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Review

Vasculature of the normal and arthritic synovial joint

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Summary. The vasculature of the normal and arthritic knee is described. The joint contains a number of different tissues, many of which are heterogeneous and each with varying degrees of vascularization. In the normal joint the vasculature is highly organised, some tissues are highly vascular with well defined vascular organisation, whilst other tissues are avascular. During arthritis vascular turnover is increased. This vascular plasticity leads to redistribution of the vascular bed and may compromise its functional ability. The normal joint is able to regulate its blood flow, but this ability may be compromised by the inflammation and increased synovial fluid volume that are associated with joint disease. Growth of the subchondral vasculature into the articular cartilage may also occur, leading to ossification of the articular cartilage.

Key words: Vasculature, Arthritis, Synovium, Normal

Introduction

Blood vessels are required for many biological processes including ossification, tissue repair following injury, the production of synovial fluid and maintenance of synovium and articular cartilage. Normal synovial vasculature has a paracrine role and can modulate inflammation and synoviocyte activity by cytokine secretion (Walsh et al., 1997). Articular cartilage must remain avascular to maintain its mechanical performance. Chondrocytes therefore synthesise and release specific angiogenesis inhibitors (Langer et al., 1976; Moses et al., 1990).

Nutrients, including oxygen, are supplied to the avascular cartilage by diffusion from the synovial microvasculature through synovial fluid or from subchondral blood vessels. Calcification of the deepest cartilage layer in the normal human adult limits diffusion from vessels in the subchondral bone, leaving the synovium as the major nutrient supply for articular cartilage (Walsh et al., 1997). Arterio-venous shunts have been identified in the synovium and offer a potential mechanism for the control of synovial blood flow (Lindstrom and Branemark, 1962).

Joints can be classified into groups, according to their location, range and nature of motion or anatomy. Synovial joints are present throughout the skeleton and vary in size. However, due to accessibility and relatively large size in man and experimental animals the knee is the most extensively studied synovial joint. Knee arthritis is a major source of distress and disability in man. This paper focuses on the vasculature of the knee.

During arthritis a number of changes to joint tissues can be observed. Rheumatoid arthritis is characterised by inflammation in the synovium which lines the joint, whereas osteoarthritis is more commonly considered to be a disease of articular bone and cartilage. This distinction is open to question, since synovitis is also a feature of osteoarthritis, and subchondral inflammation and cartilage degradation are also observed in rheumatoid arthritis. Blood vessels may contribute to a variety of pathological processes in arthritic joints. Redistribution of the synovial vasculature has been demonstrated in synovia from patients with rheumotoid arthritis, and angiogenesis may be important in the subchondral bone formation that occurs during osteoarthritis. Whether changes in the vasculature of the joint tissues precede or result from clinical arthritis remains uncertain, but the importance of normal vasculature for maintaining joint tissue integrity is clear.

Vascular anatomy of the normal joint

Non synovial tissues

Synovium, menisci, bursae, tendons, ligaments, muscles, cartilage and bone together form the joint. Bursae are closed sacks of cells similar to the mesenchymal cells that form the synovium. The blood supply to the bursae is less than that to the synovium. The tendons and ligaments form the outer layer of the joint capsule. A well-developed vascular system has been demonstrated in tendons and ligaments (McDougall

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et al., 1997) although some areas of tendons and ligaments are avascular (Lundborg et al., 1977; Petersen and Tillmann, 1999). The distribution of vascular and avascular segments of tendon varies with anatomical location (Lundborg et al., 1977). Microscopic examination of the epiligament reveals the presence of a fine vascular plexus (Bray et al., 1990). Tendons run through highly vascular tendon sheaths that are similar to the synovial lining and generate hyaluronic acid rich fluid that reduces friction as the tendons move. Synovial fluid may have a nutritional role for support of the superficial parts and gliding surfaces of flexor tendons (Lundborg and Rank, 1978).

Vessels from the eipligamentous plexus may enter deeply into the ligament or remain in the superficial layers (Bray et al., 1990). Vessels deep within the ligament are predominantly orientated longitudinally along the long axis of the ligament (Bray et al., 1990). Vascular densities vary between ligaments, although the distribution of blood vessels is similar for the anterior cruciate, medial collateral and lateral collateral ligaments (Bray et al., 1990).

