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Research Article

Corneal Laser Refractive Surgery in Patients with Systemic Autoimmune Disorders

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ABSTRACT

Growing demand for corneal refractive surgery and consequently increased number of patients who despite having autoimmune diseases ask for performing these procedures, reminds us of the importance of reviewing the considerations of refractive surgery in these clinical entities. Recent studies has broadened our knowledge in characterization and evaluation of autoimmune disorders and their potential adverse effects in outcomes of corneal refractive surgeries. In present review we summarize the pathogenesis, clinical aspects and corneal biomechanical changes in patients with systemic autoimmune disorders.

Keywords: Autoimmune disease; Cornea; Refractive surgery; Connective tissue disorder; Photorefractive keratectomy; Laser *in-situ* keratomileusis

INTRODUCTION

Corneal Refractive Surgeries (CRSs) are widely performed procedures in clinical practice. However, their use in patients with autoimmune disorders has been subjected to controversies, given that in many cases, the negative corneal sequelae of the procedure could outweigh its benefits. Several studies have evaluated various CRSs' outcomes in Sjogren syndrome, Inflammatory Bowel Disease (IBD), Rheumatoid Arthritis (RA), systemic lupus erythematosus and Ankylosing Spondylitis (AS) Some studies have concluded that corneal complications following a CRSs in underactive autoimmune diseases could be minimal, while others reported several serious outcomes including dry eye disease, corneal melting and scarring. The purpose of this review is to shed a light on pathophysiology of various eye complications caused by autoimmune disorders and the way different types of CRSs could affect those complications [1].

Systemic autoimmune disorders

Combination of Dry Eye Disease (DED) and dysregulated immune system in the presence of surgical trauma, puts the ocular surface in a circumstance that finally results in stromal melting and perforation following CRS in autoimmune disorders. Also, epithelial toxicity and healing delay caused by topical medications, aqueous tear shortage and denervation of cornea are other reasons for corneal melting in these patients. Moreover, infection or mild ocular trauma in patients with pre-existing autoimmune diseases, may result in a disturbance in the wound healing process after surface ablation, which is known as 'rapid onset corneal scaring'. Integrity of corneal structure depends not only on cell to cell interactions, but also on interactions between cell and extracellular matrix [2]. It has been investigated that in patients with tear film dysfunction (which has a high prevalence among those who suffer from autoimmune diseases), some tear components such as cytokines increase in their number. Tear proteinases like MMP-9 which are needed for maintenance and repair of extracellular matrix (collagens) of corneal stroma, lose their balance with their inhibitors and increase in tear dysfunction syndrome. Moreover,

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high serum levels of MMP-8, MMP-9 and cytokines are found in patients with high activity of their immune disease. It is hypothesised that alterations in the components of tear film, lead to increased collagen lysis and poor healing of corneal epithelium. The imbalance between a collagenase inhibitor called "Alpha-2 macroglobulin" and a proteolytic enzyme named "plasminogen activator" in tear film, eventually leads to keratolysis [3].

MATERIALS AND METHODS

Dry eye disease

The destruction of lacrimal gland cells and their eventual under funct ioning, are the underlying causes of symptomatic KCS in the context of systemic sclerosis. From a pathophysiological point of view, variety of genetic and environmental factors (including microchimerism) could lead to collagen overproduction and auto-immune driven abnormal vessel wall reactions, eventually resulting in fibrosis of visceral organs and cutaneous tissues. Muscarinic receptor (M3) blockage by autoantibodies in systemic sclerosis results in hypofunction of lacrimal glands. In addition, release of perforin-granzym A and pro-inflammatory cytokines mediated by CD4+ T lymphocytes causes apoptosis that results in lacrimal gland's destruction [4]. Histopathological studies have shown an increase in collagen fibrils (types I, III, V, VI and VII) along with other extracellular matrix proteins such as fibrilin, proteoglycans, laminin, fibronectin and tenascin. Conjunctival fibrosis with ductal involvement and de-granulated mast cells were seen as well. In addition, the enzymes released by PMNs in corneal decomposition areas are the most attributable reason of corneal ulceration in dry eye disease in the context of autoimmune disorders. Denervation of corneal sensory neurons caused by stromal ablation and flap cutting during Laser *In-situ* Keratomileusis (LASIK) and consequent lack of neurotrophic factors released by sensory nerve fibres, lead to a transient surface abnormality called LASIK induced neurotrophic epitheliopathy. LINE was suggested by and dry eye considered to be as a risk factor for developing it [5].

Meibomian Gland Disease (MGD) is thought to be the main reason of evaporative dry eye disease. Prevalence of MGD in patients with autoimmune disorders is elusive; However, it varies from 20% to 70% in healthy patients, according to various demographic and geographic differences and furthermore, a few studies have reported a higher prevalence of MGD among patients with some autoimmune disorders in contrast to healthy ones [6].

