CHAPTER 18

CONTINUOUS PASSIVE MOTION AND PODIATRIC SURGERY

Jane Pontious, D.P.M.

Continuous passive motion (CPM) devices allow a method of controlled movement to be introduced into a joint. Two devices are available for the podiatric physician, one for the ankle joint and the other for the first metatarsophalangeal joint.

Robert Salter was the first author to introduce the concept of CPM in the 1980s.[1,2] His extensive research involved studying the effects of immobilization on the synovial joints of rabbits, particularly the knee joint, to see how joint motion would be affected. Since that time, numerous authors have reported on the positive effects of using CPM following such procedures as knee joint arthroplasty. In order to understand how harmful the effects of prolonged immobilization can be to a joint, it is important to first review the basic concepts of wound healing.

PERIARTICULAR AND ARTICULAR WOUND HEALING

Wound healing has been divided into three time periods, although there is no true distinction between the three. Phase I, the inflammatory phase, begins with the initial injury to the body. The body responds by an immediate vasoconstriction to remove the cellular debris and blood products that are present within the area. This is followed by a vasodilatation which causes an increase in vascular permeability and the release of histamine, serotonin, and platelet derived growth factors which allow the leukocytes to migrate to the injured area. Other cells such as lymphocytes, monocytes and macrophages also assist in the phagocytic process. Prostaglandin, which assists in chemotaxis, and kinens, which stimulate the nerve endings producing pain, are then released.

Phase II, the fibroblastic phase, is a continuation of Phase I which allows the body to restore the injured tissue into a more functional condition. During this phase, capillary budding will occur, and fibroblasts produce collagen in an abundant, haphazard fashion. During Phase III, the remodeling phase, the collagen fibrils become more organized and are laid down along the lines of tension. The cross linking of collagen increases intra- and intermolecularly, producing a wound which is not only functional but mechanically efficient.

The healing process of articular cartilage is somewhat limited because it lacks vessels within the cartilage. Articular cartilage can heal in one of two ways. If an injury involves only the cartilage and does not penetrate to the underlying subchondral bony plate, then the healing process will be incomplete. The cartilaginous defect will become filled with tissue that is fibrous or fibrocartilaginous. However, if the injury to the cartilage extends to the underlying subchondral bony plate, the healing will be more complete, in that the defect will become filled with vascular tissue from the underlying bone and marrow and collagen will be deposited. The subchondral bony defect will become repaired with bone, but the cartilage itself will only be repaired by tissue that is fibrous or fibrocartilaginous. Only in rare instances is a hyaline cartilage produced. In either case, the tissue that is replacing the cartilagineous defect is histologically inferior to the original hyaline articular cartilage so that the weight-bearing properties of the joint are always affected.

THE EFFECTS OF IMMOBILIZATION

Immobilization will produce morphologic changes in the components that make up the tissues surrounding the joint. These tissues are composed of 80% collagen and 20% matrix. Short periods of immobilization will have a negative effect on collagen by allowing it to be deposited in a more haphazard and random fashion without regard to the usual constraint imposed upon the joint. Collagen will be over-produced and the cross linking will occur in a less organized fashion producing tissue that is less elastic.[3,4]

The matrix functions as a lubricant between the collagen fibers. A loss of pliability of the connective tissue will occur with immobilization because the amount of water and glycosaminoglycan within the matrix are reduced, thereby producing a loss of the elastic properties of the tissues. All of these findings help to promote joint contracture. Immobility within a joint will also effect articular cartilage. There will be a production of fibro-fatty type of connective tissue within the joint which leads to formation of adhesions. A direct effect on the cartilage can also occur producing cartilage thinning and cartilage fibrillation.[5-7]

INDICATIONS FOR CPM AND PODIATRIC SURGERY

CPM has been used successfully for many conditions in podiatric surgery such as rehabilitation following hallux valgus correction, hallux limitus/rigidus correction, implant arthroplasty, ligamentous reconstruction, tendon repair, tarsal tunnel surgery, and intra-articular fracture repair.[8]

Post Hallux Valgus/Hallux Limitus Surgery

CPM will not provide more motion than has been attained intraoperatively; however, it will help to maintain that motion. All osteotomies must be appropriately fixated to maintain stable osseous fixation, so you can be more aggressive with the use of postoperative physical therapy, range of motion exercises, and CPM. Postoperatively, CPM helps to maintain the flexibility of the tissues as they heal, producing a joint that has less adhesions and fibrous tissue, and a more flexible range of motion.[9]

Implant Arthroplasty

A patient who is to undergo an implant arthroplasty will already exhibit some type of limitation of motion, and may also have had previous surgery restricting the pliability of the tissues. CPM can be very effective in this case by producing a more fluid joint motion, because it allows less amounts of joint fibrosis and adhesions.

Ligamentous Reconstruction

CPM can be used effectively following ankle joint ligamentous reconstruction. It is particularly useful following intra-articular talar dome fracture repair, in helping the patient resume a more normal ankle joint motion during the immobilization period. It can be instituted in the immediate postoperative period and continued until normal range of motion is restored.

Tendon Repair

Tendon healing can be improved by preventing the formation of adhesions. This helps to restore the gliding surface of the tendon. The technique could be indicated in tendo Achilles repair, and soft tissue repair of the tibialis posterior tendon.

PROTOCOL FOR CPM USE

CPM should be initiated within the first 24 to 48 hours after surgery, because it has been found that collagen deposits in a wound as early as post-operative day two. The postoperative dressing should not be bulky, to allow the foot to fit easily into the CPM machine. Range of motion settings can be determined by the podiatric physician. It is more beneficial for the physician to place the initial setting at a low level and have the patient increase it to tolerance. The length of the cycle and total amount of motion should be adjusted by the physician. The recommended use is 6 to 8 hours per day, depending on the device. In addition to using the CPM machine, passive range of motion exercises should also be instituted. Other forms of physical therapy may be used postoperatively as an adjunct.

There are few contraindications to CPM. However, questions about the osteotomy stability, any fracture, or infectious process would all preclude the use of CPM. Caution should be exercised in initiating CPM in the immuno-compromised patient, as well as any patient with diabetes or neuropathy.[10,11]

CONCLUSION

CPM is an effective, adjunctive therapy that can be used postoperatively to help maintain the range of motion that was obtained intraoperatively. Subjectively, patients who utilize CPM post-operatively report less pain, and may decrease their analgesic requirement. CPM is not technically difficult to utilize, and is well-tolerated by patients. The use of CPM needs to be evaluated on an individual patient basis to determine if it is an effective adjunct to the postoperative therapy.

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