Cruciate ligaments may be highly dependent on the presence of synovial fluid for their nutrient supply despite the presence of both deep and superficial vessels (Whiteside and Sweeney, 1980). The ability of synovial fluid to sustain ligamentous tissue in the absence of blood supply has been demonstrated by implantation of isolated ligaments into the joint space in contact with synovial fluid for periods of up to 10 days. In the absence of direct blood supply the tissue appeared to be well maintained with possible signs of cell division and no evidence of necrosis (Whiteside and Sweeney, 1980), demonstrating the capability of synovial fluid to supply nutrients to tissues within joints.

Muscles are responsible for movement and stability of the joint. The vascularisation of muscle is variable, and depends on anatomical location (Aquin and Banchero, 1981; Gaudio et al., 1984). Muscle vascularity increases following periods of exercise training (Henriksson, 1992) and decreases with age (Aquin et al., 1980).

The epiphysial-metaphyseal region of bones is highly vascular. In the case of the proximal tibia, vessels originate from the inferior genicular artery and tibial recurrent artery to form a pattern like 'spokes of a wheel' (Nelson et al., 1960). Each spoke comprises several arteries and an equal number of associated veins (Nelson et al., 1960) or more veins than arteries (Morgan, 1959). Veins may exit the bone via a different route from that which the arteries enter (Morgan, 1959). The bones are linked together by an avascular fibrous capsule, muscles and ligaments.

Menisci are fibro-cartilaginous structures that are partially vascularised. Blood vessels enter the menisci running centripetally from the joint capsule through connective tissue. Peri-meniscal vessels run around the outer fibrous capsule to the knee joint menisci in a centripetal direction (Petersen and Tillmann, 1995). Branches of the perimeniscal artery penetrate to the inner and middle zones of the menisci in the newborn. Devascularization of the inner zone of the menisci occurs with age, such that the absolute depth to which vessels penetrate adult menisci is similar to that of the newborn, but represents a much smaller proportion of the total meniscal volume. Vessels are found only in the area closest to the joint capsule in human adults aged over 50 years (Petersen and Tillmann, 1995). Nutrition of the thicker, peripheral parts of the menisci is by the circulus articuli vasculosus, whilst deeper layers are nourished by terminal loops from the pre meniscal artery (Davies and Edwards, 1948). The joint capsule is lined by a thin layer of synovium which covers the surfaces of the intra articular structures, with the exception of the weight bearing cartilage and menisci.

Synovium

Gross anatomy of the synovium

The synovium has been described using a variety of terms, including deep, superficial, innermost, intimal, lining and sublining. To avoid confusion, the terms lining and sublining have been chosen for this text. Lining is specifically applied to the layer that is closest to the synovial fluid (Castor, 1960). In 75% of samples from normal volunteers the lining is 0-2 cells thick (Arayssi et al., 1997). The sublining is a thicker layer located in contact with the lining layer (where present) and further away from the synovial fluid. The sublining is a heterogenous tissue derived from mesenchyme, whose cellularity and vascularity decreases towards the joint capsule where it is most fibrous (Walsh et al., 1997). Where references have not distinguished between lining and sub lining layers, the terms deep and superficial are used. Deep refers to tissues closer to the synovial fluid, whilst superficial pertains to tissues further away from the synovial fluid.

Blood supply to the synovium can be derived from a number of different arteries. Following occlusion of the femoral artery, there is a transient decline in joint blood flow, followed by reestablishment of blood flow within minutes of the arterial occlusion (McDougall et al., 1997), suggesting vasodilation of remaining blood vessels.

Cellular anatomy of the synovium

The synovium comprises several distinct cell types in addition to cells of intermediate morphology. During development, the lining layer is exclusively type B synoviocytes, fibroblast like cells. The type B cells proliferate and type A synoviocytes (macrophage like cells) are recruited from the circulation (Walsh et al., 1997). In the mature joint, the synovial lining is composed mostly of type B synoviocytes in addition to type A (which represent 10-20 % of the cells), and some cells of intermediate morphology. Type B synoviocytes

are responsible for the synthesis of hyaluronan and its secretion into synovial fluid. A large proportion of the sublining comprises connective tissue with cells of undifferentiated cytology. The proportion of endothelial cells declines with age (Castor, 1960) but cellularity is similar in all common types of normal synovium, simplifying the distinction between normal and diseased tissue.