Owing to the complexity of MGD's pathophysiology, a number of disease mechanisms have been suggested including eyelids' inflammation, abnormal meibomian gland secretion, microbial floral alterations on ocular surface, obstruction of meibomian gland orifices due to keratinization and infestation of Demodex. Furthermore, in patients suffering from secondary Sjogren, SLE and RA, several other hypotheses for the disease mechanism have been considered including androgen deficiency, destruction of the gland by immune system and cytokine driven disruption of neural interactions in the gland's epithelial cells [7].

Trauma and autoimmune inflammation are the probable causes of ocular tissue changes in patients with autoimmune disorders. Tear insufficiency, direct epithelial toxic effects of topical medications like corticosteroids and altered cell activity in cornea of RA patients, make them prone to ocular surface diseases like peripheral ulcerative keratitis or exacerbating a pre-existing condition. When surgical manipulation (trauma) occurs, the first line of response is the infiltration of corneal stroma and its vessel walls by macrophages and neutrophils, a process mediated by inflammatory signals [8]. This leads to tissue degradation, melting and perforation, which marks the beginning of the process for adaptive cell-mediated immunity. Moreover, trauma can enhance inflammatory response by proinflammatory trauma induced signals, starting by stimulating fibroblasts in sclera to produce C1 component of complement system, activated by in site immune complexes. The process leads to a series of actions which would increase the permeability of vessels, help the inflammatory cells to migrate to the site of trauma and finally exacerbate the inflammation [9].

Necrotising effects of immune complexes

Deposition of immune complexes confirmed by histologic studies of episcleral and scleral vessels and cornea (as representatives of vasculitic invasion) can be boosted by trauma itself and the signals induced by it. Surface molecular upregulation and presence of Human Leucocyte Antigen (HLA-DR) in macrophages and scleral fibroblasts (which are probably induced by cytokines released as a result of surgical manipulations) make them competent antigen presenting cells that can initiate the cellular immune response against exposed surgical areas by presenting resident auto antigens to helper T-cells. This process explains the 'post operation necrotic inflammation'. Inflammatory response can be initiated by entrapment of immune complexes during surgery due to damaged scleral and episcleral vessels. Suggested this process for explaining 'postsurgical necrotizing sclerocorneal ulceration'. Of note, if the immune response was activated elsewhere in the body by similar antigens to ocular tissue or some microbial agents, cross reaction may occur within the surgery at the exposed ocular tissue. The cross reaction of anticollagen antibodies circulating in bloodstream with corneal collagens results in corneal stromal collagen dissolution [10].

Autoantibody-antigen complexes produced in the course of SLE disease, have direct and indirect pathological effects. Deposition of immune complexes in vessels and basement membrane of target lesions like ciliary body and cornea, directly causes disruption in the integrity of membrane and enhances chemotaxis of inflammatory cells. In addition, circulation of these complexes in the blood stream activates complement system, which in turn leads the body to a general state of inflammation and consequent tissue disruption [11].

Damaged intestinal epithelium by inflammatory processes can be the pathway for immune complexes to reach the ocular tissues in IBD. Moreover, gut pathogens may have a role in the modification of immune system and emergence of ocular

manifestations. Neural conduction system and nerves' morphology are altered by inflammatory cells and cause dry eye symptoms in patients with autoimmune disorders. Infiltration of inflammatory cells in lacrimal glands and other parts of ocular tissue barricade the normal nerve conduction signals. Increased levels of neurotrophin induced by overexpressed cytokines such as Tumour Necrosis Factor-α (TNFα), Interleukin-1β (IL-1β) and In terleukin-6 (IL-6) in keratocytes, abnormally fashions the nerve fibres and leads to microneuroma formation and consequent deranged neural impulses. Corneal stromal nerve thickness and nerve sprouting are seen as alteration of nerve morphology owing to inflammatory responses [12].

Keratolysis

Keratolysis is relevant to autoantibodies and the release of cytokines. Increased levels of cytokines prevails 'Matrix Metallopeptidases' (MMPs) over 'Tissue Inhibitors like Metalloproteinase-1' (TIMP-1) and as a result aggregation of collagenase in cornea, leads to a destructive keratolysis. Corneal ulceration is a late and uncommon complication of RA and given that corneal vasculature mostly present in the periphery rather than central areas, as a consequence, ulcerations more predominantly occur in the peripheral regions, owing to the increased accessibility of inflammatory cells to these areas. MMP-2 and MMP-9 are found in corneal stroma and lacrimal glands respectively. Thinning and ulceration of cornea and dry eye symptoms are consequences of their accumulation in cornea [13].

