CHAPTER ONE : THE PROBLEM

1.1 INTRODUCTION

Arthritis and other rheumatic conditions are among the most prevalent chronic conditions. In addition, arthritis is the number one cause of disability. It limits everyday activities such as dressing, climbing stairs, getting in and out of bed, or walking (Nieman, 2000).

Rheumatoid Arthritis (RA), is the most common type of chronic inflammatory arthritis (Thompson, 1998). RA is characterised by inflammation in the synovial lining of the joints, which ultimately results in cartilage and bone destruction (Norceau et al., 1995). It can affect any joint, large or small, however the small joints are the most commonly affected (Nieman, 2000). Because RA is a systemic disease, other parts of the body may be involved in the inflammatory process.

Although there is no cure for RA a lot can be done to manage the condition. Four major treatment approaches are recognised in the management of RA; medication, physical exercise, joint protection and lifestyle changes and surgical intervention (Giannini & Protas, 1992).

Exercise has shown to decrease the risk of heart disease, hypertension and strokes and to be beneficial in the rehabilitation of patients with spinal cord injuries, heart disease, obesity and diabetes. More research however is needed to show the effects of exercise on individuals with RA (Giannini & Protas, 1992).

The use of exercise in the treatment of patients with RA has been widely debated. In the late 1800's, the concept of total bed-rest became the standard of care. It was not until 1948 when the undesirable effects of prolonged bed-rest were described, that exercise resumed its role in arthritis therapy and rehabilitation (Kirsteins et al., 1991).

In RA many factors may lead to decline in functional ability. Apart from the direct consequences of the disease on the function of joints and muscles, physical inactivity contributes further to stiffness of the joints, muscle weakness and cardiorespiratory de-conditioning (van den Ende et al., 1996).

Results of an earlier study indicated that above 80% of RA patients experienced problems in muscle function of the lower extremities (strength, endurance, balance/co-ordination). Several studies using physiological methods have reported a decrease in muscle strength in RA patients as compared with healthy subjects. Furthermore, a decrease in muscular endurance and aerobic capacity has been found in these patients (Ekdahl et al., 1990). In a study on standing balance, RA patients showed a decrease in postural control as compared with healthy subjects (Ekdahl & Andersson, 1989).

Two important reasons why RA patients tend to limit their physical activity are:

1. Exercise therapy for RA has remained controversial due to perceived dangers of eliciting pain or damaging joints (Ekdahl et al., 1990).
2. The main reason for not being active is due to the pain experienced by RA patients. Thus, a vicious cycle of pain leading to physical inactivity causing new symptoms and more pain is started (Stenström et al., 1991).

Despite the absence of common agreement in the medical community regarding the use of exercise in persons with RA studies have demonstrated that an exercise therapy programme is beneficial to prevent physical de-conditioning without inducing adverse effects on the individuals joints and general health (Norceau et al., 1995). Therapeutic exercise is believed to improve physical capacities and has a positive influence regarding pain, emotional factors, cognition and behaviour (Stenström et al., 1991). Thus, many consider exercise therapy to be the cornerstone in the total management of RA (van den Ende et al., 1997).

The primary goal of exercise therapy in RA is to improve joint mobility, muscle strength and aerobic and functional capacity (Hazes et al., 1996). However, there is a debate as to what type of exercise would be the best for RA patients (Kirsteins et al., 1991). Varying the type of exercise in accordance with the phase of the disease has been recommended (Ekdahl et al., 1990). Gentle passive and active range of motion (ROM) exercises together with non-weight bearing isometric muscle exercises are the most frequently prescribed treatments and are still recommended, in particular for the patients with active disease (Hazes et al., 1996). However, during the last two decades, dynamic and weight bearing exercises have been recommended more and more, in particular in patients without active disease (van den Ende et al., 1998).

1.2 PROBLEM SETTING

There is no consensus regarding how and to what extent RA patients should train so as to obtain optimal functional capacity with a minimum of risk. Owing to a fear of enhancing joint inflammation and accelerating cartilage destruction, traditionally water exercises have been the choice of exercise mode in RA

Hydrotherapy has been shown to increase muscle strength, increase joint range of motion, improve aerobic capacity, reduce pain and improve function (Tork & Douglas, 1989). The buoyancy of water and the ability to control its temperature make it favourable for patients with muscular and joint disease. In addition, although most research conducted suggests that exercises in water are beneficial for RA patients, numerous problems exist when it comes to prescribing water therapy programmes. Proper water facilities for exercise therapy are not always available. Heated pools designed for exercise therapy are expensive and maintenance is also time consuming and costly. In addition home exercise programmes are often prescribed for RA patients, which usually consist of land-based exercises. Land exercises, specifically weight bearing exercise, also have the advantage of strengthening the connective tissue surrounding the joints and stimulates bone formation (Kirsteins et al., 1991). The above qualities are desirable because of the well-known complications of accelerated generalized osteoporosis induced by active inflammation, immobility and medication (cortizone) in RA (Hazes et al., 1996).

Unfortunately, research concerning land-based exercises for RA patients is limited and as for knowing whether weight-bearing exercise may be safe for those individuals, only a few studies have addressed this question (Klepper, 1999). Therefore, it would be beneficial to compare he effects of a land-based exercise programme with that of a water based exercise programme.

1.3 PURPOSE AND AIM OF THE STUDY

The aim of the study was as follows:

- To determine whether exercise therapy is beneficial for RA patients;
- To determine if water-based exercises and land-based exercises are equal in terms of benefits gained by RA patients; and
- to determine the effects of exercise therapy in RA patients with regards to physical capacity, emotional status and pain.

1.4 HYPOTHESIS

The following hypotheses are related to the purpose of the study:

- exercise therapy is beneficial for RA patients; and
- the positive effects (increased physical capacity, improved emotional state and pain relief) induced in RA patients following a water-based exercise programme is similar to the effects achieved by those following a land-based exercise programme.

CHAPTER TWO : LITERATURE REVIEW

2.1 ARTICULATIONS/JOINT

Most of our daily activities, from breathing or speaking to writing or running, involve movements of the skeleton. The bones of the skeleton are solid, and movements can occur only at joints or articulations, where two bones interconnect (Martini, 1995).

Three types of joints are found in the human body; they vary by the amount of motion they allow. Each joint reflects a workable compromise between the need for strength and the need for mobility (Downey et al., 1994; Martini, 1995).

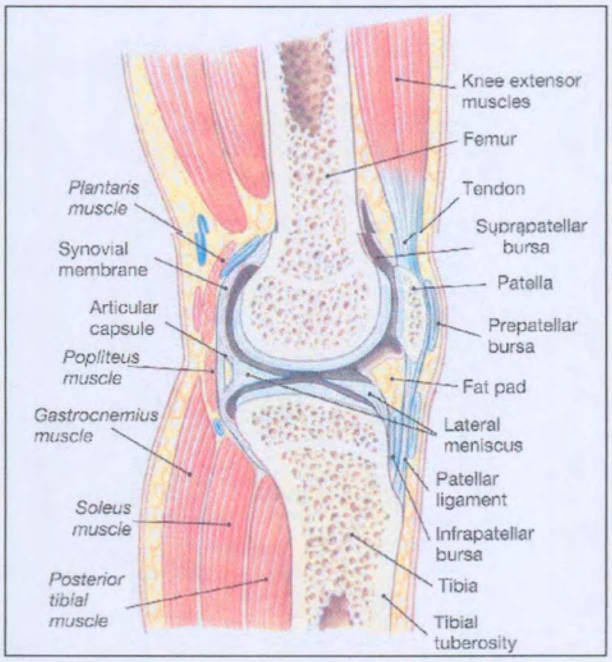

Figure 1: Lateral view of the extended right knee as seen in parasagittal section, showing the major anatomical features (Martini , 1995).

2.1.1 CLASSIFICATION OF JOINTS

2.1.1.1 IMMOBILE JOINTS (FIBROUS JOINTS/SYNARTHOROSES)

a) CHARACTERISTICS: Bones are joined to one another by fibrous connective tissue, with little or no movement in the joint (Memmler et al., 1996).

b) TYPES:

- Syndesmosis, e.g. Inferior tibiofibular joint;
- Suture e.g. Skull sutures;
- Gumphosis, e.g. Teeth in dental sockets; (Meiring et al., 1993).

2.1.1.2 SEMI-MOBILE JOINTS (CARTILAGINOUS JOINTS/AMPHIARTHROSES)

a) CHARACTERISTICS: Bones are joined to one another by cartilage. The cartilage can be hyaline cartilage or fibrous cartilage. This type of joint is slightly movable (Meiring et al., 1993; Memmler et al., 1996).

b) TYPES:

- Synchondrosis e.g. Ephiphyseal cartilaginous plates;
- Symphysis e.g. Pubic symphysis (Downey et al., 1994)

2.1.1.3 MOBILE JOINTS (SYNOVIAL JOINTS/DIARTHROSIS)

a) CHARACTERISTICS OF A TYPICAL SYNOVIAL JOINT:

- two or more bony ends articulate with one another;
- a joint capsule lined by a synovial membrane. The synovial cavity is filled with synovial fluid;
- ligaments (intra-or-extracapsular) are present which strengthens the joint;
- the articulating ends are typically covered with hyaline cartilage;
- cartilaginous discs are occasionally present (menisci) which imparts further stability to the joint;
- bursae are present over areas where friction may occur; and
- the joint moves freely; (Meiring et al., 1993).

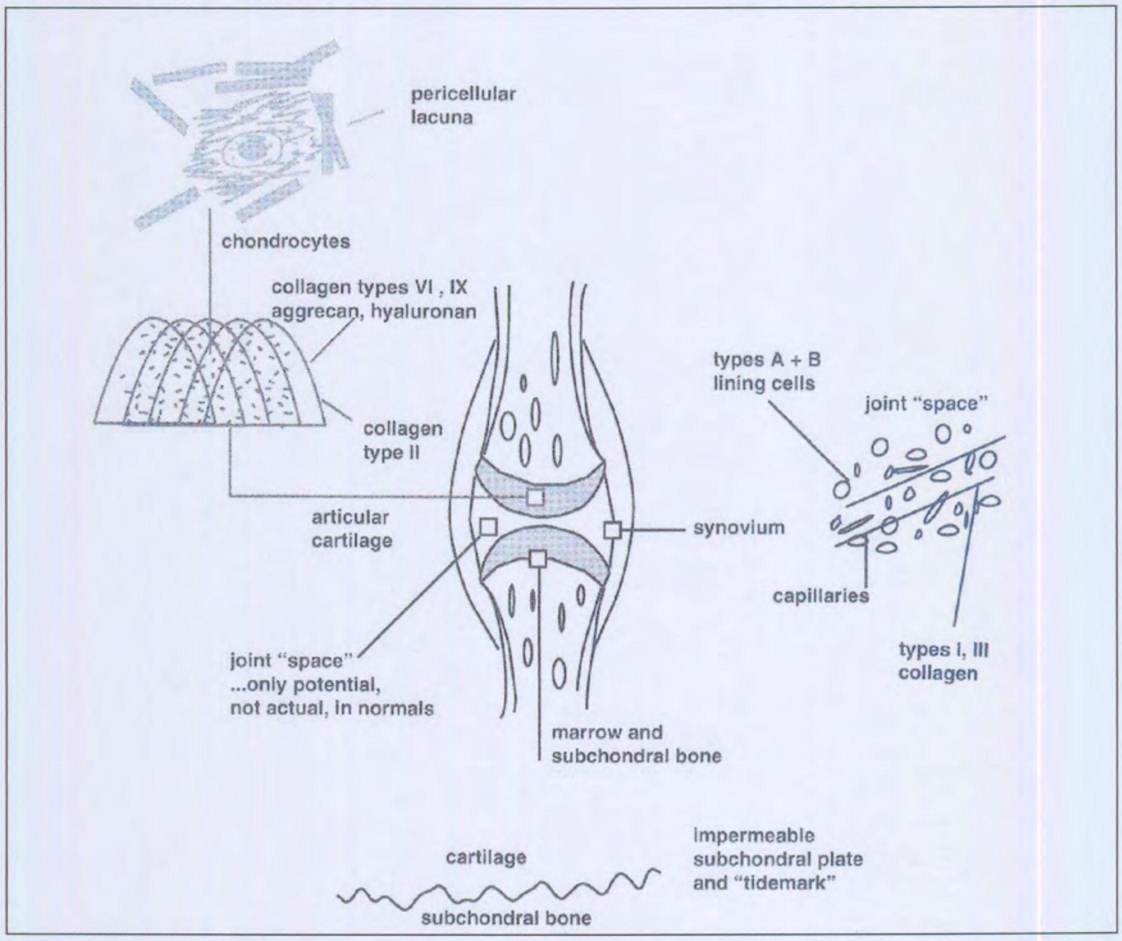

Figure 2: **The crucial components of a diathrodial joint are emphasized in the Figure. On the right, is the synovium, with its lining cells that lack a well-defined basement membrane and have a vigorous capillary supply. The subchondral bone (bottom) is impermeable in adults effectively preventing any flow of nutrients from marrow to articular cartilage. The cartilage (left) is characterized by arcades of type II collagen surrounded by aggrecan and specialized type VI and IX collagens. The chondrocytes in normal cartilage 'hermits', living singly within individual lacunae. (Harris, 1997)**

b) TYPES:

-	hinge joint e.g. elbow	}	
-	pivot joint e.g. atlas – axis	}	uni-axial
-	condylar joint e.g. knee	]	
-	elipsoid joint e.g. radiocarpal	]	bi-axial
-	ball and socket joint e.g. hip	)	
-	saddle joint e.g. first metacarpal	)	
-	gliding joint e.g. acromioclavicular	)	multi-axial

(Meiring et al., 1993)

c) TYPES OF MOVEMENTS FOUND IN SYNOVIAL JOINTS:

- flexion and extension;
- abduction and adduction;
- gliding movements;
- medial and lateral rotation;
- circumduction; and
- pronation and supination (Memmler et al., 1996)

d) DEVELOPMENT BIOLOGY OF SYNOVIAL JOINTS:

Condensation within limb buds of a growing mass of embryonic cells to form a blastema is the first step in joint development.

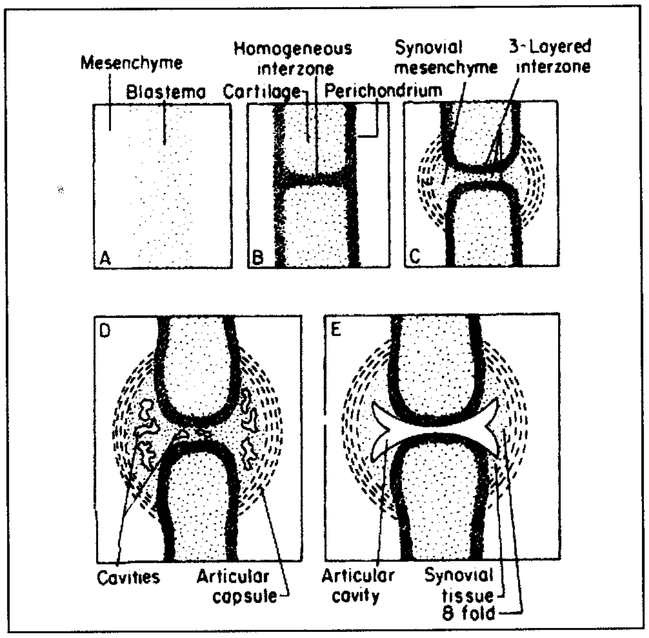

Figure 3: Diagram of the development of a synovial joint. Joints develop from the blastema, not the surrounding mesenchyme (Kelly et al., 1997).

Areas destined to become cartilage then divide the blastema. Interzones develop between these to begin formation of the future joint cavity. The joint capsule evolves as a dense layer of collagen deposited by fibroblasts surrounding the interzone. The synovium is formed from the vascular mesenchyme contained between the capsule and the joint cavity. Modeling and remodeling produces the finely crafted joints that have specialized structure and function appropriate for their role in movement and skeletal support. Of major importance in the development of articular structures is that no epithelial tissue is found in joints; they are composed entirely of mesenchymal tissue and endothelium of blood vessels (Kelly et al., 1997; Harris, 1997).

e) ORGANIZATION OF THE MATURE SYNOVIAL JOINT:

The materials that compose human joints are universal throughout vertebrates. The articulating joints are all surfaced with articular cartilage, the base of which is calcified. This calcified cartilage rests on a sub-chondral bony plate, which in turn is supported by spongy bone. The cartilage is bathed in a lubricant, synovial fluid, which also serves as a source of nutrition. The joint space is enclosed by a fibrous capsule, the innermost lining, the synovium, and serves as a filter for diffusion of materials into the synovial fluid. The joint is held together by ligaments and is traversed by tendons and, in some instances, muscles as well (Moskowitz et al., 1984).

I BONES

Two bones meet to form the joint. The ends of the bones are smooth and shaped to fit into each other. It is the shape of the bones that determines the type of movement in a joint (Sayce & Fraser, 1997). Bones are composed chiefly of bone tissue, called osseous tissue. There are two types of bone tissue. Namely, compact and spongy bone (Memmler et al., 1996).

The shape and structure of bone is continuously renovated and modified by the two processes of modeling and re-modeling. In adults, bone has been formed and the architecture is complete. The predominant cellular activity in mature bone is remodeling, a five-step process. The first step is activation, with the exposure of a mineral surface enabling osteoclasts to resorb a certain quantity of bone. Osteoclasts then spread into the area, reversing the process and replacing the osteoclasts. Then the formation phase begins. This takes several months and is followed by a phase of quiescence. The margins of this bone structural unit are visible on histology sections and are known as cement lines. It is the balance between resorption and formation as well as the rate of re-modeling that is affected by both RA and gluco-corticoids used in its treatment. One structural fact that has great importance for the function of the cartilage is that, in adults, the sub-chondral bone blocks all vascular connection or communication by diffusion between cartilage and bone marrow (Fleisch, 1997; Harris, 1997).

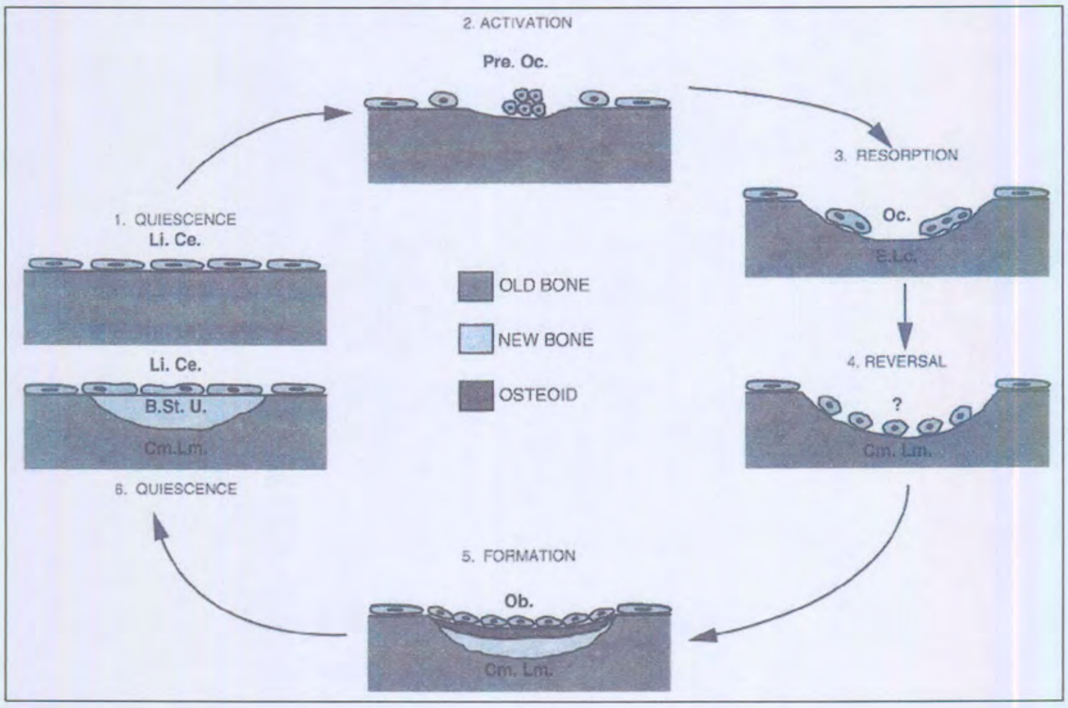

Figure 4: Illustration of the remodeling cycle in mature bone (Harris, 1997)

II SUBCHONDRAL BONE

The calcified cartilage sits on a thin subchondral plate of bone that rests on an area of spongy or cellular bone (Moskowitz et al., 1984).