Classification of synovial tissue is based on its microscopic appearance. The main tissue types are fibrous, fibroareolar, areolar, areolar adipose or adipose (Castor, 1960). Areolar is the most common of these tissues (Knight and Levick, 1983), whilst fibrous and adipose predominate in synovial samples taken from the marginal area, supra patellar bursa and posterior popliteal pouch. The suprapatellar bursa has a predominance of adipose and areolar adipose tissue (Castor, 1960). Synovial thickness varies with tissue site and type. Suprapatellar adipose synovium is on average twice as thick as the other types of synovium (Knight and Levick, 1983). Capillary density varies with location. Capillary density in the supra- and infrapatellar regions is approximately twice that in the posteromedial and posterolateral synovium (Knight and Levick, 1983). The depth of peak capillary density is similar in synovium from all regions (Knight and Levick, 1983).

In addition to human studies, experimental studies on joint morphology, blood vessel supply and blood flow have been carried out predominantly on the rabbit and cat knee due to their convenience as laboratory animals and relatively large size. Morphology of the rabbit (Ghadially and Roy, 1966), rat (Roy and Ghadially, 1967) and guinea pig (Wyllie et al., 1964) synovium is similar to that of the human.

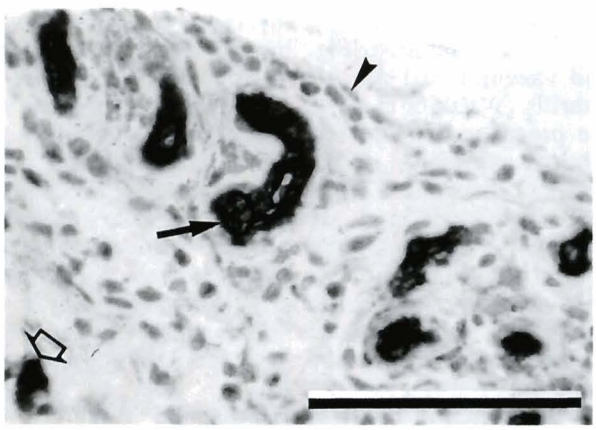

Fig. 1. Greater vascular density (closed arrow) near the synovial surface (arrow head), when compared with vascular density at a site more distant from the synovial surface (open arrow). Synovium from radiographically normal human knee with chondromalacia patella stained for angiotensin converting enzyme (black) showing normal distribution of blood vessels (Walsh et al., 2000). Rabbit polyclonal anti-human angiotensin converting enzyme antibody (RH179). Glucose oxidase nickel enhanced DAB development. Scale bar: 100 μm.

Synovial blood supply

Normal synovium of man and animals is highly vascular (Stevens et al., 1991; Ceponis et al., 1996). It contains arterioles, capillaries and venules with minute perforations or fenestrations (Veihelmann et al., 1999). The dense and highly fenestrated synovial capillary network may have evolved to satisfy the metabolic demands of the cartilage (Suter and Majno, 1964; Veihelmann et al., 1998, 1999). Electron microscopic examination of monkey synovial tissues shows fenestrations in the superficial capillaries and venules immediately beneath the synovial lining cells, with a tendency for the fenestrations to predominate on the side of the vessel closest to the joint space (Schumacher, 1969). In contrast, fenestrations have not been observed on the endothelium of the deeper synovial vessels (Schumacher, 1969). Fenestrations are also present both in normal and in diseased human synovium, and in rat synovium (Suter and Majno, 1964; Clawson et al., 1967).

Synovial vessel distribution

Synovial blood vessel distribution is highly organised and non-uniform, with most of the vessels being located within the sublining layer, in close apposition to either the lining layer or the capsule (Fig. 1).

The architecture of the capillary bed is variable within the synovial membrane (Lindstrom and Branemark, 1962). The relative proportion of arterioles, venules and capillaries varies. Long loops of arterioles supply blood to areas of synovium subject to higher levels of mechanical stress (Lindstrom and Branemark, 1962). Vessels are most scarce in tissues with the greatest mechanical requirements as the presence of blood vessels decreases mechanical strength making tissues less resistant to mechanical forces during joint movement (Lindstrom and Branemark, 1962).