Role of pro-inflammatory cytokines

Interleukin-17 released by T-helper 17 cells, has a synergic effect with other which activates Mitogen-Activated Protein Kinase (MAPK) pathways and nuclear factor Jb, eventually flaring up inflammation. In a MAPK mediated process, the presence of ocular surface stress induced by dry eyes, leads to release of pro-inflammatory cytokines. Surface stress in patients with dry eye disease who suffer from collagen vascular disorders, stimulates CD4+ helper T-cells (1 and 17) to release cytokines like IL-17. These cytokines make the corneal epithelium to produce MMPs 3 and 9, which together with the already existing imbalance between proteinases and proteinase inhibitors, results in a the thinner corneal center [14].

RESULT AND DISCUSSION

Clinical considerations

Ocular manifestations of autoimmune diseases are well known in the literature. They may occur during the course of the disease and more importantly, may be the presenting signs of these diseases. RA is a common collagen vascular disease with its ocular manifestations being Dry Eye Disease (DED), corneal changes, conjunctivitis, uveitis, episcleritis and scleritis. RA's most prevalent ocular complication is dry eye disease or Keratoconjunctivitis Sicca (KCS), which is often the initial manifestation of the disease [15]. The dry eye usually presents in patients with well-controlled arthritis and it is estimated that half of the patients with RA develop DED and 38% of them become symptomatic. Aqueous tear deficiency is the likely cause of DED in RA patients, while DED due to evaporation may also coexist. Untreated KCS may cause corneal opacification and/or lid-wiper epitheliopathy. Moreover, in advanced cases, perforation and visual loss due to paracentral corneal melts should be expected. Thereby, DED in the background of RA may result in other complications following corneal refractive surgery, such as corneal scaring, filamentary and ulcerative keratitis [16]. About half of patients who seek ophthalmological help for noticeable dry eye symptoms, turn out to have an underlying (undiagnosed) autoimmune disease. Ocular manifestations in 70% of these patients occur simultaneously or before diagnosing the main disease. DED is also common among systemic sclerosis patients that usually followed by eyelid complications like stiffness, eversion, lagophthalmos, blepharophimosis, and loss of eyelashes. 37%-79% of these patients could present with DED manifestations at any stage of the disease, which may result from either systemic complication of scleroderma or immunosuppressive treatment's adverse effects [17].

Secondary Sjogren syndrome may occur in RA, SLE and systemic sclerosis. Although secondary Sjogren syndrome is the leading cause of DED due to aqueous-deficiency, it is associated with the evaporative form of DED and less frequently with MGD. Glandular and extra-glandular ocular manifestations of Sjogren disease are defined according to whether or not the lacrimal production is affected. Sterile stromal necrosis and corneal ulceration, scleritis and uveitis are some extra-glandular manifestations of Sjogren syndrome. Early diagnosis of these signs is important, given that in more than one-third of patients, these ocular manifestations are the presenting signs of the underlying systemic disease. Therefore, early referral for Sjogren's workup should be a priority among ophthalmologists, knowing that any delay in diagnosis could lead to increased severity of both the disease and its ocular manifestaitons [18].

Impairment of meibomian glands is more severe in SSc patients with dry eye syndrome than patients without SSc, suffering from dry eye. Therefore, higher rates of evaporation and improper response to conventional therapy of dry eye alone are justifiable in these patients. In the presence of MGD related lipid layer deficiency, augmented evaporation of aqueous tear film takes place and exacerbates aqueous tear deficient dry eye. Abnormal visual acuity is another complication which SSc patients encounter. According to the study, alterations of visual acuity occur due to irregularity of ocular surface, owing to reduced blinking reflex in SSc. Moreover, rheumatic ulcers (central and paracentral ulceration) and Peripheral Ulcerative Keratitis (PUK) are among severe ocular complications of SSc that threaten the visual function notably [19].

In patients with underlying collagen vascular disease like RA and SLE, PUK's occurrence may reveal the potential existence of a fatal systemic vasculitis and sometimes may be the first sign of necrotizing vasculitis when it is in the setting of Wegner, Churg-Strauss syndrome, PAN and microscopic vasculitis. Additionally, post-surgical corneal melting in patients with collagen vascular

disease, demands early detection and intervention in order to avoid its consequent ocular complications (Table 1).

Table 1: Reported outcomes of corneal refractive surgeries in patients with autoimmune diseases.