III JOINT CAPSULE

Completely surrounding the joint and holding everything together is the tough fibrous joint capsule (Sayce & Fraser, 1997). The capsule defines the boundary between articular and periarticular tissues. The capsule varies in thickness from a thin membrane in some areas to a strong ligamentous band in others (Simkin, 1988).

IV SYNOVIUM

Synovium lines all parts of the inside of joints except for articular and meniscal cartilage, and small bare areas of bone between cartilage and synovial insertions into subchondral bone. Because the synovium is derived from mesenchymal tissue, no epithelial cells are present and there is no formal basement membrane underlying synovial lining cells (Harris, 1997). The synovium is divided into functional compartments comprising the lining region (synovial intima), the subintimal stroma and the vasculature (Kelly et al., 1994).

Synovium is highly vascularized with a large capillary bed found close to the intima (Harris, 1997). Due to the rich vascularization of the synovium, a high blood flow for solute and gas exchange is possible, not only for the synovium itself but also for meeting the needs of the avascular cartilage (Kelly et al., 1997). The capillaries have gaps between endothelial cells that may facilitate passive diffusion in both directions. The synovial tissues are poorly innervated, but the capsule and ligaments have a rich sensory supply, and these tissues are probably the main origin of pain in the rheumatic diseases (Currey, 1980).

Synovial lining cells have two principal functions:

1. synthesis of proteins, glycosaminoglycans (GAGs), glycoproteins, enzymes and growth factors, and
2. phagocytosis/endocytosis (Harris, 1997)

Lining cells can be categorized as bone marrow, i) type A synoviocytes, ii) fibroblast – derived type B synoviocytes and iii) type C synoviocytes. Type A cells have macrophage-like appearance, with multiple cell processes, residual bodies and lysosomes. They express surface human leukocyte antigen type DR (HLA – DR) antigens and Fc receptors. Type B cells, forming the majority of normal synovium, are marked by prominent rough endoplasmic reticulum. Some of these cells also have HLA – DR surface antigens but express no other monocyte-lineage surface antigens. Other cells (type C) have mixed anatomy and, possibly, mixed function (Currey, 1980; Kelly et al., 1997; Harris, 1997).

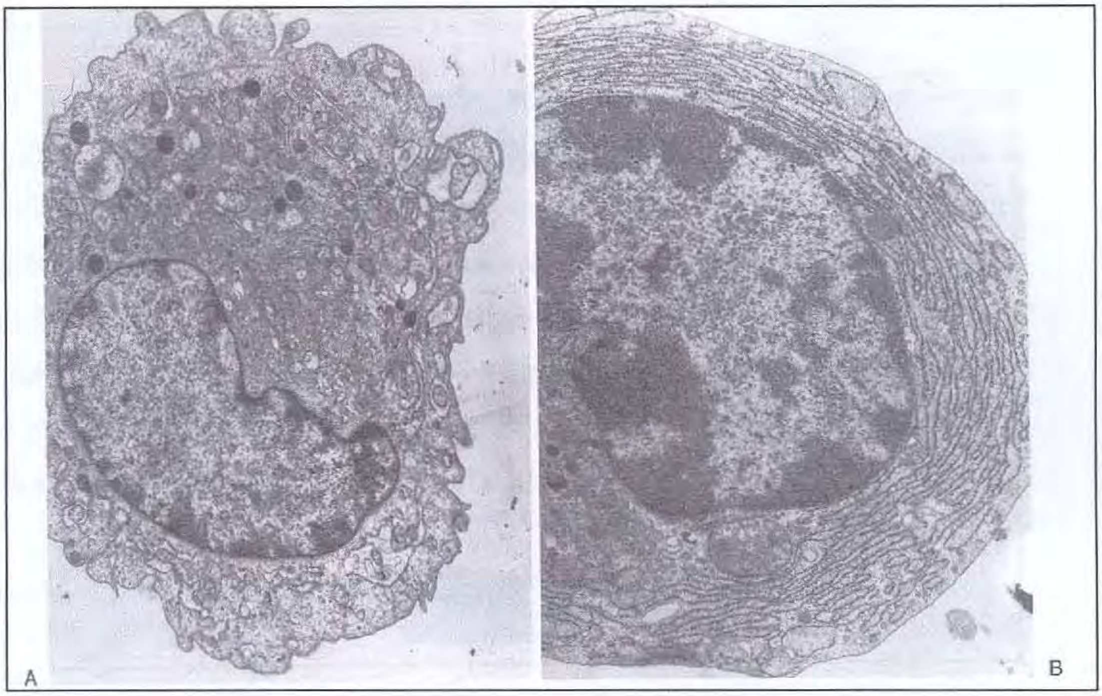

Figure 5: The large differences in function between type A cells (A) and type B cells (B) in the synovial lining are implied strongly by their morphology in these election photomicrographs. The type A cells has multiple cytoplasms processes and abundant granules, vacuoles, and dense bodies, consistent with its function as a scavenging macrophage; the type B cell has an extensive network of rough endoplasmic reticulum and a well developed Golgi apparatus, consistent with a cell primarily involved in biosynthesis of products destined for secretion from cells. (Kelly et al., 1997).

It is likely that lining cells can modulate function by differential gene expression in response to varied stimuli. Thus synovial lining cells function in accordance with the activating stimuli in their environment. If debris is present, they phagocyte it; if growth factors and inflammatory cytokines are present, they proliferate and produce proteases or matrix components (Harris, 1997).

The lining cell layer is rich in the glycoprotein fibronectin that is supported by and interwoven with a loosely arranged fibrillar network containing a mixture of fibres derived from collagen molecules types I and III. Within the capillaries and blood vessels of the synovial membrane, one finds type IV collagen, derived from the vasular endothelium, as well as type V collagen, which connects the cell surface of adjacent smooth muscle cells and pericytes with the surrounding interstitial fibres (Ball & Koopman, 1986).

V SYNOVIAL FLUID

Synovial fluid is clear, colourless to pale yellow, highly viscous fluid of slightly alkaline pH. In normal human joints, a thin film of synovial fluid covers the surfaces of synovium and cartilage within the joint space. Synovial fluid is a mixture of hyaluronan, other proteins produced by synovial cells, including lubricin (a 'bearing' lubricant glycoprotein for cartilage surfaces), and a plasma ultrafiltrate of low protein concentration that diffuses through synovial capillaries. This viscous fluid coats the synovium and cartilage, enhancing diffusion of nutrients into cartilage, but does not collect in a measurable volume (Simkin, 1988; Resnick, 1995; Harris, 1997).

The synovial fluid has three primary functions:

* Lubrication: Lubrication is essential for the protection of joint structures from friction and sheer stresses associated with movement under loading. The articular cartilages are like sponges, filled with synovial fluid. When part of a articular cartilage is compressed, some of the synovial fluid is squeezed out of the cartilage into the space between the opposing surfaces. This thin layer of fluid markedly reduces friction between moving surfaces. When the compression stops, synovial fluid is sucked back into the articular cartilages (Martini, 1995; Kelly et al., 1997).

* Nutrient Distribution: Chondrocytes are thought to derive most, and perhaps all, of their metabolic needs from the overlying synovial fluid. The normal process of diffusion is supplemented by the convection induced by cyclic compression and release of cartilage during joint usage (Simkin, 1988).

* Shock Absorption: Synovial fluid cushions shocks in the joints that are subjected to compression. When the pressure across a joint suddenly increases, the synovial fluid lessens the shock by distributing it evenly across the articular surfaces (Martini, 1995).

VI LIGAMENTS

Ligaments are fibrous structures that act to maintain joint stability and to guide joint motion. It is possible to distinguish between extracapsular and intracapsular ligaments. Extracapsular ligaments interconnect the articulating bones and pass across the outside of the capsule. These ligaments provide additional support to the wall of the joint. Intracapsular ligaments found inside the capsule help prevent extreme movements that might otherwise damage the joint (Moskowitz et al., 1984; Martini, 1995).

VII ARTICULAR CARTILAGE

The articulating surfaces of bone are covered by a layer of glistening connective tissue, articular cartilage. Articular cartilage enables low friction, high velocity movement between bones; absorbs transmitted forces, thereby protecting the underlying bone end and contributes to joint stability. It is not replaced after injury or destruction in any form resembling the original (Resnick, 1995; Harris, 1997 Kelly et al., 1997).

Cartilage is a hyper-hydrated tissue with values for water ranging from 60% to almost 80% of the total wet weight. The remaining 20% to 30% of the wet weight of the tissue is principally accounted for by two macromoleculer materials; collagen, which composes of up to approximately 60% of the dry weight and proteoglycan, which accounts for a large part of the remainder. The ash content has been estimated to be approximately 6% (Moskowitz et al., 1984).

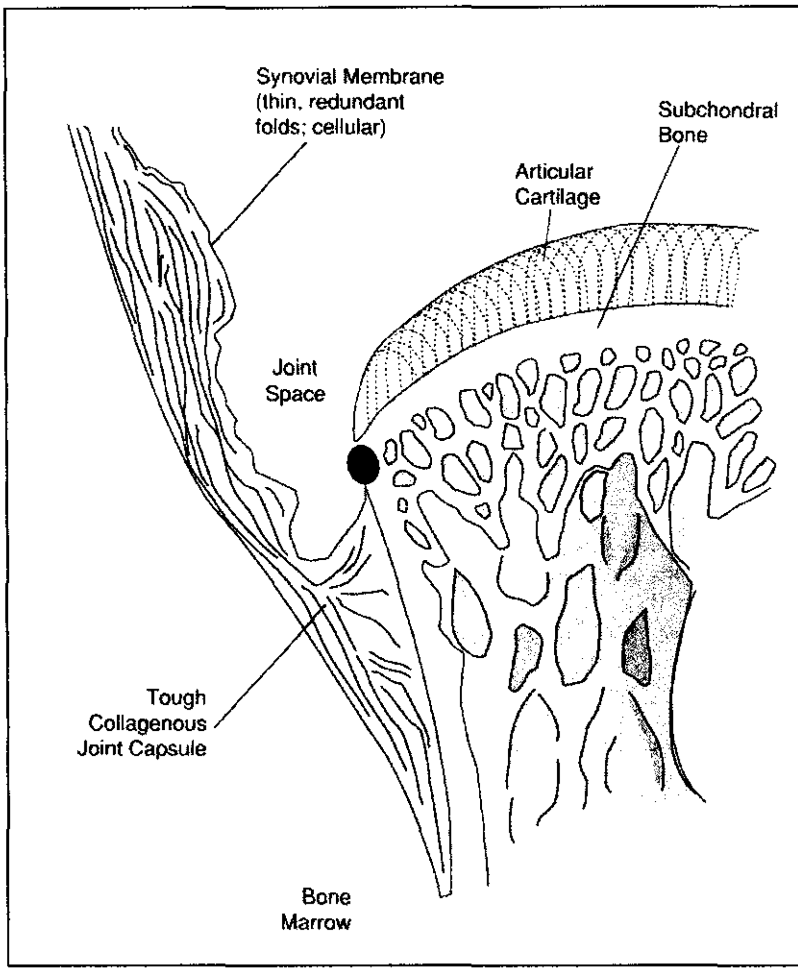

Figure 6: The black circle represents the only part within a joint that is not surfaced by synovium or articular cartilage such intermittently placed areas of bare bone may be particularly vulnerable to early erosion by proliferative synovitis. They are particularly prominent in the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints (Harris, 1997).

Vertebrates have evolved numerous mechanisms to keep the unit load in joints at around 25 kg/cm[10]. Enabling this, are the following factors :

- transfer of force of impact load into the surrounding soft tissue, ligaments and muscle;
- a normal surface incongruity of opposing cartilage surfaces that allows increasing surface contact with increasing load, and
- a cushioning effect of the flared bone regions in the subchondral areas (Harris, 1997).

* Water

The water content of articular cartilage is extraordinarily important in maintaining the resiliency of tissue, as well as contributing to the almost frictionless movement associated with a boundary lubrication system (Moskowitz et al., 1984).

* Collagen

Collagens: Type II collagen fibres, make-up 40 to 50% of cartilage dry weight. Type IX collagen, although representing less than 10% of dry weight has an extremely important function of linking the type V collagen fibres and the proteoglycans in the matrix. Type V, X and XI also are present. Their functions may be to anchor chondrocytes within the matrix. The collagens of humans can be divided into 3 groups according to size; fibrillar, basement membrane and fiber associated collagens (Harris, 1997).

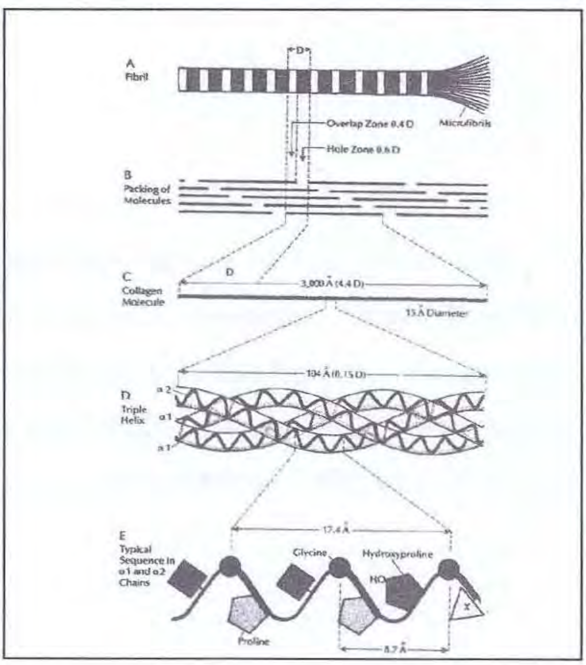

Figure 7: Schematic representation of the structure of a fibril of type I collagen (Kelly et al., 1997)

* Proteoglycans

Proteoglycans impart elasticity to articular cartilage. They make-up core protein with covalently attached glycosaminoglycans and form massive polyanionic aggregates with hyaluronate and link protein (Kelly et al., 1997).

* Chondrocytes

Chondrocytes are distributed sparsely throughout the matrix of cartilage. These specialized fibroblasts synthesize collagen and proteoglycans and provide for regular turnover and remodelling (Kelly et al., 1997).

VIII MENISCUS

A meniscus is a pad of fibrocartilage that is placed between opposing bones within a synovial joint. Menisci, or articular discs, may subdivide a synovial cavity, channel the flow of synovial fluid, or allow variations in the shapes of the articular surfaces (Martini, 1995).

IX BURSAE

Bursae are small, fluid-filled pockets of connective tissue. They contain synovial fluid and are lined by a synovial membrane. Bursae may be connected to the joint cavity or may be completely separate from it. Bursae form where a tendon or ligament rubs against other tissues. Their function is to reduce friction and facilitate gliding of one tissue over another (Martini, 1995; Kelly et al., 1997).

X TENDONS

Tendons are functional and anatomic bridges between muscle and bone. They focus the force of a large mass of muscle into a localized area on bone. Tendons consist of collagen fibers orientated in parallel in a longitudinal direction. Tendon movement is essential for the embryogenesis and maintenance of tendons and their sheaths (Brukner & Khan, 1997; Kelly et al., 1997).

XI MUSCLES

Muscles generate forces required for both joint movement and stabilization. A muscle must be long enough to permit normal mobility of the joints and be short enough to contribute effectively to joint stability. Most joints have their muscle insertions close to the Fulcrum (articular surface) so that small muscle contractions produce an extensive arc of motion of the terminal member (Kendall et al., 1993; Kelly et al., 1997).

2.2 Arthritis in General

The word "arthritis" means literally inflammation of the joint. However, in general usage, the term covers a multitude of problems affecting the joints, the muscles and the connective tissues of the body. There are over 100 different kinds of arthritis. Furthermore, arthritis and other rheumatic diseases are the main cause of pain and disability in the world (Hampton, 1997; Sayce & Fraser, 1997).

2.3 Rheumatoid Arthritis

2.3.1 General Definition

Rheumatoid arthritis is a chronic, progressive, inflammatory disease of unknown etiology in which primary pathological changes begin in the synovial fluid. The disease is systemic and characterized by hot, swollen, painful joints and frequently demonstrates erratic patterns of remissions and exacerbations. RA is believed to be the most common chronic inflammatory arthropathy (O'Sullivan et al., 1981; Ball & Koopman, 1986; Schaumacher & Gall, 1988).

2.3.2 HISTORY OF RA

The first description of RA appears to be that of Landré-Beauvais (1772-1840), who believed the disorder was a variant of gout. RA seems to be a relatively new disease, however, the question of when RA first appeared, is not a trivial one. If its origin were in antiquity, pathogenesis could be linked more closely to the composition and function of human immune responses to multiple antigens. Conversely, if the disease was not present significantly before its description in 1800, the search for a principal cause of the disease should be focused on one or several infectious agents that could have evolved (Ball & Koopman, 1986; Resnick, 1995; Harris, 1997).

Skeletal remains are of minimal help, unlike osteoarthritis, the eburnation and osteophytes of which have been identified in remains from antiquity, erosions of bone found in such remains that are typical of RA could also have been caused by tophaceous gout or a direct infection. Recognizing these limitations, paleopathologic studies have found bone erosions in thousands of Native American skeletons dating from as far back as 6 500 years ago in a circumscribed area of the upper west part of the Mississippi basin. This supports the hypotheses that RA began with geographic limitations and suggests major environmental factors in pathogenesis in a susceptible population (Harris, 1997).

It is striking in its manifestations, but unlike gout – the other archetypal rheumatic affliction – RA is not described by ancient physicians; nor has convincing evidence of the disease been found in art or literature. Portrayal of deformities consistent with RA include the following:

- *The Temptation of St Anthony*, Dutch-Flemish School (arca 1450);
- *The Donators*, Jan Gossaert (1525);
- *Avignon Pieta,* Flemish School (1470);
- *The Painter's Family,* Jacob Jordaen (1620-1650) (Clarke, 1987; Harris, 1997)

The problem here is obvious; many illnesses, including Parkinson's disease, peripheral neuropathy, leprosy or trauma, could have been responsible for the same changes in appearance of joints that were captured on canvas. Thus, the analysis of paintings and bones has failed to determine convincing dates for the first appearance of RA (Harris, 1997).

Figure 8: The earliest convincing representation is that seen in the painting hanging above the stairs at the Royal National hospital for Rheumatic Diseases in Bath. William Oliver and Jeremiah Pierce examining patients. The woman on the left has obvious RA hand deformities (Clark, 1987).

2.3.3 EPIDEMIOLOGY OF RA

Epidemiology is the study of the distribution and determinants of health – related states and events in populations and the application of this study to the control of health problems. In the past two decades the field of arthritis has received more attention than in previous decades. This can be attributed to a changing image of the field of arthritis and people with arthritis. From an affliction of old age with significant psychosomatic overtones, to a disease that respects no age, gender or geographic boundaries. (Walker & Heleva, 1996).

2.3.3.1 INCIDENCE AND PREVALENCE OF RA

Given the difficulty of definition, it is not surprising that there are differing estimates of incidence and prevalence of RA. Suffice to say the disease is common in most populations. In review of multiple studies, the estimate of prevalence of definite and classical Rheumatoid arthritis using the American Rheumatism Association (ARA) criteria (thus ignoring the common instances of possible and probable RA) is at a level of 0.3% - 1.5% (Ball & Koopman, 1986; Schaumacher & Gall, 1988; Zvaifler, 1988).

Table I: The American Rheumatism Association 1987 revised criteria for the classification of RA (Berkow et al., 1992).

ANY FOUR CRITERIA MUST BE PRESENT TO DIAGNOSE RA; CRITERIA 1 – 4 MUST HAVE BEEN PRESENT FOR > 6 WEEKS	
1	Morning stiffness for > 1 hour
2	Arthritis of >3 joint areas
3	Arthritis of hand joints (wrist, metacarpophalangeal or proximal inter-phalangeal joints
4	Symmetric arthritis
5	Rheumatoid nodules
6	Serum rheumatoid factor, by a method positive in < 5% of normal control subjects
7	Radiographic changes (hand x-ray changes typical of RA that must include erosions or unequivocal bony decalcification)

There is a marked age differentiation in the incidence of RA. Onset can occur at any age and in females there seems to be a steady progression of onset with increasing age. Males may show two peaks, first in early adulthood (ages 24 to 34) and after age 65 (Schaumacher & Gall, 1988).