Blood vessels branch towards the lining layer, forming a network of capillary plexuses. Dissection of the synovium has revealed several layers of tissues with capillary anastomoses between layers (Lindstrom and Branemark, 1962). The layer of synovium in closest apposition to the synovial fluid, has a vascular supply with few anastomoses to other layers. Synovial vessels adjacent to the articular surfaces of the normal joint anastomose with epiphysial vessels (Davies and Edwards, 1948), but never extend into the articular cartilage. The presence of capillaries at the synovium-cartilage margin suggests that they may provide nutrients to the peripheral cartilage. Vessels from the ligaments or capsule are continuous with periosteal vessels at the sites of attachment to bone and deeper capsular vessels may anastomose with epiphysial vessels (Davies and Edwards, 1948). Veins follow arteries and have a greater volume in the deeper layers with one or sometimes two veins per artery in areolar synovium (Davies and

Edwards, 1948). In the more superficial plexus there are usually 2 veins per artery with many anastomoses between them.

Capillary density not only relates to anatomical location and tissue type but also the distance beneath the synovial surface. Capillaries are located at a modal depth of 35 μm from the synovial surface (Stevens et al., 1991). This distance approximates to the thickness of 3 cells and places the majority of the blood vessels in the subsynovium. By virtue of the physical size of capillaries, steric factors will place a lower limit on their apparent depth beneath the synovial surface. Factors other than steric exclusion, such as physical or humoral factors, may also prevent location of capillaries close to the synovial surface (Knight and Levick, 1983). Capillary wall thickness varies with depth, the most superficial capillaries have thin walls, whilst deeper capillaries have more prominent endothelial cells and thicker walls (Schumacher, 1969). Capillary diameter is similar throughout the synovium and may be similar to (Knight and Levick, 1983) or generally larger than (Elmore et al., 1963) that of capillaries in other tissues. Mean diameters of 8-9 μm and individual capillaries with diameters up to 30 μm have been observed, the largest diameters being found in capillary loops (Lindstrom and Branemark, 1962). Synovial veins are long, voluminous and distorted with varicose segments (Lindstrom and Branemark, 1962) and contain numerous valves (Davies and Edwards, 1948; Lindstrom and Branemark, 1962). The density of capillaries within the synovium is over ten times greater than that of the more superficial fat and areolar tissues that surround it (Knight and Levick, 1983). With increasing age there is a tendency towards a less regular arrangement of the synovial vessels (Pasquali-Ronchetti et al., 1992).

The depth to which vessels can be located whilst still contributing to the nutrition of the articular cartilage remains uncertain. Capillaries within 25 μm of the synovial surface account for the bulk of solute exchange with the joint cavity (Knight and Levick, 1983). Two thirds of these superficial capillaries are located in areolar synovium. Measurements of oxygen tensions in tumour tissue suggest oxygen diffuses up to 150 μm from capillaries.

Thickening of vessel walls by accumulation of hyaline material leading to vascular occlusion was thought to be a degenerative change (Elmore et al., 1963). This sclerosis has been described in normal and inflamed synovial tissue and observed in normal synovium from children as young as 4 years. Sclerosis occurs more frequently with increasing age up to the third decade, after which the rise in frequency is relatively small (Elmore et al., 1963). Synovial vascular sclerosis can affect small and large joints of the upper and lower limbs. Sclerosis may be accompanied by neointima formation, with consequent reduction in the size of the vascular lumen (Fig. 2a). Intravascular thrombosis may also impair perfusion, despite subsequent organisation and recanalisation of the thrombus (Fig. 2b). These structural changes may impair local blood flow in the synovium and thereby predispose the tissue to focal hypoxia. Mechanical stress, the presence of free radicals and growth factor expression during inflammation have been proposed as possible causes for vascular occlusion (Elmore et al., 1963).

Vascular plasticity and the arthritic joint

Some age-associated changes to the vascular architecture are considered a normal part of tissue development, and relate to the changing requirements of joint tissues. Vascular adaptation or plasticity is necessary to cope with tissue damage and alterations in stresses. In some diseases, vascular plasticity may result in an abnormal architecture. In rheumatoid arthritis there is an increase in the rate of vascular cell turnover; indices of both cell proliferation and death are elevated (Fig. 2c) (Walsh et al., 1998). Localised hypoxia may stimulate angiogenesis and development of an immature vasculature.

