Upon completion of the last treatment, signs of decreased hypertonicity and fascial adhesions throughout the quadriceps muscles were apparent. The visible 9” scar, running longitudinally over the knee became very purple and red, resulting in increased warmth. The pliability of the scar increased significantly. The ability to roll and pick up the scar increased several inches from the first treatment.

Terminal extension of the left knee (screw home mechanism) was not achieved, however 2 degrees of extension was gained, resulting in 1 degree of flexion in a straight leg. The capsular end feel remained hard and firm. The capsular pattern of restriction no longer applies. The combination of treatments and homecare increased flexion to the point where the patient had equal degrees of active flexion with both the left and right knee. Most of the increases in range of motion occurred directly after treatment, whereas mobility and functionality improvements changed between treatments resulting in more controlled movements by the patient.

Overall the patient responded well to myofascial release techniques when applied directly and indirectly to the scar. Active rehabilitation proved to be effective in maintaining and improving daily function for this patient. A continued homecare plan combining more balance and proprioceptive exercises, as well as core work would be beneficial for this patient to gain further stability.
Patient’s Left Knee – Post-treatment, 9” scar
Patient underwent a total left knee replacement in February 2007 because his history, physical findings and x-rays were consistent with advanced degenerative arthritis. A successful surgery soon lead to a further manipulation (April 2007) because stiffness and swelling led to continued restriction in active flexion at the knee. There was some good crepitus during the manipulation indicating breakdown of scar tissue. Range of motion in flexion was 115-120 degrees after the manipulation. It is often the second and third months after surgery that much of scar tissue matures (Brugioni et al., 2004). It is imperative therefore for the scar tissue to be kept soft and pliable during maturation, for function and movement to improve. Patient was on a post-operative rehabilitative plan with a physiotherapist to work at increasing range of motion as well as strengthening of the knee complex. This case report was administered three years after the patient had surgery. It is possible that the subject may have benefitted more (by decreasing the chance of having a manipulation) if massage therapy treatments were received directly after surgery along with his rehabilitation program.

It was found that the greatest improvements in mobility of the affected leg (left) were obtained directly after each treatment. Soft tissue mobilization over the incision and in the surrounding ligaments and muscles responded well to the intent, depth and force of techniques applied. Patient had lost a significant amount of flexion range of motion (roughly 15 degrees) from the time he stopped his rehabilitation to the beginning of this case report.
The increase in mobility gained throughout the five treatments was due to soft tissue releases around the knee complex and the increase in pliability of the vertical 9” scar. There was no noticeable change in the capsular end feel, which is most likely due to the fact that the amount of adhesions and fibrosis present are very chronic (been there for the past 3 years). The metal plates at either end of the femur and tibia will also be responsible for the firm, hard end feel felt at baseline assessment and on completion of the treatments. The capsular pattern of restriction only remains with passive flexion. Both knees were able to actively flex to 120 degrees. The focus of treatment was specifically on the affected left knee, but the right leg was included in the homecare plan.

The effectiveness of the patients’ homecare plan was seen by the third treatment and throughout the remaining sessions. Continued massage therapy treatments should therefore focus on developing a further rehabilitation program combining more muscle balancing and proprioceptive exercises which should prove to have a significant effect on range of motion and function for a healthy, vibrant knee complex.

**Conclusion**

The results of this study 1) show the efficacy of myofascial release on scar tissue and 2) the benefits of an effective rehabilitation program. The primary objective to investigate the effects of myofascial release on scar tissue after a total knee replacement have demonstrated to be significant in improving active and passive range of motion, and functional ability at the knee complex.
Further studies and research are required to validate this report and establish possible long-term effects of myofascial release techniques on scar tissue. There is not enough evidence to support this hypothesis with only one case participant. However, it can be concluded that the protocol used was effective for this individual patient. The results indicated that myofascial release techniques, when combined with an effective homecare plan will lead to significant improvement in function and mobility of the knee complex in a post-operative patient.

The goal of this study was to increase active flexion of the left knee, while regaining strength and stability of the entire knee complex, by increasing pliability of the visible scar, and decreasing fascial adhesions of soft tissues. Regarding the case participant, these goals were met. Limited range of motion and stiffness were preventing the patient from functioning normally, but the combination of manual massage therapy techniques and rehabilitation proved to promote an active, pain-free life style.

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References


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