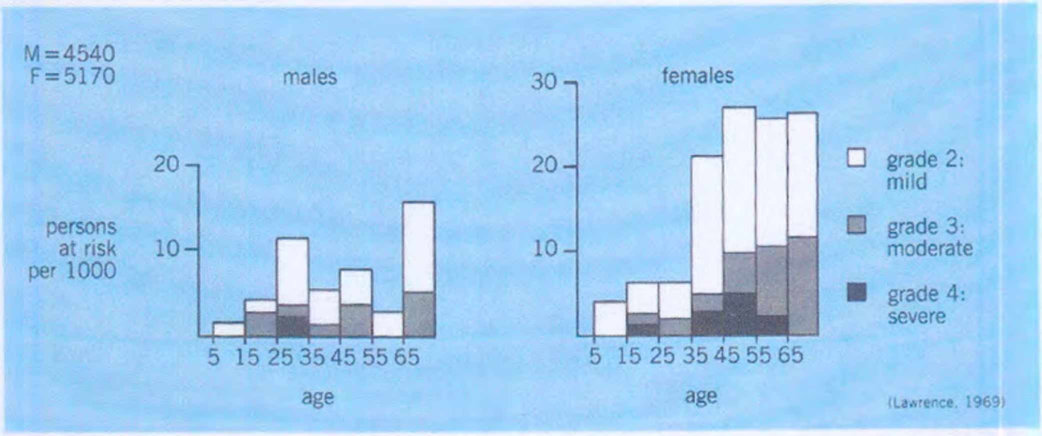

Figure 9: Age of onset of RA Based on anamesis in 1954 – 1959 (Schaumacher & Gall, 1988)

There is a clear female predominance in the disease, usually thought to be about 3:1 (female:male) (Schaumacher & Gall, 1988). However, the ratio seems to vary with age; under age 60, women predominate by a ratio of 5:1. After age 60, the sex ratio approximates equality, suggesting that males may have a protective factor that may be lost at older ages (Walker & Heleva, 1996). Life expectancy is reduced by seven years in men and three years in woman (Jenkinson, 2001).

There have been many ethnic, racial and geographic studies. In North America there appears to be an increased incidence during winter months, twice that of the rest of the year. The reason for this has not been pinpointed although increased viral upper respiratory infections, the proximity of individuals during cold weather and the effect of cold weather on symptoms have all been implicated. Climate has not been shown to have any specific effect on RA although good studies have not been done (Schaumacher & Gall, 1988).

RA has a worldwide distribution and involves all racial and ethnic groups. Prevalence estimates for ARA criteria of definite RA are remarkably constant at 1% in white populations (Walker & Heleva, 1996). Extremely low incidences of RA have been reported in Japan (0,2%) and Porto Rico, (Schaumacher & Gall, 1988). Using the same criteria, another report showed RA's prevalence has ranged from a low .1% in a rural South African black community, to 3.0% among Finnish whites (Zvaifler, 1988; Walker & Heleva, 1996).

Most studies comparing rural and urban incidence of RA do not show remarkable differences. Social class, occupation and similar factors show no consistent special risk factors. Latitude, longitude and altitude have no known influence (Schaumacher & Gall, 1988).

While it was previously reported that no genetic and familiar inheritance of RA occurs, recent data suggest this not to be true (Schaumacher & Gall, 1988). There are some useful data from studies of twins and other siblings (Zvaifler, 1988). Firm data are published showing that there is an increased disease concordance in monozygotic, as compared to dizygotic, twins. These studies give firm support to a genetic influence in the disease, because both identical and fraternal twins in these studies had been exposed to the same environmental influences (Harris, 1997).

Recent advances in tissue typing have shown the cell surface antigen HLA-Dw4 to be related to the incidence of RA. There is a lesser association with HLA-Cw3. Only a small number of individuals with the HLA- Dw4 type actually contract RA and the correlation is far from complete, suggesting a multi-factorial pathogenesis (Zvaifler, 1988).

The role of infectious agent(s), as etiological factors in RA, remains under active investigation. The possible protective effect of oral contraceptives and post-menopausal estrogens remains controversial despite several epidemiologic studies (Kelly et al., 1997)

2.3.4 PATHOGENESIS AND ETIOLOGY OF RA

RA is an inflammatory disease with autoimmune features chiefly affecting synovial joints. In more severe cases there are extra-articular and systemic complications (Smolen et al., 1992). After the initial inflammatory response occurs, a subsequent series of inflammatory events, vascular proliferation and cytokine production occur which features are critical in the initiation and perpetuation of disease and which epiphenomena is not yet known. Until the roles of various factors and the sequence of response is known, therapy is, of necessity, largely empiric (Schaumacher & Gall, 1988; Zvaifler, 1988).

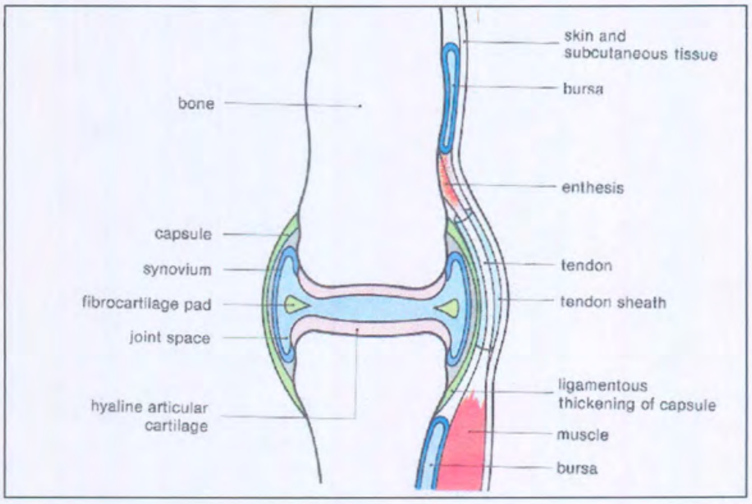

Figure 10: The main pathological features of RA (Dieppe et al., 1986)

2.3.4.1 THE STAGES OF RA

RA may be divided into 5 stages. Each stage is characterized by the status of the uncontrolled inflammation present in the joint.

a) STAGE 1 (NORMAL)

In this stage, people with RA have no symptoms of arthritis and their joints appear normal. Some of these people may be genetically susceptible to arthritis. Having the HLA – DR4 gene alone is not sufficient to cause someone to develop RA. It is presumed that some unknown trigger initiates the development of arthritis in the genetically susceptible person; that is, an unknown factor triggers the inflammatory process and other unknown factors keep it going (Schlotzhauer & McGuire, 1993).

A "best guess" is that several environmental stimuli, possibly viruses or retroviruses, infect an individual who has the appropriate genetic background and through some mechanism the inflammatory response is focused in joints (Kelly et al., 1997).

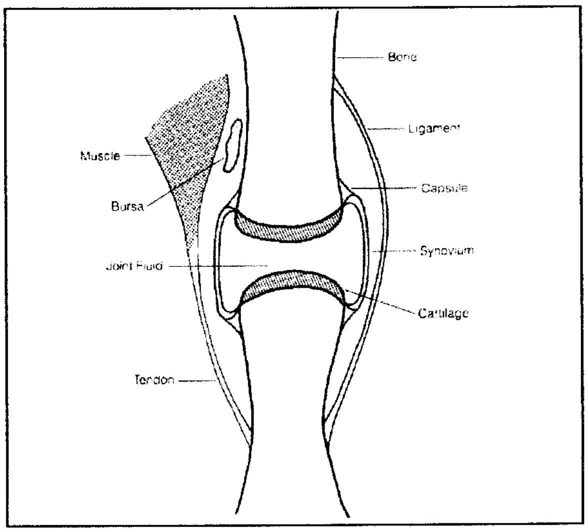

Figure 11: Normal joint (Schlotzhauer & McGuire, 1993).

- **STAGE 2**

This is the stage during which people with RA first have symptoms. The earliest event seen within the synovium of patients with RA is mild synovial lining layer proliferation and vascular changes. Small lymphocytes which account for 20 – 30 percent of the leukocyte (white blood cell) population, migrate to the synovial lining, causing what is called synovitis or inflammation of the synovium. The macrophages and lymphocytes continue to promote inflammation by producing cytokines, the chemical signals that are sent from one cell to another. There are several known cytokines and new ones are discovered all the time. Important cytokines produced include Interleukin – 1B (IL-1B), Tumour Necrosis Factor – a (TNF-α), Interleukin – 1∞(IL-1α) and Interleukin – 6 (IL-6). We are just starting to appreciate their individual roles and how they help produce the symptoms of RA. Cytokines can induce an increase in the number of blood vessels going to the synovium and with increased blood flow, the joints become warm. The increased number of blood vessels may also be in response to hypoxia, which has been demonstrated in RA synovium. The leakage of cytokines into the blood stream may also contribute to the fatigue that is so common in RA. Other cytokines are partially responsible for stimulating cells to produce prostaglandins and leukotrienes, (local hormones) both, which are potent producers of inflammation. Continued production of cytokines, prostagladins, leukotrienes and other substances lead to swelling, warmth and pain in the joints (Schaumacher & Gall, 1988; Schlotzhauer & McGuire, 1993; Martini, 1995; Weider, 2000).

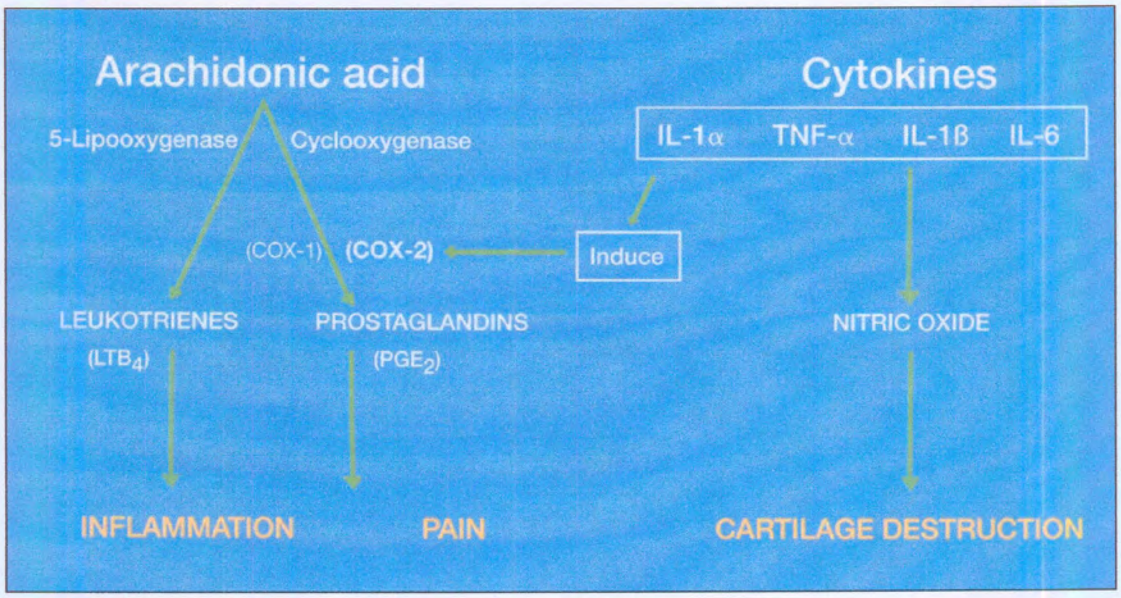

Figure 12: The inflammatory trigger mechanisms (Weider, 2000).

It is also during this stage that B-lymphocytes are transformed into another type of white blood cell, the plasma cell, which manufactures antibodies. Antibodies, also referred to as immunoglobins, are destructive proteins that the body normally produces to fight against foreign viruses and bacteria. In RA for reasons that are unclear, the body appears to produce an excessive amount of antibodies. One particular antibody often found in the blood of people with RA is called the Rheumatoid Factor (RF). The production of RF exacerbates the inflammatory process. Although no data implicate RF as a principal causative agent in RA, the role of antiglobulins in the amplication and perpetuation of the process is well supported (Schlotzhauer & McGuire, 1993; Kelly et al., 1997).

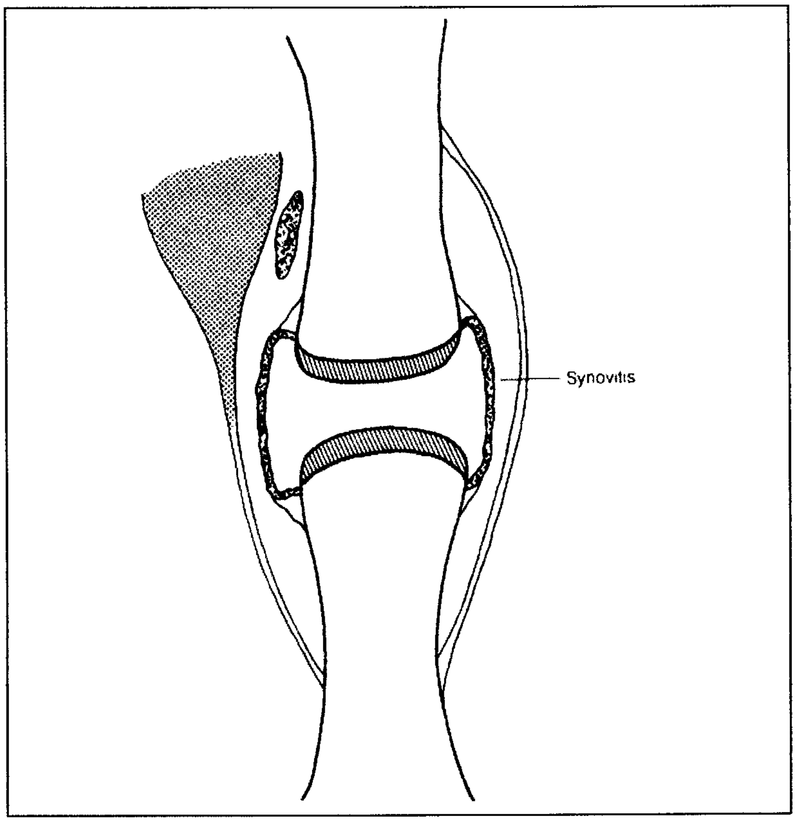

Figure 13: Stage 2 RA (Schlotzhauer & McGuire, 1993).

- STAGE 3

In this phase of RA there is a marked proliferation of several cell types in the synovium. The synovial lining becomes hyper-plastic and the subsynovium becomes edematous and protrudes into the joint cavity, often forming villi. As a result the synovium becomes much thicker, or hypertrophied, and this makes the joint feel doughy or spongy. An increase in the amount of synovial fluid in the joint adds to the stiffness and limitation of motion of the joints. (Accumulation of joint fluid is known as joint effusion). (Schaumacher & Gall, 1988; Schlotzhauer & McGuire, 1993).

With RA there is also an increase in hyaluronic acid, the lubricating substance in the synovial joint fluid. Hyaluronic acid is synthesized by fibroblast-like synovial lining cells, and synovial fluid under normal circumstances has a concentration of approximately 3g/l. Many people believe that increased hyaluronic acid is responsible for morning stiffness (or morning gelling) and stiffness experienced after sitting for a prolonged period of time without moving (gelling phenomenon). (Schlotzhauer & McGuire, 1993; Kelly et al., 1997).

Joint fluid contains inflammatory white blood cells called neutrophils (or polymorphonulear leukocytes). Why lymphocytes reside in the synovial lining and neutrophils appear in the synovial fluid is unclear. In the joint affected by RA neutrophils join lymphocytes in perpetuating the inflammatory process (Schlotzhauer & McGuire, 1993).

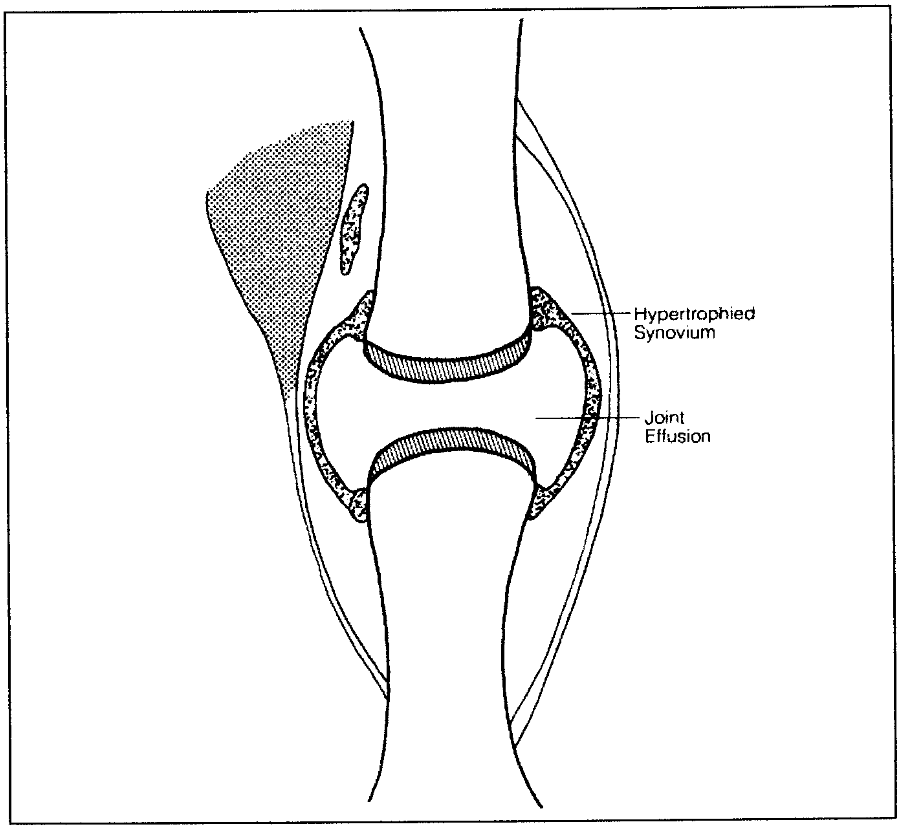

Figure 14: Stage 3 RA (Schlotzhauer & McGuire, 1993)

- STAGE 4

Chronic arthritis is characterized by destruction of articular cartilage, ligaments, tendons and bones. In this stage of RA the inflammatory cells particularly macrophages, continues to liberate proteolytic enzymes, (collagenases), which directly attack articular cartilage and bone, together with the ligaments and tendons associated with the joint capsule. Bone erosions occur where the synovium attaches to bone, producing characteristic periarticular defects on radiographs. The articular cartilage is gradually destroyed by an inflammatory membrane referred to as pannus. It starts at the periphery of the articular surface (at the normal interface between synovium and articular cartilage) and gradually works toward the center. Joint ligaments are weakened by inflammation induced collagenolysis (Zvaifler, 1988; Schlotzhauer & McGuire, 1993; Walker & Heleva, 1996).

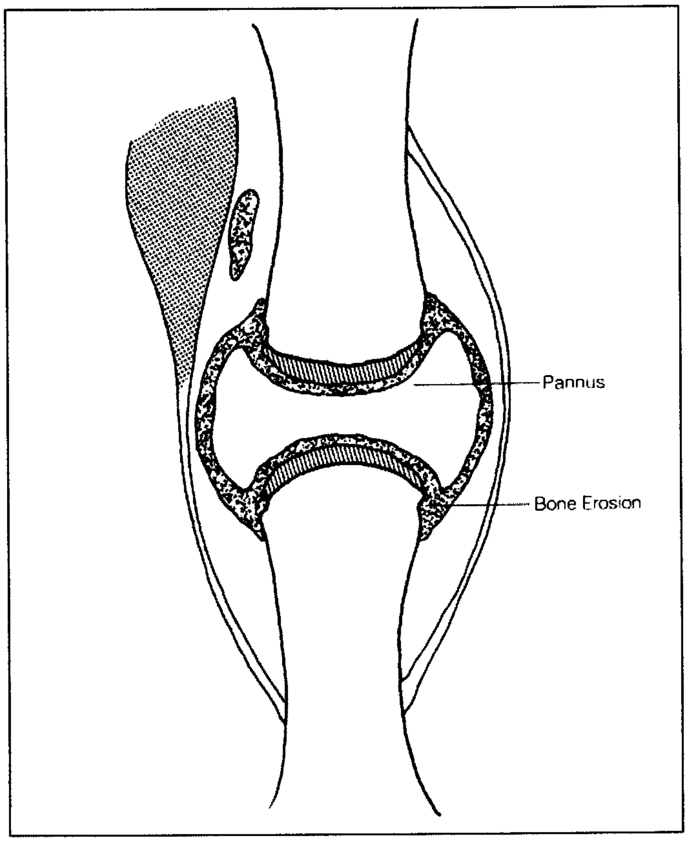

Figure 15: Stage 4 RA (Schlotzhauer & McGuire, 1993)

- STAGE 5

The end result of these pathologic changes is highly variable since the disease may arrest at any stage. In longstanding RA, uncontrolled swelling can cause ligaments and tendons to stretch, adding to the instability of the joint. Often muscles atrophy and become weaker because of disuse. Stretched ligaments and tendons and atrophied muscles interfere with the joints ability to function properly, often resulting in a joint that does not move as it was intended to. Inflammation and pannus can spread along the tendons in tenosynovitis, making the tendons weak and putting them at risk for rupture (Zvaifler, 1988; Schlotzhauer & McGuire, 1993).