Angiogenesis and vascular redistribution are characteristically observed in synovia from patients with rheumatoid arthritis. The median depth of blood vessels from the synovial surface increases and the synovial lining becomes hyperplastic. The growing synovial pannus invades adjacent bone and articular cartilage, causing localised joint damage. Vessel redistribution may account for the apparent reduction in the number of vessels near the synovial lining layer and the lack of correlation between arthroscopic appearance and surface thermographic findings. Shunting blood flow from deep to cutaneous circulation may diminish thermal gradients on skin overlying inflamed joints (Salisbury et al., 1983). The initiating factor for vessel redistribution is unknown but demonstrates the plasticity of the vascular architecture in disease.

Clinical and histological synovitis is associated with vascular proliferation (Fig. 2c) (FitzGerald et al., 1991), and vascular cell death in patients with rheumatoid arthritis (Walsh et al., 1998). It has been suggested that the presence of abnormal vasculature is required for clinical expression of joint inflammation in the early stages of rheumatoid arthritis (FitzGerald and Bresnihan, 1995; FitzGerald et al., 1991). The increase in distance over which nutrients must diffuse is consistent with a reduction in the efficacy with which rheumatoid synovium nourishes articular cartilage (Stevens et al., 1991). The role of synovial angiogenesis and vascular redistribution in rheumatic disease has recently been reviewed (Walsh, 1999).

The articular cartilage is avascular in the normal, mature joint (Walsh et al., 1997). Vascularisation of articular cartilage would compromise its biomechanical properties and mechanical loading would be expected to compromise vascular function. Cartilage generates a variety of anti-angiogenic factors that can inhibit its vascularisation, and prevent enchondral ossification (Langer et al., 1976; Moses et al., 1990).

During osteoarthritis, new vessels invade the cartilage from the underlying bone, probably in response to perturbations in the balance between angiogenic and anti-angiogenic factors (Bromley et al., 1985). Subchondral bone formation also is increased in osteoarthritis, as indicated by an increase in the bone fraction, radiological subchondral sclerosis, and radiographic 'hot spots' observed on bone scans of arthritic joints (Layton et al., 1988). Angiogenesis stimulating activity is increased in plasma of patients with osteoarthritis, suggesting that angiogenesis may play an important role in new bone formation in this disease (Brown and Weiss, 1988; Jones et al., 1994). VEGF-like immunoreactivity also is increased in the synovium (Koch et al., 1994) and synovial fluid (Fava et al., 1994) of some patients with osteoarthritis.

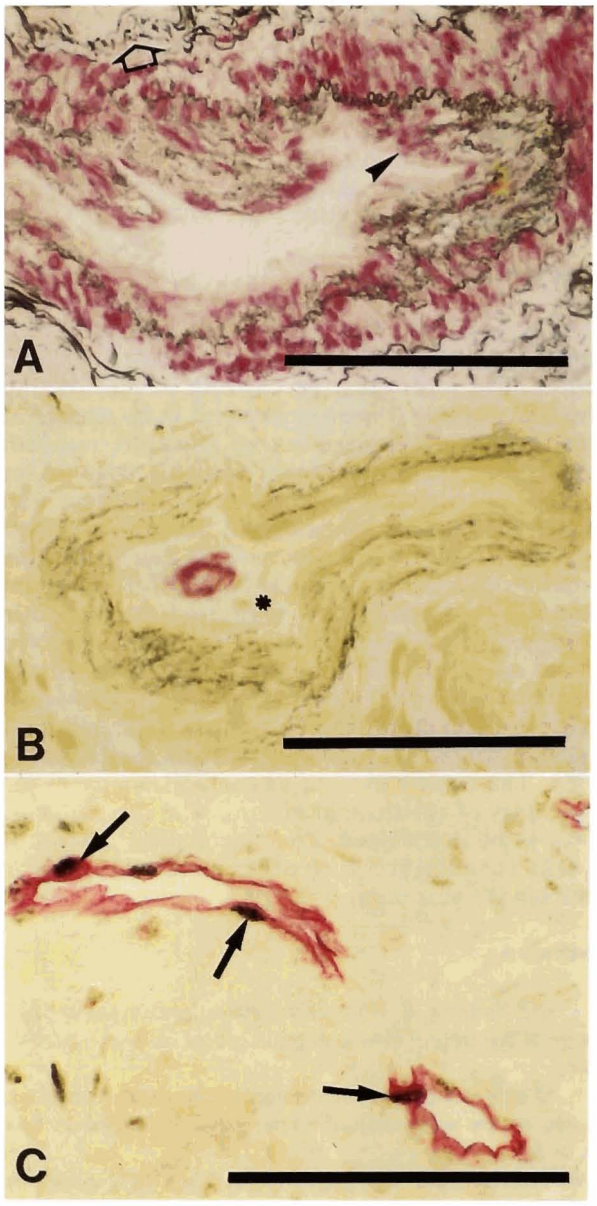

Fig. 2. a. Human synovium from osteoarthritic hip removed at total joint replacement showing vascular sclerosis and neointima deposition (arrow head) within the walls of the elastic lamina (open arrow). Stained for desmin (red) and elastin (black). Mouse monoclonal (clone 33) antibody against desmin with avidin biotin complex alkaline phosphatase and Vector-red development. Elastin stained by Verhoeff's method (Bradbury and Rae, 1996). **b.** Recannalisation of blood vessel in human synovium from osteoarthritic hip removed at total joint replacement. Presence of non muscular area (*) between elastin (black) and smooth muscle α-actin (red) positive vasculature, suggesting occlusion of exisitng blood vessel and recannalisation. Mouse monoclonal (clone 1A4) against smooth muscle α-actin with avidin biotin complex alkaline phosphatase and Vector-red development. Elastin visualised by Verhoeff's method (Bradbury and Rae, 1996). **c.** Synovium from patient with rheumatoid arthritis stained for PCNA (proliferating cell nuclear antigen) (black) and the endothelial marker, CD34 demonstrating the presence of PCNA positive endothelial nuclei (arrows) within vascular endothelium (red). Multiple sequential avidin biotin complex immunohistochemistry visualised using glucose oxidase Nickel enhanced DAB (diaminobenzidine) and alkaline phosphatase and Vector-red development. Scale bars: 100 μm.

Joint blood flow

Control of joint tissue blood flow

Synovial arterioles display a basal level of vasoconstrictor tone that is lost following severance of the appropriate sympathetic nerves (Ferrell et al., 1990). Stimulation of articular sympathetic nerves reduces blood flow to the synovial and surrounding areolar and fibrous tissues by 90-45% in the cat and rabbit respectively (Ferrell et al., 1990; McDougall et al., 1997). Locally generated vasoconstrictors such as angiotensin II and endothelin I, as well as sympathetic nerves containing noradrenaline and neuropeptide Y may reduce synovial blood flow. Sensory nerves have an efferent vasodilator activity mediated by substance P and CGRP release. Nitric oxide generation by endothelial cells also may mediate tonic vasodilation.

Measurement of blood flow and changes during arthritis

Histologic studies demonstrate vascular changes during disease. Measurement of joint blood flow has been used in attempts to quantify clinical disease and the severity of synovitis. Blood flow within the synovium can be measured by a number of techniques, although each has its limitations. Doppler imaging allows a small area of tissue to be monitored closely, whilst radioisotope clearance techniques give information regarding the whole joint, but cannot be focussed on a particular region of a tissue. Due to its large size the knee joint has been the subject of most such work, although studies have also involved the peripheral, smaller joints. Injection of radioactive sodium (^{24}Na) or xenon (^{133}Xe) into the joint and its subsequent loss from the joint, and the rate of uptake of gadolinium-diethylenetriamine pentaacetic acid (gadolinium-DTPA), measured using a magnetic resonance image scanner, each has been used to assess blood flow. Areas of

highest Gadolinium-DTPA uptake show as 'bright' areas on the magnetic resonance images and correlate with blood vessel fractional area determined on tissue sections (Gaffney et al., 1998).