When the cartilage is eroded and the supporting structures are loosened, other changes often occur which alter the shape and function of the joint. These mechanical changes are a result of more abnormal forces occurring across the joint than of on-going inflammation in the joint itself (Schlotzhauer & McGuire, 1993).

In some joints affected by RA adhesions can form between opposite joint surfaces and fibrous tissue may develop, leading to fibrous ankylosis. This may be followed by ridging between the two joint surfaces with cartilage or bone. In extreme cases the bones may be completely fused (bony ankylosis) (Walker & Heleva, 1996).

Late in this stage, after the cartilage is totally eroded, the amount of inflammation and swelling often decreases. This is sometimes referred to as a burned-out joint. At this stage, the stretched supporting structures can actually become even looser as the swelling pushing against them decreases. The looseness of these supporting structures can seriously affect the stability of the joint (Schlotzhauer & McGuire, 1993)

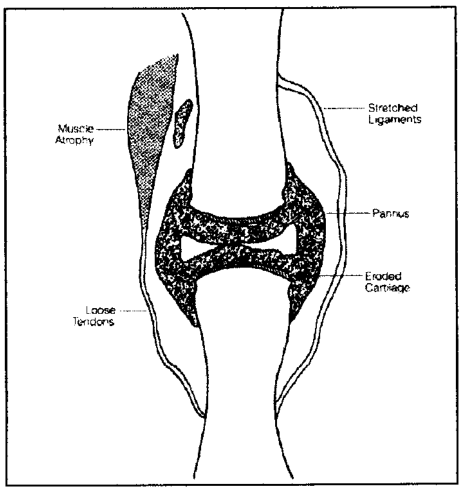

Figure 16: Stage 5 RA (Schlotzhauer & McGuire, 1993)

2.3.4.2 Extra-articular Disease

Although RA predominantly affects the joints, it is truly a systemic disorder that affects the whole body. Symptoms include fever, night sweats, weight loss, anorexia, fatigue and myalgias, which may be due to inter-leukin – 1. Arthritic patients frequently present with anemia, leukocytosis, thrombocytosis, elevated sedimentation rate, hypoalbuminemia and hyperglobulinemia. Inflammatory lesions affect a wide variety of organs including the heart, lungs, central nervous system, vasculature and the eyes. Although these lesions are usually asymptomatic, they are present in a significant number of patients and may lead to clinically evident disease and death (Clarke, 1987 ; Schaumacher & Gall, 1988).

Although the occurrence of extra-articular manifestations is usually associated with more active articular disease, this is not always the case. In general, extra-articular disease is seen in patients with persistently active, erosive arthritis in the presence of high titers of rheumatoid factor, circulating immune complexes and low levels of serum complement. This suggests that the underlying pathogenesis of extra-articular disease is immunologically medicated. Although no primary antigen has been found, deposition of circulating immune complex is considered the underlying cause of extra-articular disease. Using crude estimates about 75% of the RA population have one or more extra-articular complications (Ball & Koopman, 1986; Schaumacher & Gall, 1988).

a) SKIN

Nodules are the classical non-articular markers of the disease. Rheumatoid nodules, with a characteristic pathological appearance, are found in 20% of patients with RA They are frequently found in a subcutaneous location, where skin and subcutaneous tissues are subject to pressure. Nodules develop gradually and are usually not painful. The commonest location is the region of the olecranon process of the ulna. Other sites at which they may be found include the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints of the hand and overlying the ischial tuberosities and the heels (Clarke, 1987; Bennett, 1988; Walker & Heleva, 1996).

b) BLOOD VESSELS

Small vessel arteritis is an uncommon, but dreaded complication of RA. Inflammation of small or medium size blood vessels may produce vasculitic lesions of the skin. In severe cases, ulcers may develop. Inflammation of blood vessels is usually associated with the deposition of antigen antibody complexes (immune complexes) in the blood vessel wall. When vasculitis occurs in the blood vessels supplying the peripheral nerves, nerve function may be lost, resulting in isolated areas of numbness and weakness (mononeuritis multiplex) (Clarke, 1987; Walker & Heleva, 1996).

c) PULMONARY MANIFESTATIONS

The pleural membranes may be inflamed in RA leading occasionally to pleurisy, or more commonly to symptom-less pleural thickening. Pleural effusions are found at times, and may lead to chest pain and breathlessness. Rheumatoid nodules may occur in the pleura. The lung itself may be involved in RA with interstitial fibrosis and pneumonitis (Walker & Heleva, 1996). Rarely, rheumatoid nodules develop in the lung tissue (Schlotzhauer & McGuire, 1993).

d) CARDIAC MANIFESTATIONS

Although symptomatic cardiac disease is not common in RA, cardiac disease in RA can take on many forms. Acute episodes of pericarditis are described in RA. These may lead to chest pain and breathlessness and may be associated with a pericardial effusion. More commonly, a chronic constrictive thickening of the pericardium is found in patients with longstanding RA and this may lead to breathlessness and heart failure. Rheumatoid nodules are occasionally found in the myocardium and on the heart valves (Bennett, 1988; Kelly et al., 1997; Walker & Heleva, 1996).

e) EYES AND MOUTH

Sjögrens syndrome is a common association of active seropositive disease, seen most often in women. It is characterized by the drying-up of many of the glandular secretions from mucous membranes. The most notable symptom is dry eyes, with a gritty sensation under the eyelids, no tear secretion and difficulty in opening the eyes in the morning. A dry mouth is another possible consequence making it difficult to eat dry food and sometimes causing considerable problems with dental hygiene (Clarke, 1987; Schlotzhauer & McGuire, 1993).

f) VOCAL CORDS

Another rare complication of RA is involvement of the joints of the vocal cords. Usually there are no symptoms, although some persons experience hoarseness, difficulty swallowing, and a feeling of fullness in the throat or pain radiating toward the ear (Schlotzhauer & McGuire, 1993).

2.3.5 CLINICAL MANIFESTATIONS OF RA

2.3.5.1 PATTERNS OF ONSET

RA may begin in a variety of ways. RA develops in varying locations and has different patterns of joint involvement. The onset may be acute, occurring within only a few days, or insidious, the most common mode of onset; some studies describe an 'inter-mediate' onset over a few weeks (Ball & Koopman, 1986; Walker & Heleva, 1996).

2.3.5.2 JOINT MANIFESTATIONS OF RA

As joints become progressively involved in RA they may initially demonstrate pain, stiffness and swelling. The swelling is frequently warm on palpation, but usually shows no signs of inflammation or discoloration. The initial swelling may be due to increased synovial fluid, and may be fluctuant. As joint involvement progresses, the synovial lining tissues will proliferate and the joint swelling will be due in part to the accumulation of tender inflamed synovial lining tissues. In the final stages of the disease, joint destruction and deformity may occur, but there may be little residual evidence of inflammation and pain (Walker & Heleva, 1996).

The initial manifestations of RA are frequently in the smaller peripheral joints. As the disease progresses, inflammation may spread to the larger central joints, while the inflammation in the peripheral joints persists. The progress of the disease usually shows bilateral symmetry (Bennett, 1988).

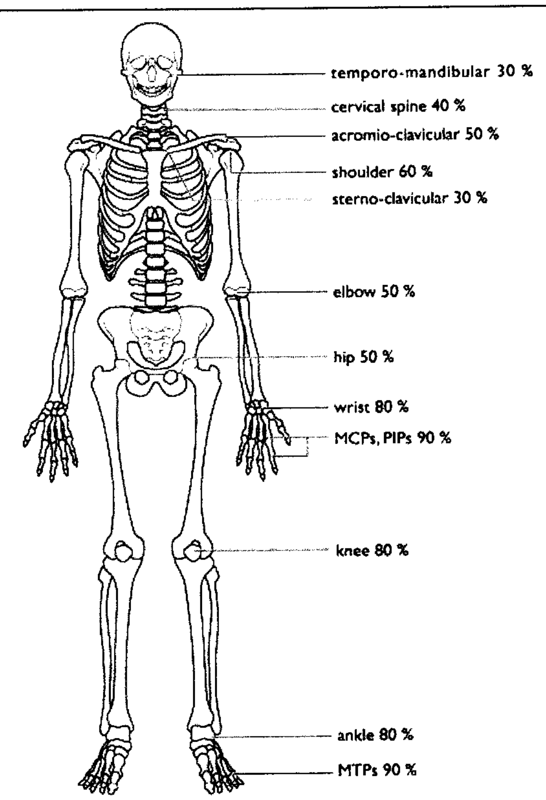

Figure 17: Frequency of RA in the various joints (Thompson, 1998)

a) **HANDS**

The PIP joints of the index and middle fingers are commonly involved in the outset (Schaumacher & Gall, 1988). The initial joint changes may be pain, with tender swelling and marked stiffness. Patients in the early stages may find it difficult to flex the fingers, especially after a period of immobility and it will become increasingly difficult to carry-out activities of daily living that involve grasping and manipulating small objects (Walker & Heleva, 1996). As the disease progresses it is likely to involve all the fingers. Characteristic deformities develop in the rheumatoid hand, including boutonniere and swan-neck deformities in the fingers, together with ulnar deviation and volar subluxation of the MCP joints. This will interfere significantly with all types of hand function. Particularly the loss of the ability to maintain a good pinch (O'Sullivan et al., 1981; Bennett, 1988; Walker & Heleva, 1996).

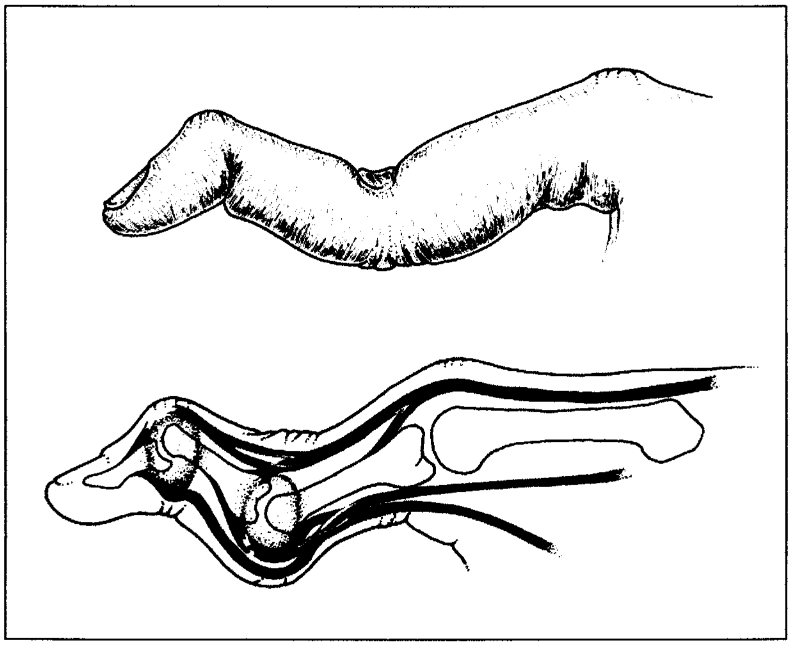

Figure 18: Swan-neck deformity (O'Sullivan et al., 1981)

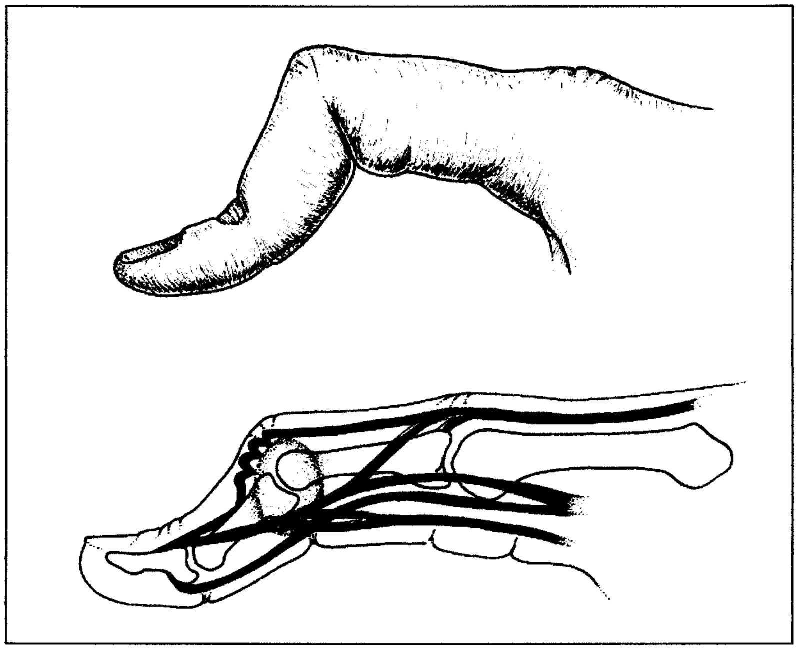

Figure 19: Boutonniere deformity (O'Sullivan et al., 1981)

b) **WRISTS**

In simple functional terms, the wrist provides a mechanism to help extend the range of activity of the hand, and a fulcrum for the muscles of the hand. Severe involvement of the wrists is common. The earliest objective evidence of wrist involvement may be limitation of motion (Schaumacher & Gall, 1988). Erosions may develop in all the carpal bones. In the process of grasping, there is a greater compression strain over the bones of the radial compartment of the wrist. Consequently, when the carpal bones are damaged by rheumatoid inflammation, the radial aspect of the carpus is likely to collapse first. This will produce radial deviation of the metacarpals (Clarke, 1987; Bennett, 1988; Walker & Heleva, 1996).

One of the most common manifestations of RA in the wrist is tenosynovitis in flexor tendon sheaths. Inflammatory changes in the flexor tendons may lead to compression of the median nerve as it runs under the flexor retinaculum of the wrist. The ischemia resulting from this may produce carpal tunnel syndrome, with pain, hand weakness, numbness and tingling in the fingers supplied by the median nerve (Walker & Heleva, 1996; Kelly et al., 1997).

c) **ELBOWS**

While elbow synovitis and pain affect the majority of patients with RA at some time, only 15 to 20% of patients develop severe, potentially disabling involvement (Ball & Koopman, 1987; Schaumacher & Gall, 1988).

One of the earliest findings, often unnoticed by the patients, is the loss of full extension. When the olecranon fossa becomes obliterated by synovium, extension of the elbow is limited, since the olecranon can no longer be driven home into its fossa. As inflammatory destruction of the elbow continues, the anterior margin of the articular surface of the proximal ulna becomes eroded and destroyed, allowing the olecranon to migrate in a cephalad direction. At the same time, the head of the radius maybe eroded (Walker & Heleva, 1996; Kelly et al., 1997).

d) **SHOULDERS**

The shoulder is a key to the function of the entire upper limb. The shoulder is involved in almost 50% of patients with RA (Schaumacher & Gall, 1988).

All components of the shoulder joint may be involved in RA; the synovium of the glenohumeral joint, distal third of the clavicle, various bursae, the rotation cuff and other muscles. In the early stages, glenohumeral involvement may limit abduction of the shoulder. Shoulder effusions maybe found. The bursae that surround the shoulder joint may become inflamed. As rheumatoid damage to the shoulder progresses, the tendons of the rotator cuff may become stretched or ruptured, allowing the head of the humerus to migrate upwards across the glenoid. This may progress until the humeral head impinges on the acromion. In the final stages, most glenohumeral movement will be lost and the shoulder maybe limited to a few degrees of abduction and flexion, associated with scapula rotation (Walker & Heleva, 1996; Kelly et al., 1997).

e) **FEET & ANKLES**

Early involvement of the feet is almost as common as hand and wrist involvement (Schaumacher & Gall, 1988).

Involvement of the toes in RA frequently begins with synovitis of the metatarso-phalangeal joints (MTP). The MTP joint of the great toe frequently develops a valgus deformity, while the MTP joints of the remaining toes often develop hyperextension or dorsal subluxation. The interphalangeal joints of the toes remain flexed producing the claw-toes/hammer-toes deformity. The dropped metata heads will expose the joints to direct pressure that, in turn, will lead to callus formation in the sole. Often gait is altered as pain develops during push-off in striding. (Clarke, 1987; Walker & Heleva, 1996; Kelly et al., 1997).

The midtarsal joints also may be involved and may also contribute to increasing pain when walking. Erosions may develop in the talocalcaneal joint, sometimes leading to fusion (Walker & Heleva, 1996).

The ankle is less commonly involved than the hands, wrist and feet, but tibiotalar swelling and loss of subtalar motion can occur (Bennett, 1988).

f) **KNEES**

The knee joints are commonly affected in rheumatoid arthritis. Although the knee joint is not usually the initial joint affected, 30% of patients will have knee involvement early in their disease course (Schaumacher & Gall, 1988). In the early stages of RA of the knee, increased secretion of synovial fluid may lead to an effusion which will produce pain at the extremes of flexion and extension, as well as a visible bulge (Bennett, 1988; Walker & Heleva, 1996).

If pressure within the knee joint remains elevated, fluid may leak into the semi-membranous bursa, producing a bakers cyst, which in turn may rupture, releasing fluid into the subcutaneous tissues of the calf. In which case a swollen painful calf – the pseudothrombo-phlebitis syndrome is produced. Treatment of this acute condition should focus on the avoidance of weight bearing. If the ruptured Baker's cyst should recur, surgical synovectomy of the knee may be required (Ball & Koopman, 1986; Walker & Heleva, 1996).

As RA of the knee joint progresses, all three compartments (patellofemoral, medial and lateral) may be involved. As the subchondral bone of the tibial plateau collapses, valgus or varus deformities of the knee may develop. In the later stages of rheumatoid damage, the knee may demonstrate lateral instability, due to weakness of the medial or lateral collateral ligaments, as well as anterior and posterior instability due to damage to the cruciate ligaments (Walker & Heleva, 1996).

Quadriceps wasting invariably accompanies knee disease and further predisposes to instability. Muscle weakness may also lead to loss of full active knee extension. The knee is usually less painful if rested in the flexed position, and resulting capsular fibrosis and muscle shortening result in fixed flexion deformity (Dieppe et al., 1986).

g) **HIPS**

Clinical involvement of the hip joint in patients with RA is difficult to diagnose early, and may follow a varied pattern of progression or remission in untreated patients and in response to drug therapy. Radiographic surveys have noted that approximately half of the patients with established disease will have radiographic evidence of inflammatory hip disease (Schaumacher & Gall, 1988; Kelly et al., 1997).

Pain in the hip region in early RA is often the result of bursitis, which is characterized by local tenderness. In advanced RA inflammation of the hip joint may lead to pain and stiffness on all movements of the hip. However, the earliest clinical sign of true hip involvement is loss of internal rotation. These symptoms will be particularly severe on weight-bearing and will be exacerbated on climbing stairs and hills. The pain may be referred anteriorly to the groin or posteriorly to the lower back and buttocks. With increasing damage to the hip joint, patients may develop an antalgic gait and Trendelenburg's sign may become positive. Full extension of the hip may be limited by a flexion contracture (Ball & Koopman, 1986; Dieppe et al., 1986; Walker & Heleva, 1996).

h) **CERVICAL SPINE**

The cervical spine, especially the synovial atlantoaxial joint, has a higher frequency of significant clinical and radiographic involvement in RA than the dorsal, lumbar or sacroliliac joints, probably due to greater use and motion (Schaumacher & Gall, 1988).

Few patients with rheumatoid arthritis will not experience episodes of neck pain. For most this is a relatively unimportant, if painful, complication, but for a small proportion, neck involvement can be totally disabling, or even life threatening. The arthritis can attack the small joints, soften ligaments, erode vertebrae and thicken the ligamentumflavum (Clark, 1987).

The atlanto-axial joint and the midcervical region are frequent sites of inflammation, which can lead to pain, subfuxation and nerve compression as well as decreased mobility. Involvement of the C_1 and C_2 vertebrae may produce life threatening situations if the transverse ligament of the atlas should rupture or if the adontoid process should fracture or herniate through the foramen magnum (O'Sullivan et al., 1981).

2.3.6 GENERAL MANAGEMENT OF RA

Rheumatoid disease should be regarded as a systemic disorder, in which the joints are often the primary target organs. The general goals of management must include pain relief, the suppression of the inflammatory process, the maintenance of joint function and preparation of the patient to cope with the responsibilities and pleasures of daily living. In an ideal setting, this is best achieved by a team approach to patient management. The ideal therapeutic team is likely to include a family physician, a rheumatologist and members of the health professions with special skills in the care of arthritis, including physiotherapists, occupational therapists, biokineticists, dieticians, social workers and nursing staff (Walker & Heleva, 1996).

Although patients with RA may be similar, no two are identical. In the management of individuals, it is the subtleties of the particular disease pace and process, matched with element of personality that make each therapeutic challenge unique (Kelly et al., 1997).