^{133}Xe and ^{24}Na clearance have been used as measures of synovial blood flow. The clearance rates from normal joints vary from day to day (Harris and Millard, 1956) and are also different between men and women (Jacox et al., 1952). The half-life for ^{24}Na is greater for women than men. ^{24}Na clearance is most rapid during the first 10 days of the menstrual cycle (Jacox et al., 1952), suggesting an influence of hormonal factors on synovial blood flow rate. The pattern and rate of ^{133}Xe clearance is altered in persons with rheumatoid arthritis. ^{133}Xe clearance rate is elevated and is exponential in rheumatoid patients, whilst normal knees have a slower, bi-exponential clearance (St. Onge et al., 1968). A bi-phasic clearance has not been reported for ^{24}Na (St. Onge et al., 1968). ^{133}Xe clearance rate in the normal knee is elevated by increases in the total injected volume whereas the total injected volume does not affect the half-life for ^{133}Xe clearance in the rheumatoid knee (St. Onge et al., 1968). This difference may reflect a pressure-sensitive homeostatic mechanism that is deficient in rheumatoid arthritis patients. Alternatively, it may represent more satisfactory isotope dispersion in the rheumatoid knee due to the presence of a greater initial fluid volume.

Tissue temperature is increased with increasing blood flow. A number of studies have attempted to correlate skin temperature with joint inflammation. Temperature gradients around joints may reflect underlying inflammation better than does absolute skin temperature. The normal knee displays a negative temperature gradient between the deep tissues and the skin (Salisbury et al., 1983) and a distinctive skin temperature gradient pattern with the coolest parts over the patella, and warmest areas being the back of the knee and towards the shafts of the tibia and femur (Salisbury et al., 1983). Thermal gradient patterns on the skin are thought to represent metabolism and blood flow in the underlying tissues (Salisbury et al., 1983), and are not affected by absolute skin or environmental temperatures. It has been suggested that infra-red thermography correlates well with sites of local synovial hyperaemia and blood flow (Arnold et al., 1989).

Pressure and blood flow

Pressure in the normal intraarticular space is close to, or lower than atmospheric pressure (Jayson and Dixon, 1970a,b). Subatmospheric tissue pressures facilitate capillary opening and blood flow to the synovium. However, in the inflamed knee, intraarticular pressure may rise sufficiently to inhibit blood flow in the synovium. Pressure fluctuations of up to 1.5 mm Hg, occurring in time with those of the systemic blood circulation have been recorded in the intraarticular space of rheumatoid arthritis sufferers (Jayson and Dixon, 1970c). These pressure waves cease as intraarticular pressure rises, possibly due to inhibition of synovial blood flow, as intra-articular pressure becomes similar to luminal pressure in synovial blood vessels (Jayson and Dixon, 1970c). Pulsations of the greatest amplitude are found in joints with active inflammatory disease (Jayson and Dixon, 1970c). Pulsation has been recorded over a wide range of intra-articular pressures, from 22 to 247 mm mercury (Jayson and Dixon, 1970c). Similar waves of pressure, but with lesser magnitude (0.05 mm Hg) have been demonstrated in normal knee joints (Jayson and Dixon, 1970c).

During exercise, pressure in the normal knee is reduced further (Jawed et al., 1997), maintaining capillary patency and synovial blood flow. In knees of patients with rheumatoid arthritis, intraarticular pressure rises and may reach pressures greater than arterial during exercise. The increase in joint pressure cuts off the blood supply to the synovium and upon reperfusion, blood flow increases above basal levels. Hypoxic-reperfusion cycles may facilitate the generation of free radicals, which can cause tissue damage, resulting in an exercise related tissue injury (Gaffney et al., 1995). Similar patterns of pressure elevation have been observed both in small and large joints (Gaffney et al., 1995).

Conclusions

The synovial joint is a complex structure containing a number of different tissues, each having a specific function. The joint must be capable of motion and withstanding repeated stresses imposed from a range of directions whilst maintaining an adequate nutrient supply to the tissues. Synovium is highly adapted for supplying nutrients to joint tissues. In disease, the vascular anatomy and physiology of the joint is altered and function may be compromised by changes to the tissues. Synovium is frequently involved in joint pathology. Recent work has suggested osteoarthritic pathology may originate in the bone, rather than the cartilage as previously thought. Ossification of the deeper layers of articular cartilage occurs following invasion by subchondral vasculature. The articular vasculature displays a high degree of plasticity during arthritis. The contribution of vascular plasticity to the pathogenesis of rheumatoid arthritis and osteoarthritis remains to be determined. Pharmacological control of the joint vasculature may offer novel therapeutic potential in the near future.

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