2.3.6.1 MEDICAL MANAGEMENT

Taking medications can be inconvenient and few medications are free of potential side effects. In the treatment of RA however, the benefits of medication almost always outweigh their inconvenience of risk. Medications decrease inflammation and prevent the permanent damage that can occur when RA is not brought under control. They can also help control pain. In short, medications are an essential ingredient in the treatment of RA (Schlotzhauer & McGuire, 1993).

The three major groups of medications prescribed for the treatment of RA are :

- first-line drugs, which are used to reduce inflammation quickly. Aspirin and other non-steroidal anti-inflammatory drugs (NSAID), are the first-line drugs (Ball & Koopman, 1986; Schlotzhauer & McGuire, 1993).
- second-line drugs, which are used in an attempt to induce remission. These are the Disease-modifying anti-rheumatic drugs (DMARDS) and the immunosup presents (Schlotzhauer & McGuire, 1993). While they rarely induce true remission, they are much more effective than the NSAID's and in a number of

cases have been shown to slow the process of joint destruction (Liang & Logigian, 1992) and;

- Corticosteroids, better known as cortisone or steroids (Schlotzhauer & McGuire, 1993). Corticosteriods are the most dramatically effective short-term anti-inflammatory drugs. RA, however, is usually active for years, and clinical benefits from corticosteriods often diminish with time. Furthermore, corticosteriods do not appear to prevent the progression of joint destruction (Berkow et al., 1992).

2.3.6.2 ALTERNATIVE AND COMPLEMENTARY THERAPIES

According to the Arthritis Foundation (Unproven Remedies for Arthritis Treatment) due to the fact that there is no cure for RA and the disease causes pain, most people will want to try anything to get some relief.

Special diets, vitamin supplements, and other alternative approaches have been suggested for the treatment of RA. Although many of these approaches may not be harmful in and of themselves, controlled scientific studies either have not been conducted or have found no definite benefit to these therapies. As with any therapy, patients should discuss the benefits and drawbacks with their doctors before beginning an alternative or new type of therapy (Scammel et al., 1996).

Two popular therapies are glucosamine and chondroitin sulfate found in the dietary supplements osteoEze and arthroEase. A few small studies have suggested benefits but no long-term controlled studies have been done to prove safety and effectiveness (Mayo Clinic, 1998). Other well-known alternative therapies for RA include procydin (an antioxidant produced from pine bark and grape seed), Methylsulfonylmethane (MSM) (dietary sulfur) and the African potato.

2.3.6.3 SURGICAL MANAGEMENT

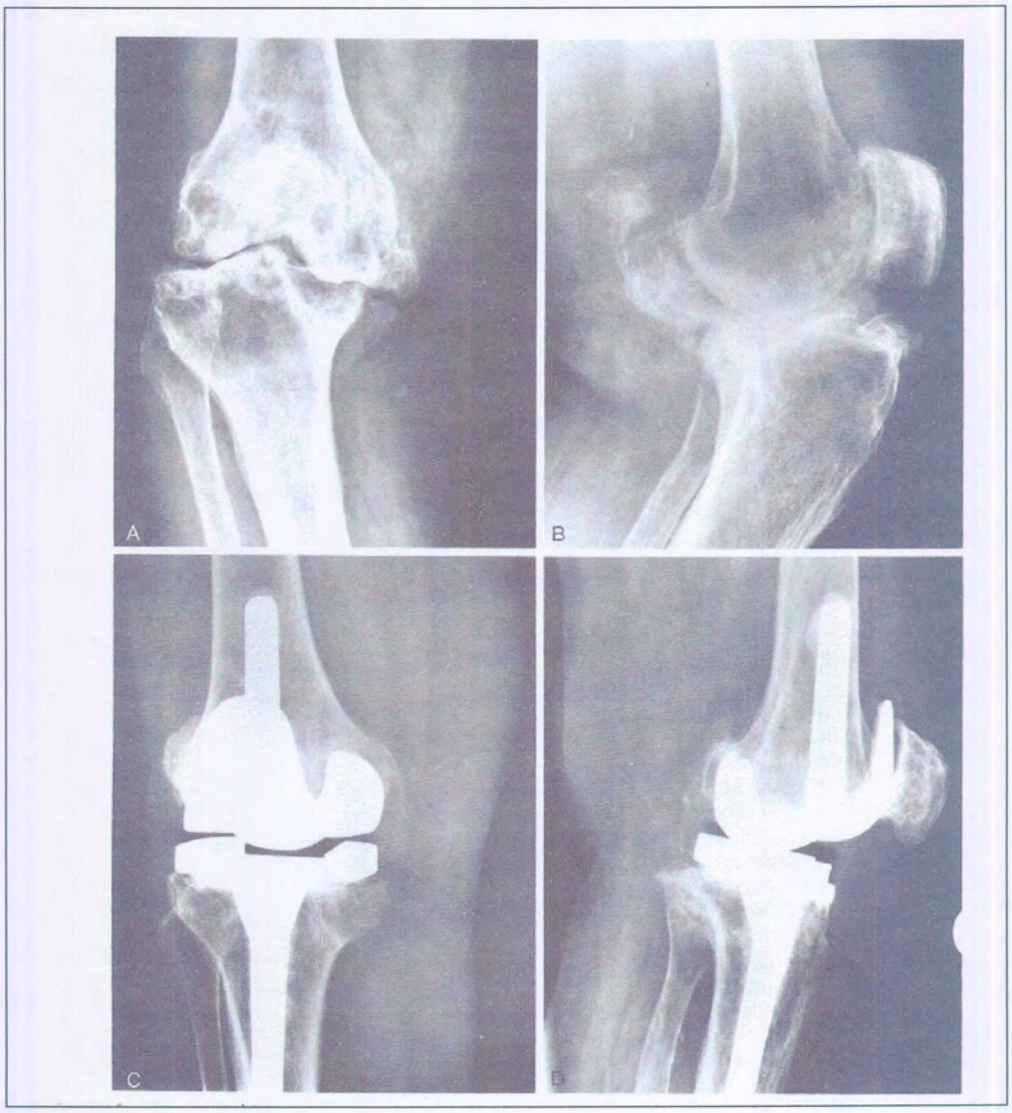

Figure 20: Roentenograms taken after implantation of a semi-constrained total joint prosthesis demonstrating good correction of varus deformity (Moskowitz et al., 1984).

Surgery needs to be offered at the proper time, it needs to be appropriate to the patient's needs and should be followed by adequate rehabilitation. Sometimes, despite timely medical therapy, RA continues to cause inflammation and joint damage. When other therapies have not been successful, surgery may be necessary. Indications for surgery include, pain relief and the maintenance or improvement of function. The surgeon who operates on patients with arthritis, especially those with RA, should be familiar with the special requirements of the patient with multiple joint involvement. In general lower extremity surgery is performed before upper-extremity surgery in order to ensure that the patient remains ambulatory. However, exceptions to this occur when a patient has such poor upper-extremity function that they could not tolerate ambulatory aids or a platform walker to assist them in rehabilitation following lower-extremity surgery (Clark, 1987; Sledge, 1988; Schlotzhauer & McGuire, 1993; Kippel & Dieppe, 1994).

a) PREVENTATIVE SURGERY

It would be nice to think that surgical techniques could be employed to prevent joint damage. But weighed against this is the lack of total predictability of any surgical technique and the discomfort with consequent muscle atrophy. Some surgeons recommend early synovectomy of the small joints of the hand, wrist, elbow and knee. When there is a large bulky synovial overgrowth in RA, the removal may significantly reduce the total amount of diseased tissue and improve the patient's general condition (Clarke, 1987; Resnick, 1995; Walker & Heleva, 1996).

b) RECONSTRUCTION

The development of joint replacement surgery has made great advances in the treatment of arthritis (Liang & Logigian, 1992). A number of joints are suitable for replacement;

- The Hip: Replacement of the hip joint is now a standard procedure and is often extremely successful when pain and limitation are severe enough to prevent the patient from carrying out activities of daily living and impact adversely on the patients quality of life (Schlotzhauer & McGuire, 1993).
- The Knee: Knee replacement has become much more successful since the realization that, unlike the hip, one prosthesis is insufficient to cover all eventualities (Clarke, 1987). Following hip or knee replacement, intensive physical therapy will be required to ensure that the patient regains a full range of movement post-operatively (Schlotzhauer & McGuire, 1993).
- The Ankle Joint: The true ankle joint is suitable for replacement but it must be remembered that the subtalar joint may also be responsible for much of the pain and dysfunction that cannot be corrected by ankle replacement (Clarke, 1987).
- The first carpometacarpal joint and the first metatarsophalangeal joint: The metacarpophalangeal joints do reasonably well when replaced but the

interphalangeal joints are most disappointing and are rarely tackled (Clarke, 1987).

- Shoulder Joint: Prosthetic shoulder joints are now becoming available and while they do not always increase the range of motion to the damaged joint, they will frequently reduce pain (Schlotzhauzer & McGuire, 1993).
- The Elbow: Has been disappointing, although it is improving (Clarke, 1987).

c) **COSMETIC SURGERY**

Patients often ask for cosmetic surgery on a deformed hand to make it more attractive. However, restoring appearance may damage function (Clarke, 1987).

d) **SALVAGE**

Occasionally it is necessary to perform fairly drastic surgery to retreat from a serious anatomical or pathological problem:

- Arthrodesis: Arthrodesis relieves pain by uniting the bones of the joint into a permanent, yet useful position, preventing any motion at the site (USA College of Foot and Ankle Surgeons, 1997).
- Fusion of the Spine: Particularly the cervical spine, may be absolutely indicated if neurological damage is occurring (Clarke, 1987).

In addition, athroscopic surgery allows the surgeon to examine the joint and at the same time. The surgeon can take a biopsy of tissue to confirm a diagnosis or perform corrective procedures such as removing damaged cartilage or ligament repairs (Schlotzhauer & McGuire, 1993).

2.3.6.4 JOINT PROTECTION & SPLINTING

a) **JOINT PROTECTION**

Joints that have been affected by inflammation, swelling, and arthritis changes, can be damaged more easily than normal joints. Pressures from outside and inside can contribute to deformity. Thus, it is important that patients are educated on how to protect their joints during activities of daily living (O'Sullivan et al, 1981; Kelly et al., 1997).

There are numerous methods for teaching joint protection techniques and over the year's written materials and audiovisual presentations have been developed to assist in this phase of patient education. One effective method developed by Gruen and Wingert, is based on the use of "the four P's" – pacing, planning, priorities and positioning. These four basic principles may be effective for conserving energy and protecting joints (Banwell & Gall, 1988).

* <u>Principles for Pacing</u>

- Take frequent rest breaks throughout the day;
- Take breaks during activities before you begin to feel tired;
- On good days, pace your work so you will feel less tired at the end of the day; (Banwell & Gall, 1988)

* <u>Principles of Planning</u>

- Plan small amounts of work each day, never over-do;
- Follow a heavy task with a less demanding task; (Banwell & Gall, 1988)

* <u>Principles for setting Priorities</u>

- Make a list of chores in order of importance;
- If you feel tired or in pain, postpone certain activities until another day; (Banwell & Gall, 1988)

* <u>Principles for Positioning</u>

- Use the stronger or larger joints when performing heavy tasks;
- Use each joint in its most stable and anatomic plane to reduce potential for deformity;
- Change positions frequently;

- Use assistive devices to prevent joint injuries; (Banwell & Gall, 1988)

b) SPLINTING & ORTHOTICS

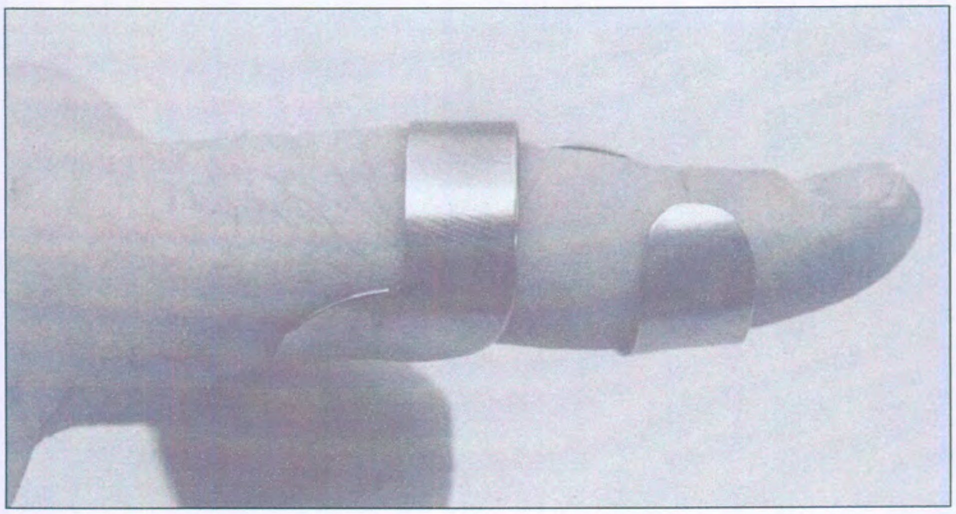

Figure 21: Ring splint for boutonniere deformity prohibits flexion of the PIP joint (Banwell & Gall, 1988)

A splint or orthosis is a device used to support a weak or unstable joint, immobilize and rest a joint in order to relieve pain or maintain a body segment in a more functional alignment (Gerber, 1988). Splinting is an especially useful intervention for the wrist and hand in RA. A resting splint helps control inflammation and pain. A functional splint supports joints in a functional position during activity (Liang & Logigian, 1992). Due to the fact that significant foot involvement occurs in 80% of patients with RA, orthoses for the feet are commonly used. The patient with RA may have fore-foot problems of painful callosities, Cock-toe deformity, sub-luxed MTP joints, and hallux valgus. These problems are easily accommodated by providing a deep, wide, soft leather shoe that allows for adequate toe clearance and metatarsal pad or bar to remove weight from the MTP joints (Gerber, 1988).

2.3.6.5 NUTRITION

Few modalities of treatment for RA involve more options than food. The list of 'arthritis diets' and 'arthritis cookbooks' are staggeringly long. According to the Arthritis Foundation (diet, guidelines and research) researchers are looking with increased interest at the role diet may play in arthritis. There are some scientific reasons to think that diet might affect certain kinds of arthritis. But there is not enough evidence to clearly understand how the diet may harm or aid or whether people with certain kinds of arthritis should adopt special diets. It is generally agreed that the most important dietary factor is the quantity of food eaten and the weight of the patient eating it. Obesity is very harmful for arthritis in weight bearing joints. Added weight magnifies the degradative potential of weight bearing in patients with active synovitis. Therefore, a balanced diet, daily multivitamin supplements and achievement of ideal weight constitute a good approach for all patients (Kelly et al., 1994; Jestadt, 2001).

2.3.6.6 PHYSICAL THERAPY & EXERCISE

Proper treatment for RA, including the benefits of exercise, has been the subject of debate for decades. Understanding the historical change in attitude about exercise may assist in the understanding of the importance of exercise as part of the treatment for RA (Schlotzhauer & McGuire, 1993).

In the late 1800's, the concept of total bed-rest became the standard care. Rest therapy, the antithesis of exercise, was prescribed because it was thought to reduce pain and inflammation and to preserve joint function (Kirsteins et al., 1991; Melton-Rogers et al., 1996; Jenkinson, 2001;).

Clinical studies that demonstrated that rest reduced inflammation are cited as justification for ruling out exercise. In animals with crystal-induced synovitis, exercised knees demonstrated increased inflammation in comparison to rested knees. Studies showed larger effusions, higher white blood cells counts and more intense synovitis in exercised compared to non-exercised joints (Fam, 1990).

Furthermore, exercise can elevate pressure inside the joint and result in altered biochemical changes in RA joints. Dramatic increases in intra-articular pressure with isometric and dynamic exercise in RA joints can cause reduced capillary blood flow and joint hypoxia (Blake, 1989).

Although there has been concern that exercise may exacerbate RA, these fears are based on rather scant data and the effects of hospitalization and bed-rest for RA, have been subject to only a few controlled studies (Jenkinson, 2001).

It was not until 1948, when the undesirable effects of prolonged bed-rest were described, that exercise slowly started to resume its role in arthritis therapy and rehabilitation. Negative effects of prolonged bed-rest on the body include muscle weakness (1 – 2% a day in healthy subjects and is more pronounced in the presence of joint disease), bones lose calcium and become more brittle and overall fitness diminishes (Kirsteins et al., 1991; Schlotzhauer & McGuire, 1993; van den Ende et al., 2000).

Gradually more and more health care providers began prescribing exercises for their patients and with time, the amount of prescribed exercise had increased. Gentle range-of-motion exercises aimed at preserving joint motion and cautious muscle strengthening exercises, became essential components of the treatment regimen (Schlotzhauer & McGuire, 1993).

In the past twenty years, man has become much more exercise conscious and trends in therapeutic advice for patients with RA, reflects this. Moreover, recent studies have shown that exercise does not exacerbate disease and can be beneficial. The types of exercises prescribed for the RA patient has also changed dramatically from the traditionally prescribed isometric and range-of-motion exercises (van den Ende et al., 1998; Jenkinson, 2001).

What physicians and others have learned from changes in treatment adds up to this : Body systems including the joints, work better when they are used, than when they are not used (Samples, 1990).

a) BENEFITS OF PHYSICAL THERAPY AND EXERCISE FOR RA PATIENTS

The biomechanical principles of various joint tissues such as articular cartilage, bone, ligament and muscle are well documented. All of these tissues are affected by arthritis and influenced by exercise. Biological soft tissue remodels over time in response to increased or decreased mechanical loading, as occurs in exercise or joint immobilization. The therapeutic use of exercise in arthritis is based upon the assumption that bone, ligament and muscle change in size and alter material properties as a function of the amount and magnitude of tissue use. The condition of the tissue is closely related to the dynamic interaction between positive tissue re-modeling due to use and tissue decay due to disease and disuse. Therefore, the proper choice and appropriate utilization of exercise is essential in order to provide a therapeutic, rather than harmful, effect. Furthermore, an appropriate balance between rest and exercise is necessary. Rest and exercise are complementary elements of the management of active disease and the best balance should be found between rest and exercise for each patient (Banwell & Gall, 1988; van den Ende, 2000).

Benefits of appropriate exercise for RA patients include:

- increased energy;
- increased muscle strength and endurance;
- increased joint stability;
- help prevent joint deformities; and
- decrease pain
- improve daily function (Hampton, 1997; Sayce & Fraser, 1997; Stenström et al., 1991; Bartlett, 1999; Klepper, 1999).

In addition, it appears that exercise may induce changes in circulating immune function that would appear helpful in regulating inflammation (Shephard & Shek, 1997).

Exercise affects more than just the symptoms of arthritis, it also helps in improving bone density, increases cardiorespiratory fitness, promotes self-esteem, improves the quality of sleep and decreases muscle tension and anxiety (Schlotzhauer & McGuire, 1993; Hampton, 1997).

b) THE OBJECTIVES OF THEAPEUTIC EXERCISES

The term exercise evokes a variety of images. From the standpoint of rehabilitation, exercise therapy (over and above the psychosocial and physiological benefits of recreation), is designed to achieve specific therapeutic goals (Swezey, 1978).

The objectives of exercise therapy in RA have changed along side with the changing views of exercise and RA (van den Ende, 1998). However, the main objectives are :

- preserve motion or restore lost motion, increase muscle strength and increase endurance;
- provide cardiovascular conditioning;
- increase bone density;
- control pain;
- enhance a feeling of well-being; and
- provide active-recreation (Walker & Heleva, 1996; Bartlett, 1999)

c) PAIN CYCLE

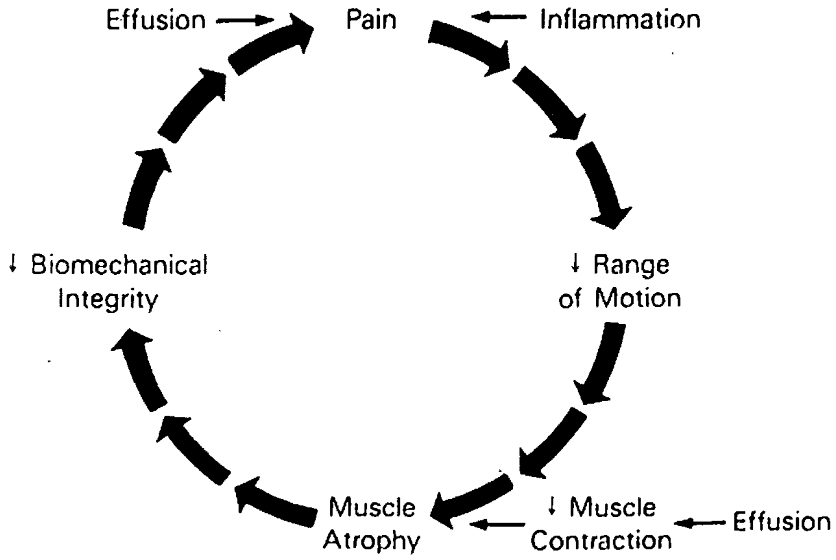

FIGURE 22 : Joint effusion and inflammation cause the pain that begins the cycle of musculoskeletal problems associated with arthritis. Patients often respond to pain by restricting joint motion and increasing time at rest; with fewer contractions, muscles atrophy, range of motion is lost and total bio-mechanical integrity is diminished. This in turn may lead to increased pain (Hicks, 1990)

A vicious circle of pain, leading to physical inactivity, causing new symptoms and more pain, is frequently seen among chronic pain patients. Patients with RA, are no exceptions. Inflammatory arthritis such as RA can involve joint structures (synovium, cartilage and bone) and their surrounding soft tissues (muscles, skin, tendons and ligaments). The resulting problems are soft-tissue and synovial swelling, erosion of cartilage and bone, stretching or rupture of tendons, muscle atrophy, and decreased bone density. This process creates limited joint mobility, muscle weakness, and joint instability. These compromises in bio-mechanical integrity of the joint and its surrounding tissues that result in pain, altered loading response and patterns of motion that are often energy inefficient. The RA patient then limits activity, which increases these problems (Hicks, 1990; Stenström et al., 1991).

d) Considerations in Designing an Exercise Programme

Prescription of exercises should be based on the patients diagnosis and level of disease activity with the functional limitation of each joint assessed individually. Disease activity and disease severity may change over time requiring periodic revision of the exercise prescription (Kelly et al., 1997).

I Assessment of Local or Systemic Involvement

Careful assessment of all local structures (joint and soft tissue) should be done by physical examination and radiograph review. Not all joints will require the same exercise techniques. What is fine in one joint area may be contraindicated in another. Systemic involvement should be assessed by careful examination and review of laboratory data and radiographs (Hicks, 1990).

II Stages of Joint Involvement

The stage of joint involvement should be assessed. It should be determined if the involved joint is an acutely inflamed, sub-acute, or chronic state. The type of exercise received will differ for these stages (Hicks, 1990).

III Functional Status

Evaluation of functional status of patients with arthritis is important in planning a comprehensive treatment programme. Many instruments have been developed to measure function in rheumatic conditions, several of which are becoming widely used, for example, The Health Assessment Questionnaire (HAQ) (Gerber, 1988; Kelly et al., 1997).

IV TYPE OF PAIN

Pain control is often a major concern. It is good to determine if a patient's joint pain is from a degree of inflammation, purely from mechanical derangement, or from both. This will influence the exercises given (Gerber, 1988; Hicks, 1990).

V PREPARATION FOR EXERCISE

Usually patients with inflammatory arthritis benefit from the use of heat modalities prior to stretching exercises in order to increase tendon extensibility and decrease pain (Gerber, 1988; Hicks, 1990). In addition, level of readiness, confidence to begin exercising, expectations about the benefits of exercise, previous experience with physical activity and current lifestyle should be taken into account. Discussions should focus first on encouraging physical activity and allaying fears as well as helping patients to identify opportunities to become more physically active (Bartlett, 1999).

V DISTINGUISH BETWEEN TRUE MUSCLE WEAKNESS FROM GENERALIZED FATIGUE OR DECREASED STAMINA

The former may require a specific strengthening programme whereas the latter is likely to require aerobic conditioning or planning of one's day to permit enough time to successfully complete one's necessary activity (Gerber, 1988).

e) EXERCISE CATEGORIES

For RA four types of exercise by objective exist :

- range-of-motion (ROM) or stretching exercises;
- strengthening exercises;
- cardiovascular conditioning; and
- recreational activities (Banwell & Gall, 1988)

I RANGE-OF-MOTION OR STRETCHING EXERCISES

Figure 23: An example of a range-of-motion exercise

The ability to move a joint or series of joints smoothly and easily throughout a full ROM, is certainly essential to healthy living. ROM is a major focus of exercise in joint disease. Because the health of many joint structures and their ability to repair themselves is highly dependent upon motion of the joint, in addition the maintenance of functional ROM is necessary for daily activity and efficiency of movement. Another important fact to bear in mind is, that when activities are performed with joints in non-optimal positions because of limited joint motion, muscles are placed at a biomechanical disadvantage, greater forces are placed across the joints, and fatigue occurs earlier (Banwel & Gall, 1988; Gerber, 1988, Hicks, 1990; Prentice, 1991).

* Factors which may impair joint motion:

- Weakening, stretching or degenerative changes in the joint capsule, ligaments or other supportive tissues.
- Cartilage erosion, loose bodies or pannus that interfere with smooth articulation of joint surfaces.
- Shortening of muscles and tendons crossing a joint, resulting from muscle spasm, atrophy or fibrosis.
- Edema of tissue which surrounds or overlies the joint.
- Loss of skin elasticity (as in sclerodema) or dermal scar (Banwell et al., 1988).

* Range-of-Motion Evaluation

Goniometric assessments of both active and passive ROM are indicated. If extreme pain or poor tolerance prohibits effective measurement of joint range, a function ROM assessment should be substituted. Functional ROM tests are performed by asking the patient to touch various body landmarks. During the ROM assessment, tenderness on palpation or crepitus should be noted (O'Sullivan et al., 1981; Nieman, 2000).

* Types of range-of-motion exercises

ROM exercises involve moving each joint as far as it can comfortably be moved in all directions (Schlotzhauer & McGuire, 1993). Three types of ROM exercises exist;

- Passive: Movement within the unrestricted ROM for a segment that is produced entirely by an external force; there is no voluntary muscle contraction. The external force may be from gravity, a machine, another individual, or another part of the individual' own body.
- Active: Movement within the unrestricted ROM for a segment that is produced by an active contraction of the muscles crossing the joint.
- Active-Assistive: A type of active ROM in which assistance is provided by an outside force, either manually or mechanically, because the prime mover muscles need assistance to complete the motion (Kisner & Colby, 1996).

ROM exercises should be done as a therapeutic procedure for all joints that demonstrate evidence of arthritic involvement. For patients with systemic types of disease, such as RA it may be wise to include ROM for all joints as a precautionary measure. The exercises should be done in as active a mode as possible with passive motion used only when absolutely necessary. Two indicators for passive motion would be the acutely inflamed joint, which the patient is unable to move because of pain or spasm and severe myostitis in which active muscle contraction is contra-indicated. Passive motion, is extremely useful but dangerous if mismanaged. Some essential rules should be stressed; the need to respect the physiology of the joint, to work within the residual ROM of the affected joint, to work with one joint at a time and within only one pain on each occasion while avoiding compensatory and trick movements. The rule of avoiding pain is fundamental. Assistive or active exercise is preferred because it minimizes external stress on joint structures, uses the patients own musculature and gives the patient control over the activity (Simon & Blotman, 1981; Banwell & Gall, 1988; Gerber, 1988).

The Arthritis Foundation (Exercise and your Arthritis) stresses the fact that daily activities do not move the joints through their full ROM and should not replace stretching and ROM exercises.

* <u>Heat Modalities</u>

The patient's compliance with the exercise programme and the effectiveness of the programme can be greatly helped by taking advantage of the proper use of heat and/or cold applications to involved joints. There are many ways to apply heat. Heat may be applied to a single joint or a few specific joints by hot packs or a heating pad; or heat may be applied to all affected joints in a hot bath, whirlpool, or Hubbard tank. If there is significant difficulty getting the patient into and out of the tub, seating the patient in a chair in a stall shower with a bath sheet pinned around his/her neck to maintain maximal body contact with the hot water may also be very effective (Banwell & Gall, 1988; Gerber, 1988; Kelly et al., 1997).

* <u>Recommendations</u>

It is usually recommended that ROM exercises be done once or twice a day with 6 to 10 repetitions of each range, although no studies document the advantage of 10 repetitions over 5. A joint with either acute inflammation or infection should be put through its range only 2 to 3 times per session and then maintained in the anatomic position emphasizing extension. In this way the joint range will be maintained while the joint is rested. Many patients report that they prefer to perform ROM exercises twice daily – once in the morning to "loosen-up" and once later in the day when they feel more energetic and active. It is important to remember that overzealous stretching or improper technique can have harmful effects on a joint, especially if it is inflamed or unstable. Having a biokineticist or physical therapist to initially monitor and teach the patients proper technique is essential (Banwell & Gall, 1988; Hampton, 1997; Nieman, 2000).

* Assistive Devices

The buoyancy of water is a great assistance to patients and enables them to focus on achieving full range. Mechanical assists such as pulleys, are often helpful so long as the assistance is of appropriate force and not harmful to other joints. In particular, pulley exercises for the shoulder should not cause damage to the hands when used to grasp handles. Other assistive techniques include "wall-walking", in which the fingers are "walked" up the wall to provide ROM to the shoulders. In this case, the friction of the fingers on the wall provides assistance to achieve the range. Any pattern of single or combined motions can be employed as long as the patient is diligent in completing the entire range for involved joints (Banwell & Gall, 1988; Gerber, 1988).

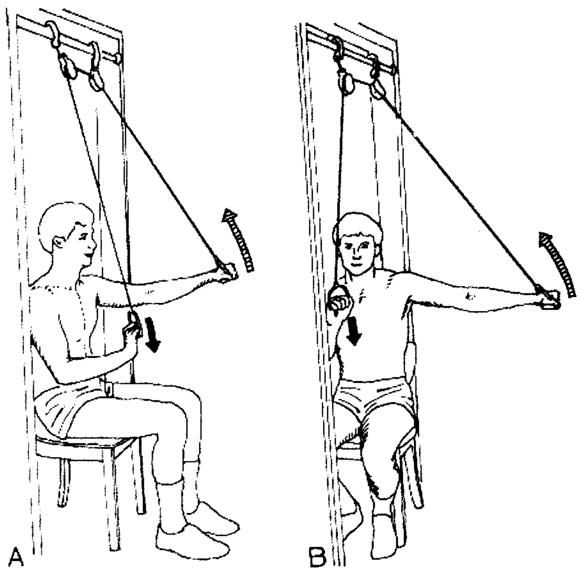

Figure 24: (A) Shoulder Flexion and (B) Abduction using overhead pulleys to assist the motion (Kisner & Colby, 1996)

- Limbering-up Exercises

All patients with generalized arthritis (RA) should be taught a regimen of limbering-up exercises, which should be preformed each morning – perhaps before getting out of bed or while in the bath. Limbering-up exercises are a sequence of exercises that move all the main joints of the body (Clark, 1987; Sayce & Fraser, 1997).

Table II: Limbering-up Exercises

Each of these exercises should be repeated ten times, either just before getting out of bed or shortly after, before dressing
1. Dorsiflexion and plantar flexion of the ankles
2. Circumduction of the ankles
3. Flexion and extension of the knees
4. Static quadriceps contractions
5. Gripping and stretching the fingers
6. Flexion and extension of the wrists
7. Circumduction of the wrists
8. Flexion and extension of the elbows
9. Stretching the arms above the head
10. Gentle roll of the head from side to side (Clark, 1987)

Table III: Critical ranges of motion that subserve function (Liang & Logigian, 1992)

Temporomandibular jaw	1 inch of jaw opening
Shoulder	Flexion 45 degrees
	Abduction 90 degrees
	External rotation 20 degrees
Elbow	70-80 Flexion
Wrist	5-10 degrees dorsiflexion
	10-15 degrees supination
Finger	
MCP	} Flexion > 50 degrees
PIP	}
DIP	}
CMC	Internal rotation > 30 degrees
Hip	0 degrees extension to 30 degrees flexion
Knee	Neutral to 60 degrees flexion
Ankle	20 degrees plantar flexion to 10 degrees dorsiflextion

Key: MCP = metacarpophalangeal; PIP = proximal interphalangeal; DIP= distal interphalangeal; CMC = carpometacarpal

II STRENGTHENING EXERCISES

Muscle weakness, contractures and atrophy often contribute to the clinical picture of RA patients (O'Sullivan et al., 1981). Atrophy of type II fibres is most common (Kelly et al., 1997). Multiple contributing factors that influence muscle involvement include:

- disuse atrophy resulting from decreased activity;
- reflex inhibition in muscles surrounding inflamed joints;
- primary or associated myositis;
- steroid use;
- joint subluxation; and
- changes in direction of pull of tendons (O'Sullivan et al., 1981; Banwell & Gall, 1988; Ytterberg et al., 1994)

* Muscle Strength Evaluation

Standard manual muscle tests may be used but can be inappropriate because of pain that occurs at the end of the active range of motion of the joint. Thus, resistance should be applied within the patient's pain free range only. Isokinetic machines have also been used to measure muscle strength and endurance of major muscle groups in RA patients. Speeds of 90° to 120° per second are recommended. In addition, functional assessments can be done such as grip-strength and activities of daily living (O'Sullivan et al., 1981; Hicks, 1990; Nieman, 2001).

* Objectives of Strengthening Exercises

Adequate muscle strength and endurance functions to absorb impact and shock in weight bearing and optimal strength will also serve to protect and preserve the joint. However, the ultimate objective of strengthening exercises is the recovery or maintenance of function rather than the restoration of normal muscle morphology (Banwell & Gall, 1988). For instance knee extensor and flexor muscle training has been shown to improve the time-up-and-go test in individuals with rheumatoid arthritis and thus improving functional ability (McMeeken et al., 1999).

* Principles for Planning a Strengthening Programme

- The joint condition should not be worsened by the exercise;
- The muscle should not be exercised to -fatigue, and any resistance offered to isotonic or isometric contractions should be sub-maximal;
- Actively inflamed joints should not be put through many repetitions and movement should not be resisted;

- No exercise should ever cause severe pain or discomfort;
- Muscles acting on actively inflamed joints should be exercised isometrically for both strength and endurance;
- The appearance of joint swelling and pain that exceeds one to two hours in duration following exercise are indications of excessive exercise, especially if symptoms increase overnight (Walker & Heleva, 1996; Sayce & Fraser, 1997).

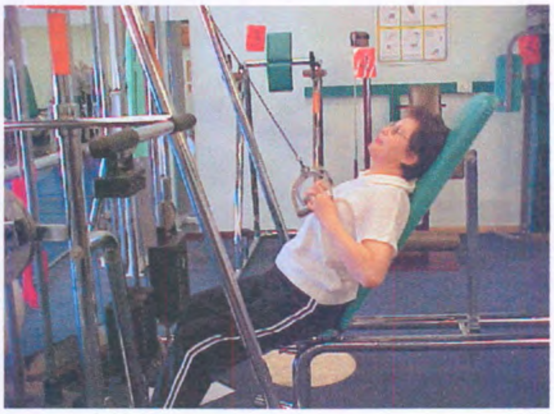

Figure 25: Example of a Strengthening Exercise

* Types of Strengthening Exercises

Strengthening exercises are those that provide enough resistance or "over-load" that the muscle fiber responds with a physiologic change or increased recruitment. Such resistance can be provided in an isometric, isotonic or isokinetic mode, depending on the biomechanical integrity of the joints involved (Simon & Blotman, 1981).

- ISOMETRIC EXERCISES

Isometric exercises involve simply tightening or contracting muscles without producing joint motion, an activity that helps maintain muscle strength (Schlotzhauer & McGuire, 1993). Their advantages in rehabilitation in the rheumatic diseases are considerable. There is no joint obstruction resulting from movement, thus preventing the inhibition of activity due to pain or inflammation (Simon & Blotman, 1981). Therefore, for RA patients with acute forms of the disease, static programmes should be used to prevent possible decrease in muscle function (Ekdahl et al., 1990). Furthermore, it is thought that an isometric programme is associated with the least amount of shear stress across the joint and less intra-articular pressure and juxtaarticular bone destruction (Hicks, 1990).

The stimulus in isometric exercise can be increased with the use of stationary resistance opposite the direction of muscle pull if movement were to be achieved. For example, pushing the elbow against a wall will provide a stronger isometric contraction in the deltoid than simply trying to tighten the muscle. The resistance of one's own body – pushing one body part against another can also be effective (Banwell & Gall, 1988). Elastic bands may also be used as an adjunct to isometric strengthening exercises. These are elastic bands (or tubing) that stretch slightly but are very strong (Schlotzhauer & McGuire, 1993). Variations can also be used such as isometric reversals, slow reversal or slow reversal hold, super imposed over mass patterns using sub-maximal resistance, particularly in the early stages of recovery. In addition, manually resisted isometric reversal techniques can be applied in functional postures, such as sitting, standing or a variety of ambulation stances (Walker & Heleva, 1996).

Contractions held for 6 seconds, repeated 5 to 10 times are generally recommended. Even a brief isometric contraction (one contraction held for 6 seconds once a day) increases strength of a muscle (Hicks, 1990; Harris, 1997). It is practical for arthritis patients to strengthen muscles isometrically because many everyday tasks use isometric contractions (Hicks, 1990). The anatomic areas most likely to benefit from isometric strengthening exercises include neck flexors and extensors; the shoulder rotator cuff muscles, deltoid, triceps and biceps; abdominal muscles and back extensors, and the quadriceps, posterior tibialis, toe extensors and flexors (Gerber, 1988).

Figure 26: Example of an Isometric exercise

- ISOTONIC EXERCISES

Isotonic exercise is a dynamic form of exercise. In this type of contraction, there is either lengthening (eccentric) or shortening (concentric) contraction of muscle fibres, and the adjacent joints move through the available ROM (Hicks, 1990; Kisner & Colby, 1996). Isotonic rehabilitation is traditional. By changing the position of the muscle group in question, it follows a natural progression: assisted contractions, movements without resistance, non-weight bearing movements, movements against gravity and movements against resistance. It is aided by the classical trappings of rehabilitation: pulleys, springs etc., (Simon & Blotman, 1981). Isotonic strengthening allows good recovery of muscles and joints, but should be used with caution, particularly with actively inflamed and painful joints (Simon & Blotman, 1981).

Low load high repetition resistive muscle training is recommended and has been shown to be clinically safe (Komatireddy et al., 1997). High-resistance, and high-impact muscle strengthening exercises are not recommended. Exercise placing high-resistive forces across arthritic joints can increase inflammation and should be avoided. These high forces would also be detrimental in the face of joint instability (Hicks, 1990; Nieman, 2000). Despite, concerns about high-load resistive muscle training, study was conducted by Rall et al. (1996), using intensive progressive resistive exercise (80% of 1-RM), for three months in patients with well-controlled RA. There was a 54 –75% increase in maximal strength of all major exercise muscle groups, more importantly there was no exacerbation of disease activity.

The Nautilis or Universal gym can be used for an isotonic programme for arthritis patients with non-acute joints and no joint derangement (Hicks, 1990). In addition, if resistance equipment is used, such as dumbells, the procedure for holding the weights should not cause stress to the finger or wrist joints or other joints attached to the weight (Schaumacher & Gall, 1988).

Daily activities require both isometric and isotonic contractions. For instance, picking up a suitcase is isotonic and carrying it is isometric. Therefore it is best to train both isometrically and isotonically for activities of daily living (ADL), if possible (Hicks, 1990).

- ISOMETRIC VERSUS ISOTONIC EXERCISES

Gentle passive and active ROM exercises together with isometric muscle exercises are the most frequently prescribed treatments and are still recommended in the textbooks, in particular for the patients with active disease (Hazes et al., 1996). Historically, dynamic exercises were thought to enhance pain and disease activity, and to provoke joint damage. During the last two decades, dynamic exercise forms that are considered more efficient in increasing muscle strength have been recommended more and more, in particular in patients without active disease (van den Ende et al., 1998).

The choice between these two types of muscle contractions depends on the inflammatory status of the joints on which the muscles are acting and on the objective of exercise. It is believed that isometric exercise at sub-maximal effort offers greater protection for inflamed and unstable joints (Walker & Heleva, 1996). Thus, a patient with highly inflamed joints, where pain is a major limiting factor; a static programme may be considered in order to prevent a possible decrease in muscle function (Ekdahl et al., 1990). In patients with less active disease, dynamic training is advised because dynamic exercise has been shown to be more effective in improving muscle strength and function. Function improves more significantly with dynamic training probably due to the fact that everyday activities mostly consist of dynamic movements (Boström et al., 1998; van den Ende et al., 2000).

Thus, it appears that more intensive training of a dynamic sort should be considered for RA patients with non-acute forms of the disease (Ekdahl et al., 1990). Furthermore, there is some evidence that intermittent cycles of intra-articular pressure rise during dynamic exercise might increase synovial blood flow, suggesting a beneficial effect of dynamic exercises in joint inflammation (van den Ende et al., 2000).

Judiciously applied, isotonic exercise will enhance muscle performance and improve function without detrimental effects on disease activity. It must however be tailored to the needs of the patient with RA, taking into consideration factors related to age, severity, strength, amount of joint destruction and the patient's special needs. In addition isometric or isotonic muscle work, combined with mass muscle contractions using normal patterns, may provide the greatest potential for improvement in functional performance (Walker & Heleva, 1996; Hakkinen et al., 1999).

The American College of Sports Medicine recommends that strengthening exercises be done two to three times per week (Nieman, 2000). While the number of repetitions and resistance can be gradually increased to tolerance (Walker & Heleva, 1996).

- RESISTED MUSCLE WORK

Strengthening exercises should be introduced as early as possible to the patient with arthritis, even before loss of strength has taken place. It is also important to remember that muscle strength training may be successful in RA patients, although improvements as great as those seen in healthy persons may not be obtained (Banwell & Gall, 1988; Lyngberg et al., 1994).

In applying resistance, extreme care should be exercised. Isometric manual resistance in the sub-acute stage progressing to isotonic work confers many advantages over mechanical resistance. More specifically, the operator can:

- handle the limb with care, avoiding painful regions;
- gauge and vary the amount of resistance the patient can sustain throughout the range, without stressing the joints;
- gauge better the patient's power output, particularly when compliance is a problem;
- vary more readily the point where resistance is applied;
- resist more readily opposing muscle groups during reciprocal motion or during postural stabilization; and
- apply more effectively facilitatory techniques such as pressure on the muscle belly and the stretch response (Walker & Heleva, 1996).

In most situations, the point of resistance should not cross a joint, but preferably be applied to 1 joint at a time. The amount of manual resistance for isometric work should not exceed the patient's ability to maintain the position and in the sub-acute stage should be sub-maximal. Patients with acutely inflamed joints should perform free active isometric work with minimal or no outside resistance. In order to obtain a training effect resistance to isotonic work must not exceed 80% of the patient's maximal effort and in all cases movement should not be impeded (Walker & Heleva, 1996).

- ISOKINETIC EXERCISE

Isokinetic exercise is performed on an isokinetic machine that controls the velocity of muscle contraction by means of a rate-limiting device. The Cybex II Kim-Com, Lido and Biodex represent these machines. The force or torque of the contraction is controlled by the rate. At high speeds (180°/sec), lower force is generated by muscle, whereas at low speeds (30 – 60°/sec), a large force is generated. In most cases, isokinetic exercise has not been recommended for patients with inflammatory arthritis, because it is thought that greater stress is placed across the joint with this form of muscle contraction than with sub-maximal isometrics or low-weight-arc isotonic exercise (Hicks, 1990; Gerber, 1988). There is however, controversy over this issue. Studies in isokinetic versus isometric and isotonic strength training have been done. In a study conducted by Lyngberg et al., (1994), it was found that isokinetic training done at 50% maximal voluntary contraction was just as safe as isometric training. In addition, strength gains were significant. Van den Ende et al., (2000), found that isokinetic training during active disease, if closely supervised and adjusted when necessary, is well tolerated and more effective than a traditional exercise regimen of isometric exercise. Thus, it appears that isokinetic exercise can be appropriate in many cases of arthritis when joint damage is not severe, since the resistance will be varied and conform to the pattern of force production without overloading weaker portions of the range (Banwell & Gall, 1988).

Figure 27 : Example of an Isokinetic Exercise

- ISOLATED MOVEMENTS VERSUS MASS PATTERNS

Since the ultimate object of therapeutic exercise is to restore or maintain function, functional mass movement patterns are the technique of choice:

- mass movement patterns are based on observed normal activities, incorporating three dimensional movements;
- the brain knows nothing of individual muscle action but knows only of movement; hence, the movement patterns, are easier to learn; and
- in managing a complex and widespread joint disease like RA mass movement patterns, especially those performed bilaterally, are less time consuming and provide for normal and coordinated group action of muscles as well as integrated joint mechanics (Walker & Heleva, 1996).

In contrast, isolated muscle work and simple joint movements take longer to learn and longer to perform. However, isolated movement can be useful for specific regional impairments, where mass movement patterns may be contra-indicated due to joint damage or deformity (Walker & Heleva, 1996).

Figure 28: Example of a Functional Mass Movement

Table IV: Important muscle and joints targeted for strength training and stretching for RA patients

MUSCLE & JOINTS TARGETED FOR STRENGTH TRAINING & STRETCHING		
	Muscle Group	
Joints	**Strengthen**	**Stretch (ROM)**
Head and neck	Extensors, retractors	All muscle groups'
Scapulo/humeral	Scapular retractors and Depressors Shoulder flexors, abductors, and rotators	Scapular protractors and elevators Shoulder adductors and rotators
Elbows	All muscle groups	All muscle groups
Forearm, wrist, and hands	Supinators, pronators, Adductors and abductors of wrist and fingers, flexors and extensors of wrist and fingers	Supinators, pronators Wrist and finger flexors and adductors Hand intrinsics
Hips	Abductors,extensors, rotators	Flexors, rotators, and adductors
Knee	Extensors, flexors	Flexors (hamstrings, gastrocnemius)
Foot and ankle	All muscle groups	All muscle groups
Trunk	Flexors, extensors	All muscle groups

(Walker & Heleva, 1996)

III CARDIORESPIRATORY CONDITIONING

Cardiorespiratory endurance is the ability of the lungs and heart to take in an transport adequate amounts of oxygen to the working muscles, allowing activities that involve large muscle masses to be performed over long periods of time (Fox et al., 1993).

RA may lead to physical disabilities such as a decrease of performance, in ambulation and manual tasks. Likewise, cardiorespiratory function and exercise tolerance appear very limited in persons with RA, as much because of physical inactivity as of disease. A proper level of physical fitness is nevertheless necessary for those individuals to maintain their performance in activities of daily living (Norceau et al., 1995). In addition, aerobic exercise is important because the life expectancy of patients with RA is lower than that for the general population. Cardiovascular diseases, including atherosclerotic coronary artery disease, are major cause of death among these patients (Asanuma et al., 1999).

In the past, the treatment of arthritis has often excluded aerobic exercise for fear of increasing joint inflammation and accelerating the disease process. Until recently, most physicians and therapists recommended that the arthritis patient use great caution in exercise programmes and not participate in vigorous activity which may result in an increase in pulse or respiration rate. Vigorous exercise was seldom recommended and little attention was given to cardiorespiratory conditioning. With the popular interest in 'aerobic' exercise in the 1970's and 1980's, patients with arthritis began asking if they could participate in these activities. A seven-year study in Sweden demonstrated that those who participated in conditioning exercises as well as the usual ROM and strengthening activities had better outcomes in functions, occupational status and physical parameters (Banwell & Gall, 1988; Norceau et al., 1995; Nieman, 2000).

Properly designed conditioning activities that take into account the level of joint stability, pain and other limiting factors can be very helpful to arthritis patients who are not in acute phases of their disease (Banwell & Gall, 1988). Benefits derived from participating in aerobic exercises include :

- improved functional level and ability to perform ADL
- an improvement in general health;
- weight reduction;
- reduced fatigue; and
- improved self-concept and emotional status (Walker & Heleva, 1996).

* <u>Aerobic Capacity Evaluation</u>

The American College of Sports Medicine recommends using various walking tests, including the six-minute walk test or the one-mile walk test in order to determine pre-exercise aerobic capacity (Nieman, 2000).

* <u>Types of Aerobic Exercises</u>

Exercises that use smooth and repetitive motions are recommended. Cardiovascular activities that may help persons with arthritis and that do not place excessive amounts of stress on damaged joints include the bicycle ergometer (low to moderate resistance), the cross-country ski-machine. Walking has also been found to be suitable for many persons with arthritis and is often preferred over other forms of training. Walking on soft surfaces such as grass or a tartan track can help reduce the stress load on the lower-limb joints. Also, it is very important that the patient has a good pair of walking shoes to help absorb the shock. Rigid or semi-rigid arthotics should be considered for biomechanical correction at the ankles and knees (Samples, 1990; Rimmer, 1994; Nieman, 2000).

A modified aerobic dance programme with low impact exercises may also be an excellent way to improve cardiovascular endurance, provided the activities are done on a soft surface such as a mat and do not excessively load damaged joints. The emphasis should be on slow, relaxed movements (Rimmer, 1994).

Denmark researchers found that a water exercise programme was effective in increasing aerobic capacity of persons afflicted with RA. The buoyancy of the water reduces the stress load on the joints and helps the person feel more relaxed (Rimmer, 1994).

A study conducted at Columbia University found that exercising both the arms and legs simultaneously will burn more calories without placing additional stress on the cardiovascular system. In essence, a person can do more work without the same feeling of fatigue. Since persons with arthritis have a low exercise tolerance, this study has important implications. Moving the arms vigorously while walking or using a bicycle ergometer, such as the Schwinn Air-dyne, where the arms and legs work together, may be more beneficial in improving cardiovascular fitness and burning calories than the standard method of exercising the lower or upper body alone (Rimmer, 1994). A sufficient warm-up and cool-down is essential. Applying light massage and heat or ice as a pain control measure is also recommended. In addition, aerobic sessions should always begin and end with ROM exercises (Samples, 1990; Nieman, 2000).

- WEIGHT BEARING VERSUS NON-WEIGHT BEARING EXERCISES

Weight bearing and conditioning exercises have long been discouraged in RA patients because of fear of damaging the joints (Hazes et al., 1996). Traditionally non-weight-bearing isometric strengthening exercises and ROM exercises have been advocated (van den Ende et al., 1996).

Weight-bearing exercise does however have its advantages, such as strengthening the connective tissue surrounding the joint and stimulating bone formation. The above qualities are desirable for patients with RA (Kirsteins et al., 1991). Due to the fact that accelerated generalized osteoporosis induced by active inflammation and immobility is a well-known complication of RA (Hazes et al., 1996; Cortet et al., 1998; Hakkinen et al., 1999). Furthermore, RA sufferers taking corticosteriods (cortisone, prednisone) or immunosppressive drugs (methotrexate, imuran) are at increased risk of developing osteoporosis (Schnitzler, 2000).

It has been shown that during diminished weight-bearing physical activity, bone resorption is favoured over formation in the remodeling cycle. On the other hand, with mechanical stimulation remodeling is uncoupled, and bone formation is stimulated, resulting in an increase in bone mass until it has adjusted to the increased loads (Hakkinen et al., 1999).

Although research on weight-bearing activities for RA patients is scarce, studies have demonstrated that RA patients can participate in aerobic and weight-bearing exercise classes without an increase in disease activity or detrimental effects in the short-term (Hazes et al., 1996). In a study conducted by Kirsteins et al. (1991) it was found that patients with RA could tolerate at least two one-hour sessions of Tai-Chi Chuan exercise per week over a ten-week course, if some guidelines were followed. In 1995, Norceau et al. (1995) quantified the enhancement of aerobic power in individuals with RA enrolled in dance-based exercise programme. Unfortunately, both studies do not provide information on the long-term impact of weight-bearing exercise, and thus we do not know if the absence of adverse effects after weight-bearing exercise would be maintained for a long period of exercise training (Kirsteins et al., 1991, Norceau et al., 1995).

Thus, weight-bearing activity with limited ground impacts does not provoke short-term adverse effects on joint status, but caution should still be applied when prescribing weight-bearing activities (Norceau et al., 1995).

Figure 29: Example of a cardiorespiratory conditioning exercise

* INTENSITY

Prior studies in RA have not quantified the duration, resistance load, intensity, or progression of exercise, information that is vital in determining a more precise "dosage" (Harkom et al., 1985). A few guidelines do however exist. The recommendation for intensity is based on pre-exercise fitness assessment. Persons who are de-conditioned should begin at a low intensity. In persons with low initial capacity, an intensity of 50–60% of maximal heart rate, is both safe and adequate to produce a training effect. For persons with average levels of fitness, intensity of 60–80% of maximal heart rate will be appropriate (Hicks, 1990; Walker & Heleva, 1996).

High-intensity exercise is clearly associated with increased injury and relapse. For the person with arthritis, maintaining intensity at a safe and satisfying level is a challenge for both the exerciser and the Biokineticist. It is often the younger patient who presents the greatest challenge. Balancing joint health, intensity and socially desirable activities is necessary to produce age appropriate, enjoyable and safe exercise opportunities (Walker & Heleva 1996).

However, it is interesting to note that in a study conducted by Van den Ende et al. (2000) it was found that in patients with moderate disease activity, there was a reduction in the number of clinically active joints after vigorous exercise. It might be speculated that improved muscle function in stabilizing the joints has a positive effect on joint inflammation. But further research was suggested with larger sample sizes on the benefit and a disadvantage of a continued regimen of intensive exercise.

* DURATION

Duration of the exercise session is highly variable and can be manipulated with intensity to provide the desired exercise stimulus. Duration of the aerobic portion of the exercise probably needs to be at least 30 minutes to produce a change in fitness. Minimal requirements for health however, suggest that 20 minutes of even low intensity activity may be protective. Two modifications in duration may provide particular benefit to persons with arthritis unable to safely exercise vigorously for 30 minutes. Firstly, interval training, and secondly, the use of additive bouts of exercise. For some patients, exercise can be accumulated throughout the day with several short sessions (Walker & Heleva, 1996; Nieman, 2000).

* FREQUENCY

A frequency of three to four times a week for an aerobic stimulus appears to produce optimal results in terms of cardiovascular benefit with a minimal risk of injury or fatigue. A frequency of five days per week is safe and effective when the intensity is low (Walker & Heleva, 1996).

Finally, aerobic activities must be pursued with caution because of the various pathologic processes that may impose limitations upon endurance (Banwell & Gall, 1988).

IV RECREATION

Many patients can continue exercises they enjoy. In some cases, adaptive devices, such as wrist splints for playing racquetball or tennis, may be necessary. However, some activities should be avoided, high impact activities such as basketball or volleyball, or other sports that involve jumping up and coming down hard, may aggravate arthritic joints. Golfing, gardening, hiking on gentle terrain and other hobbies requiring physical activity are examples of activities that patients with arthritis commonly find enjoyable. Recreational activities are important and benefit both fitness and psychological state (Samples, 1990; Semble et al., 1990; Nieman, 2000).

V EXERCISE PYRAMID

An exercise programme for RA patients should always be individualized according to the patient's needs and the severity of the disease at the time. However, an exercise pyramid for arthritis patients has been devised as a general guideline. Exercises to develop range of motion and flexibility provide the foundation, followed by muscle strengthening, aerobic exercise and recreation (Nieman, 2000).

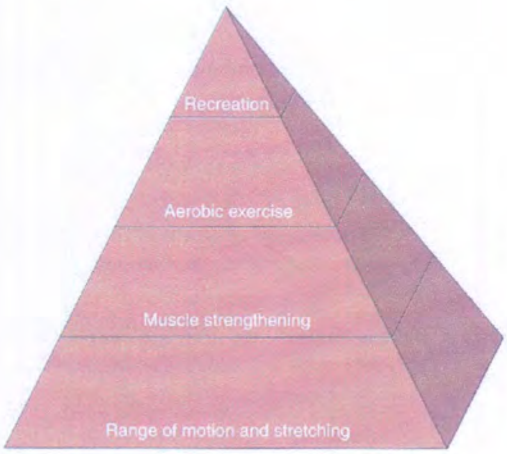

Figure 30: Exercise Pyramid (Nieman, 2000)

c) HYDROTHERAPY

The beneficial use of water in the treatment of joint complaints was advocated by Hippocrates, cultivated by the Romans, exploited by the Spa enthusiasts of the Eighteenth Century and channeled towards contemporary practice as a result of the World wars, when exercise was included to speed up soldiers recovery. Today, hydrotherapy remains a useful tool in the biokineticist's armory and favourable claims made on its behalf are upheld by many patients, many of whom have RA (Hall et al., 1996).

The water temperature should ideally be at body temperature, as cold water inhibits mobility and causes painful joints (Carse, 1991). However, opinions differ and hydrotherapy water is generally used at a temperature of around 34°C. Whatever its source, it offers three areas of interest in rheumatological rehabilitation. The effect of vasodilation and of analgesia is assured. A certain amount of caution should nevertheless be observed in the case of inflammatory arthritic disease where a certain increase in pain could result. The hydrostatic force brings about a relative relief, varying with the level of immersion by reducing loading, decreasing the need for support and giving the patient a feeling of lightness and appreciable freedom. On the other-hand, hydrodynamic resistance can also be used. It changes according to the level of immersion, the speed of displacement and use of technical aids (floats, fins). A resistance, which is easy to control and practical to use, can thus be achieved (Simon & Blotman, 1981). Thus, exercise combined with the physical properties of water, provides a unique setting for people with RA to increase their ROM, strength and function (Tork & Douglas, 1989).

Hydrotherapy has been shown to increase muscle strength, increase joint range of motion, improve aerobic capacity, reduce pain and improve function (Hall et al., 1996). Furthermore, in a study conducted by Stenström et al. (1991) it was found that intensive training in water does not lead to any undesirable consequences among those RA patients who want such training.

Hydrotherapy has many practical applications in the treatment of rheumatic diseases. Contraindications should be remembered, particularly in the case of poor cardiac condition, venous stasis and ulcers of the leg. Active dermatological conditions are a relative contra-indication (Simon & Blotman, 1981).

Figure 31: Hydrotherapy for RA Patients

d) RE-EDUCATION OF GAIT

Performing a standard gait analysis may be necessary for RA patients who have severe disease, altered biomechanics, and a need for orthotics; also assessing balance. Pain and the effects of joint inflammation and destruction hamper the mobility and ambulatory activities of patients with RA. The restrictions are not only limited to lower limb structures but also involve all weight-bearing joints, including those of the upper limbs when walking aids, such as canes, crutches or a walker, are required. Per acutely inflamed weight-bearing joints should not be unduly stressed and frail destroyed joints may not provide sufficient stability to ambulate safely. Under these conditions, walking aids must be considered (O'Sullivan et al., 1981; Walker & Heleva, 1996; Nieman, 2000).

Techniques of rhythmic stabilization will be helpful in the re-education of upright posture and a sense of balance. Propulsion forwards, backwards or sideways can be initiated with the assistance of the therapist, actively by the patient or against resistance. Walking can then be progressed from parallel bars to crutches, canes and free walking (Walker & Heleva, 1996).

e) <u>POSTURE</u>

Patients with RA frequently have problems maintaining correct posture, whether in lying, sitting, standing, walking or during the performance of a variety of activities. Incorrect posture can lead to contracture of soft tissue structures, poor balance and increased energy expenditures; all are detrimental to the rehabilitation outcomes of these patients. The American College of Sports Medicine recommends assessing capacity to accomplish daily activities of living by observing ability to walk with balance and symmetry, ability to sit and then stand up, and ability to stand in one place without difficulty (Walker & Heleva 1996; Nieman, 2000).

Postural awareness and correction with mirror feedback in sitting, standing and walking is a useful approach and increases the patient's perceptions of their body position in space. Proper balance and posture can be taught by applying judiciously techniques of rhythmic stabilization in a variety of starting positions.

Whether in sitting or lying, the guiding principle is the maintenance of well-supported functional positions, patient comfort and frequent changes of position (Walker & Heleva, 1996).

f) EXERCISING DURING A FLARE-UP

During an arthritis flare-up, exercises may need to be curtailed, but the RA patient should not stop exercising altogether. Gentle passive and active ROM exercises together with isometric muscle exercises are the most frequently prescribed exercises for patients with active disease. Most joints, including the inflamed ones, reap benefits from moving it through their full ROM. Isotonic strengthening exercise may be painful during a flare-up and thus should be substituted with isometric exercises to prevent muscle atrophy. Depending on the extent of the flare-up, aerobic activities may either have to be modified or avoided for the time being (Sobel & Klein 1993; Hazes et al., 1996).

g) EXERCISES FOR SPECIFIC JOINTS

* THE HAND

There are all manner of characteristics that distinguish man as being different from the rest of the animal kingdom, but ultimately, it is our ability to manipulate objects in the environment that has enabled our species to take advantage of our large cerebral capacity. Hands are made to function (Clarke, 1987). The hand-wrist unit involves complex biomechanical problems in RA. Appropriate exercises to improve strength and mobility are important to hand rehabilitation (Hicks 1990).

Restriction in passive PIP joint flexion is exaggerated when the MCP joints are passively extended and is often attributable to tight intrinsic musculature and is the basis for intrinsic stretching exercises designed to minimize MCP sub-luxation and swan neck deformity (Swezey, 1978). Thumb adductors should also be stretched (Hicks, 1990). In a study conducted by Dellhag et al. (1992) it was found that stiffness as well as pain was reduced in RA patients who performed active hand exercises.

Range-of-motion exercises to maintain mobility are best performed as two to three stretches, two to three times per day with manual assistance of the opposite hand. Similarly, an effort to maintain mobility in the boutonniere deformity of the PIP joints of the fingers is performed with manual assistance or with pressure on a tabletop, deck of cards or 'Bunnellblock' (Swezey, 1978).

Weakness of the extensor carpi ulnaris and intrinsic hand muscles contribute to the development of biomechanical problems. Median nerve compression contributes to hand weakness. Reflex inhibition of hand muscle function because of pain augments the problem (Hicks, 1990). RA can affect the various types of grip, therefore the patient should be tested for power grip using a suitable grip strength meter, for the ability to do up small buttons, to write and perform only function related to work or housework (Clark, 1987).

Table V : Factors diminishing hand-grasp strength in RA

FACTORS DIMINISHING HAND-GRASP STRENGTH IN RA
• Synovitis in joints • Reflex inhibition of muscular contraction secondary to pain • Altered kinesiology, distored relation of joint, bones and tendons during motion • Flexor tenosynovitis, with or without rheumatoid nodules on tendons • Vascular ischemia → pain, from altered sympathetic tone • Edema of all structures, from inflammation and perhaps altered lymphatic drainage • Intrinsic muscle atrophy and or fibrosis (Kelly et al., 1997)

Intrinsic and Extrinsic musculature is usually strengthened by the normally increased hand activities accompanying reduction of pain or by successful therapy (Schaumacher & Gall, 1988). However, Brighton et al. (1993) found that simple hand exercises were beneficial for the rheumatoid hand as far as grip and pincer grip strength was concerned. Strengthening by forceful grasping (ball squeezing) activity in the rheumatoid hand predisposes the joins to derangement as a consequence of excessive stresses from torques exerted by the flexor tendons on inflamed MCP joints (Schaumacher & Gall, 1988; Hicks, 1990). If intrinsic muscles are to be put on a strengthening regimen, one six-second isometric exercise per day performed with the fingers partially extended in a comfortable, pain-free position, utilizing (1) manual resistance from the opposing hand, or alternatively (2) a rubber band around adjacent fingers and (3) a sponge between adjacent fingers for volar interosseous or thumb adductor – short flexor resistance, should provide the minimal optimal stress (Swezey, 1978).

When deformities are present, exercises should be done in the opposite direction of the deformity. Any exercises that might aggravate the drift should be avoided. It is imperative that patients don't perform activities that put unnecessary stress on involved joints (Shaumacher & Gall, 1988).

Figure 32: **An example of a hand exercise**

* THE WRIST

In simple functional terms, the wrist provides a mechanism to help extend the range of activity of the hand, and a fulcrum for the muscles of the hand. The objectives of exercise for the wrist are to preserve mobility, prevent deformity and maintain strength. Early involvement of the ulnar aspect of the wrist in rheumatoid arthritis leads to loss of supination, while radiocarpal and intercarpal swelling and destruction restrict flexion, extention and ultimately, pronation as well as radial and ulnar deviation. Active, and assisted by the opposite hand, daily range-of-motion exercises for the wrist should include stretching into extension, ulnar and radial deviation and pronation and supination (Swezey, 1978; Clark, 1987; Hicks, 1990).

Key exercises for the wrist include:

- wrist dorsiflexion stretch;
- isometric strengthening of wrist extensors; (this exercise should be avoided if tenosynovitis of the wrist and finger is present); and

- pronation-supination stretching using a lightweight rod as an assisting device (Swezey, 1978; Hicks, 1990).

Excessive force in flexion and ulnar deviation should be avoided. Wrist splints in slight extension, decreases pain during activity and allows better grips (Schaumacher & Gall, 1988).

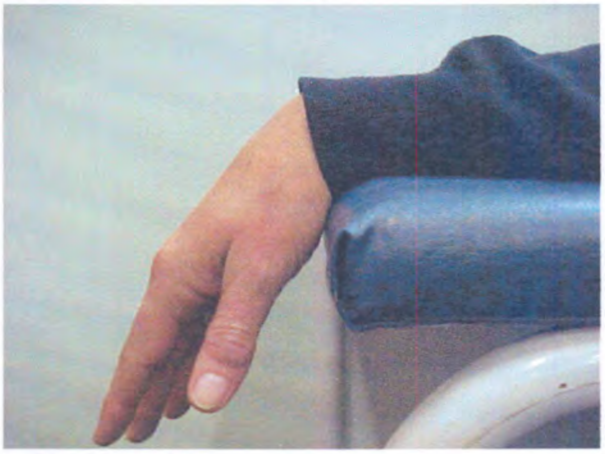

Figure 33: An example of a wrist exercise

* THE ELBOW

Flexion deformities are frequent but, up to 30°, they are rarely of functional importance. About 90° of elbow flexion is needed for ADL. What needs to be assessed is whether elbow movement, when combined with shoulder movement, will allow the hand to get to the mouth and to the back of the head for grooming. Loss of extension is seen early in RA, so active ROM exercises should be done early to maintain full extension (Clark, 1987; Hicks, 1990). Loss of elbow motion, particularly extension, is difficult to restore and attempts to vigorously stretch the elbow could increase articular damage and should be avoided (Schaumacher & Gall, 1988; Hicks, 1990). In addition to flexion and extension deformities, there can be limitation of motion between the capitellum of the humerus and the radial head that inhibits pronation and supination, which can seriously affect hand function (Clark, 1987; Schaumacher & Gall, 1988).

Isometric as well as isotonic exercises should be done to improve the strength and endurance of elbow flexors and extensors. Manual resistance, the use of a ball or an elastic tube, are useful (Swezey, 1978; Hicks, 1990).

Figure 34: An example of an elbow exercise

* THE SHOULDER

The shoulder is the classic mobility joint. Shoulder motion and strength are often compromised as a result of pain from glenohumeral synovitis, inflammation of the subdeltoid and subacromial bursa and bicep tendon and weakness and tears of the rotator cuff mechanism. Scapular weakness also occurs and muscle atrophy and contracture of soft tissues are common, as is adhesive capsulitis (Hicks, 1990). Because some limitation of joint motion is almost universal in chronic cases of R.A, attention to ROM exercises early in the course of the disease may minimize loss of motion and functional impairment (Clark, 1987; Schaumacher & Gall, 1988).

When assessing the shoulder, it should be put through its full range, starting with total elevation (asking the patient to put his hand up to the ceiling) and the looking at flexion, extension, internal and external rotation and abduction. From a functional point of view, the same considerations as with the elbow are important (that is, access to mouth, back of head and perineum), together with such activities as reaching up to get items from a shelf, and getting the shoulder into a comfortable position to dress. In addition, the shoulder joint should be assessed clinically for stability and by radiographs before stretching and ROM programs, is recommended (Clark, 1987; Hicks, 1990).

Since the shoulder is capable of so many kinds of motion, the prescribed exercise regimen should combine several movements to work your shoulder to their full potential. After pain and inflammation are controlled, passive ROM and Codman gravity – eliminated pendulum exercises are done (Hicks, 1990; Sobel & Klein, 1993).

Exercises to stretch the shoulder beyond 90 degrees progress first to the use of a reciprocal pulley. The unaffected arm pulls down on one end of a rope suspended overhead through a pulley and gently stretches the contractured shoulder into flexion, abduction or external rotation, depending on positioning. Active abduction is often more painful than flexion and hence slower to recover. Because active abduction is painful, this exercise should be avoided until late in the restorative programme and then performed with the hand supinated in order to avoid painful impingement of the greater tuberosity of the humerus on the coracoacromial ligament (Swezey, 1978; Hicks, 1990).

Somewhat more vigorous than the reciprocal pulley stretching exercise is "wall walking". Flexion, abduction, extension and internal and external rotation are performed in turn by changing body alignment and proximity to the wall. Marks placed on the wall at the points of maximum stretch create motivating "benchmarks" of progress. To help restore maximum mobility in the late convalescent phase of a shoulder problem, batons, canes, broomsticks and the like may be prescribed to assist stretching. These are held in both hands with the "good" arm assisting the affected shoulder. Forceful stretching is contraindicated in moderately or severely deranged joints with decreased shoulder motion caused by tight soft tissues and joint involvement (Swezey, 1978; Hicks, 1990).

A technique known as rhythmic stabilization is a form of isometric exercise in which manual resistance is applied to one side of a proximal joint and then to the other as the patient holds a closed-chain position to facilitate a simultaneous isometric contraction of muscles on both sides of a joint. Rhythmic stabilization is an effective technique for passive mobilization of the glenohumeral joint, particularly when pain is mild but sufficient to inhibit movement (Swezey, 1978; Resnick, 1995).

Isometric strengthening exercises can easily be done using a ball or elastic tubing in a position of comfort, to strengthen the shoulder abductors and external and internal rotators. External rotation is the key to pain-free shoulder action and maintaining or regaining external rotation is the prime purpose of the rehabilitation programme (Swezey, 1978; Liang & Logigian, 1992). It is very important that patients are supervised when doing shoulder exercises in order to ensure that they are moving the glenohumeral joint and not relying on scapulothoracic motion (Schaumacher & Gall, 1988).

Figure 35: An example of a shoulder exercise

* THE HIP

When hip involvement occurs it can lead to devastating functional consequences. The joints of the lower extremity are critical to mobility, which is essential to independence, so early identification of hip involvement and treatment of functional problems, is vital (Liang & Logigian 1992).

As some limitation of motion is almost always present in patients with longstanding disease, the use of ROM exercises early on may minimize muscle wasting, loss of motion and functional impairment is important (Schaumacher & Gall, 1988).

Hip motion can be diminished in all planes and particularly in internal rotation. The tensor fascia lata often becomes tight and causes hip pain. Stretching of hip flexors, extensors, internal and external rotators and abductors is indicated, as well as stretching of the tensor fascia lata (Hicks, 1990). When hip pain is intense, stretching exercises are best done in a pool, using water buoyancy to assist in ROM (Swezey, 1978).

Early hip contractures are most effectively detected by the Thomas test (patient spine, flex one leg as far as possible to patients chest, observe to see when other leg starts to flex). Another useful guide to assess the amount of contracture is to observe how well patients cross their legs (knee versus ankle) (Liang & Logigian, 1992).

Weakness of the hip extensor and abductor muscles can occur and is contributed to by gluteus medius inhibition by hip effusion. These problems affect gait, self-care and sexual performance. Isometric and isotonic strengthening exercises with emphasis placed on the hip extensor on abductor group (Swezey, 1978; Clark, 1987; Hicks, 1990).

It is important to bear in mind that often one leg is affected more than the other, and shortening will occur. This, in turn, will lead to low back pain due to the short leg syndrome (Clark, 1987). Exercises can also be useful in weight reduction, if necessary (Schaumacher & Gall, 1988).

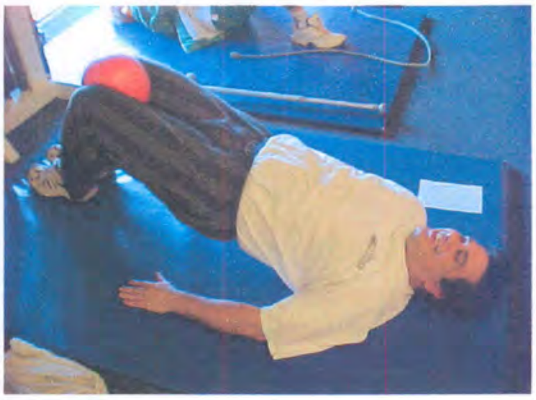

Figure 36: An example of a hip exercise

* THE KNEE

The knee is a complex joint which needs to be able, not only to extend fully, but also to undergo the few degrees of rotation in the last 5 - 10° of extension which lead to locking. This enables people to stand for long periods without using much muscle power. In addition, during ambulation, the knee is mechanically stable only in full extension (Swezey, 1978; Clark, 1987).

Quadriceps atrophy may occur in the first few weeks of inflammatory joint disease. Isometric and isokinetic testing will reveal decreased strength. Knee effusion inhibits quadriceps contraction and removal of effusion effects an immediate increase of the force of muscle contractions of the quadriceps. A tight joint capsule and ligaments with over pull of the hamstring muscles favour early knee flexion attitude and loss of full knee extension. If full extension is not possible, stability during ambulation depends largely on the strength of the quadriceps that is invariably weakened from the arthritis. This predisposes the arthritic joint o increased mechanical stresses and further joint dysfunction. Active synovitis causes cartilage and cruciate ligament destruction and the collateral ligaments become stretched, resulting in varying degrees of instability (Swezey, 1978; Hicks, 1990).

Knee range-of-motion exercises and quadriceps strengthening are vitally important. Exercise focuses on ROM and stretching to maintain at least the 90° to 100° of knee flexion needed for kneeling and stair climbing. The hamstrings are stretched because their tightness limits knee extension (Swezey, 1978; Hicks, 1990).

Large knee effusions should be removed because they decrease quadriceps strength, and forceful stretching in their presence may result in joint capsule rupture. Quadriceps strengthening is recommended early in the decrease process to help maintain the correct balance between hamstring and quadriceps strength and prevent over-pull from the hamstrings. Deep knee bends should be voided and cycling is best avoided until all signs of inflammation have subsided (Swezey, 1978; Hicks, 1990).

Figure 37: An example of a knee exercise

* THE ANKLE AND FOOT

It is easy to forget that the ankle is in fact two separate joints – the ankle proper and the subtala joint. The ankle joint is responsible for plantar and dorsiflexion while the subtabla produce inversion and eversion of the foot. Both joints are frequently involved in RA and make walking painful and difficult.

Stretching of ligaments results in hind-foot pronation and forefoot eversion. Ankle dorsiflexion is compromised by shortened Achilles tendon. Intrinsic muscle contractures cause hyperextension of the MTP joints and flexion of PIP joints (Clark, 1987; Hicks, 1990).

Exercise is aimed at maintaining ankle – foot ROM, stretching tight tendons, and strengthening key muscles. Exercises to maintain mobility in the ankle and foot basically involve active or assisted stretching into the normal planes of motion, eg., ankle: dorsiflexion, plantar flexion; tarsal: foot circling into inversion and eversion; and toes: flexion and extension (Swezey, 1978; Hicks, 1990).

Isometric strengthening for the extrinsic foot muscles are essential, specifically the toe extensors and flexors and the pasterion tibial muscles (Swezey, 1978; Hicks, 1990).

Figure 38: An example of an ankle exercise

* THE NECK

Exercises involving the neck in rheumatoid arthritis patients, should be approached with extreme caution because of the possibility of unstable neck joints (Sobel & Klein, 1993).

Mechanical restriction of lateral flexion and rotation insofar as it is a consequence of lower cervical osteoarthritic bony proliferation will not be affected by efforts to mobilize the neck, but the often large component of restriction of motion that is a consequence of muscle and ligamenteus shortening, can be effectively stretched. Neck stretching is best performed with the neck muscles as relaxed as possible. Cervical isometric exercises can be used to preserve or restore musculature weakened by chronic neck pain. This can be tried in rheumatoid arthritis if cervical subluxations or radiculopathy is not present (Swezey, 1978).

Good posture should also be taught to RA patients in an attempt to limit stress, cervical pain and muscle spasms associated with poor posture (Walker & Heleva, 1996).

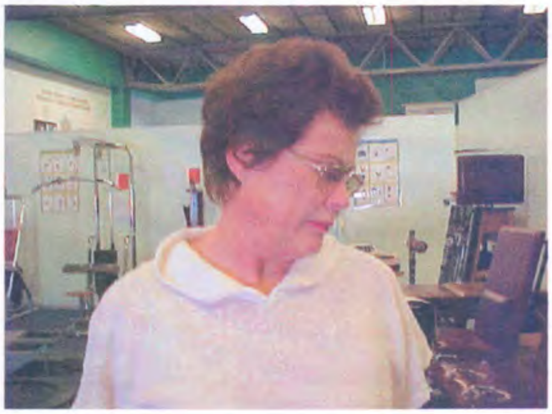

Figure 39: An example of a neck exercise

* TEMPOROMANDIBULAR JOINTS

The temporamandibular joint is commonly involved in RA. Radiographic changes include erosions, osteoporosis, joint space narrowing, decreased ROM, and flattening of the glenoid fossa of the temporal bone. Local heat to the area, stretch exercises (such as opening the mouth as wide as possible as well as stretching the mouth in all directions as if chewing a large piece of toffee), and muscle relaxants may be helpful (Resnick, 1995; Sobel & Klein, 1995; Walker & Heleva, 1996; Kelly et al., 1997).

h) PRE-SURGICAL MANAGEMENT

Exercise is a crucial element of both preoperative conditioning and post-operative healing. The value of pre-surgical physical conditioning should be explained to the patient and a structured, individualized programme should be offered at least two to three weeks prior to surgery. A three-pronged approach is at the core of pre-surgical management: determined anti-inflammatory therapy, general physical conditioning and strengthening the muscles that will be directly compromised by the surgery (Clark, 1987; Sobel & Klein, 1995; Walker & Heleva, 1996).

General conditioning will involve a modified aerobic training programme. The object is to increase endurance and cardiovascular conditioning. If the up-coming surgery involves a weight-bearing joint, aerobic exercise is also beneficial to burn calories in an attempt to lose weight, if necessary. As RA is a systemic disease that may compromise cardiac and pulmonary function, surgical candidates must be taught pre-operative breathing exercises and abdominal muscle strengthening exercises to help with coughing and expectoration.
A programme to strengthen muscles that are directly compromised is very important for successful surgical outcomes. If joint surgery is contemplated (eg. For a knee replacement), isometric resisted exercises to the quadriceps and hamstring muscles will be required to strengthen muscles that may be reflexly inhibited by pain (Sobel & Klein, 1995; Walker & Heleva, 1996).

i) POST-SURGICAL MANAGEMENT

The exercises done for rehabilitation are every bit as important as the surgery. The patient with RA more than any other surgical candidate, is susceptible to severe de-conditioning and vascular and cardiopulmonary complications. Those confined to bed in the immediate post-operative period must begin the day following surgery, in bed, a general activity programme designed to minimize muscle atrophy, joint contractures, demineralization of long bones, vascular obstructions and chest complications (Sobel & Klein, 1995; Walker & Heleva, 1995).

Generally, muscle tone and joint mobility must be restored as early as permissible. Isometric setting exercises are by far the safest to perform when movements in the early stags are contra-indicated. Similarly, resisted exercises to the contralateral limb or other body segments, as well as providing conditioning, will produce stimulation of muscles at the surgical site, through overflow. After the surgical wound is healed, the patient may begin to exercise safely in a pool, well supported by water buoyancy. More often than not, the patient with RA following surgery will ambulate with assistance or walking aids. Initially, the patient progresses from performing transfers in and out of bed or chair, followed by standing, non-weight bearing, or partial weight bearing. An excellent medium for early ambulation is a hydrotherapy pool equipped with parallel bars. Rhythmic stabilization exercises to the trunk and limbs, in sitting and standing with aids, is useful preparatory strategies that correct postures and provide patients with confidence. In later stages, mechanical resistance may be added to the programme (Walker & Heleva, 1996).

j) ADHERENCE TO EXERCISE PROGRAMMES

Although a considerable body of knowledge exists about adherence to fitness and cardiac rehabilitation exercise programmes, very little research has been done on patterns and mediators of adherence in arthritis exercise programmes. This is unfortunate because even the best exercise programme is useless if there are no participants (Banwell & Gall, 1988).

Compliance with exercise programmes in arthritis varies from 50 to 95% in the literature. Children have special compliance problems. The highest compliance is within supervised programmes or where feedback mechanisms exist (Hicks, 1990). A detailed programme using behavioural management strategies has been developed for use in all areas of health and fitness. This programme includes shaping, reinforcement, control, reinforcement fading stimulus control, contracting, cognitive control, self-monitoring and generalization training. This type of programme would be appropriate to either the group or individual setting and could be easily applied to the participant in an exercise programme for people with arthritis (Banwell & Gall, 1988).

Regular exercise at an appropriate level requires discipline and determination. Everything should be done to assist with compliance with exercise progrmmes to ensure that the desired goals can be reached for patients with inflammatory arthritis, it is best to plan so that progrmmes take place in the late morning and early afternoon. In the early morning arthritics tend to have more pain and stiffness and in the late afternoon they tend to be more fatigued. The patient should be told the reason for each type of exercise and should understand the short-term and long-term goals of the programme. Exercise that increases pain and discomfort most often will decrease compliance. Therefore patients should be warned against excessive exercise and taught its signs (Hicks, 1990; van den Ende et al., 1996).

1. Post exercise pain lasting longer than 2 hours
2. Undue fatigue
3. Increased weakness
4. Decreased ROM
5. Increased joint swelling (Hicks, 1990)

Adherence to an exercise programme can be greatly improved if the RA patient enjoys the activities they have to do. In addition, group activities that allow for socialization, require only a minimum of life-style disruption, and are view as recreational are more likely to being maintained than solitary, more athletic activities.(Harkom et al., 1985).