Year	Patients age (years/sex	Background disease	Preoperative refractive error	Type of corneal refractive surgery	Complication	Management	Final outcome
2010	50/F	Ulcerative colitis	4.50-1.00 × 97 (OD) -5.50-0.75 × 3 (OS)	LASIK	Corneal melting along flap edge with ulceration within 3 days of surgery/bilateral stromal inflammation	Topical corticosteroid fusidic acid gel oral oral doxycycline	Gradual resolution of the flap infiltrates and re-epithelialization of the overlying defects
2012	40/F	Crohn's disease	3.75-0.75 × 121 (OD) 4.25-0.25 × 177 (OS)	LASIK	Necrotizing keratitis (Corneal stromal infiltrates at the flap edge)	Topical corticosteroid, oral prednisolone, oral doxycycline	Recurrent infiltrates in right eye at 2 months follow up (treated with oral prednisolone and doxycycline), residual subtle subepithelial haze at last follow up
	30/M	Crohn's disease	-7.00-0.25 × 96 (OD) -7.75-0.25 × 52 (OS)	PRK	Necrotizing keratitis (Corneal stromal infiltrates)	Topical corticosteroid, oral prednisolone, oral doxycycline	Sub-epithelial haze and corneal infiltrates resolved
2012	24/M	Ulcerative colitis	Moderate myopic astigmatism	LASIK	Acute non-granulomatous uveitis in left eye	Topical corticosteroid, oral prednisone 20 mg daily	Hypopyon resolved
2008	30/F	Sjogren syndrom	High myopia -8.5-1.75 × 35 (OD) -7.0-1.5 × 135 (OS)	LASIK	Severe punctate epithelial keratopathy	Topical corticosteroid, punctal plugs, lubrication, systemic immunosuppressant	Prolonged severe dry eye and refractive regression
	20/F	Sjogren syndrom	-6.5-1.0 × 105 (OD) -6.0-1.75 × 80 (OS)	LASIK	Severe punctate epithelial keratopathy	Topical corticosteroid, lubrication, systemic immunosuppressant	Minimal resolution of dry eye symptoms

2002	41/F	Systemic lupus erythematosu	Myopic astigmatism -4.00-0.50 × 10 (OD) -6.00-1.00 × 175 (OS)	PRK	Severe late onset reticular corneal scarring in right eye after retreatment	Mechanical debridement	Corneal haze decreased/VA improved
2008	32/M	Cogan's syndromes	Astigmatism	LASIK	Diffuse lamellar keratitis	Topical corticosteroid	Similar episodes of late-onset DLK occurred
2009	36/M	Ankylosing spondylitis/10 years	Moderate myopic refractive error (-5.00 diopters in both eyes)	LASIK	Diffuse lamellar keratitis stage III in left eye 3 years after the surgery	Frequent topical prednisolone acetate 1% drops oral doxycycline 100 mg twice daily	Recovered corneal parameters in topography

Note: F-Female; M-Male; LASIK-Laser-Assisted *In situ* Keratomileusis; PRK- Photorefractive Keratectomy

Other ocular manifestations of RA are corneal changes, especially in peripheral parts such as thinning, acute stromal keratitis, acute corneal melting and sclerosing keratitis is also reported as a complication of Granulomatosis with Polyangiitis (GPA) and unclassified arthritis [20].

Considering RA's other ocular manifestations, gradually thinning of the peripheral part of cornea with no clinical inflammation is seen in the most benign form of keratitis called contact lens cornea. Although contact lens type is proceeding slowly, it may turn into limbal severe inflammation which is an alarming sign of acute corneal melting. Sclerosing type on the other hand, is characterized by thickening and opacification of the peripheral cornea near the site of scleritis that may lead to lipid deposition, vascularization and scarring. About 25%-35% of the SLE patients experience dry eye symptoms as the most common ocular finding that are often related to Secondary sjogren syndrome [21].

Moreover, vascular changes of the retina and severe vision loss due to vascular occlusion in the retina or optic nerve may be seen. According to previous reports, 88% of patients who had retinopathy were in active sessions of their systemic disease and additionally, they had lower survival rates than patients without retinopathy. Other ocular manifestations that affect cornea such as corneal scarring, ulceration or filamentary keratitis may also occur. Episcleritis, conjunctivitis and more importantly, scleritis, which is in association with systemic disease activity, are among other reported ocular manifestations of SLE. Besides, corneal alterations like superficial punctate keratitis, peripheral ulcerative keratitis, keratoendotheliitis with corneal edema, interstitial keratitis and recurrent corneal erosion are rarely reported [22].

Vision loss may also occur due to optic neuritis and neuropathy. The optic nerve is involved in about 1% of patients with SLE and its dysfunction may be the presenting sign of a systemic disease. Visual field defects, painless vision loss, pupillary abnormalities and impaired colour vision may also be seen. Eyelids' cutaneous involvement has also been observed in SLE patients. Lesions clinically mimic eczema or chronic blepharitis, should be taken into consideration, especially when they are unresponsive to routine treatments. Appearance of discoid lupus rashes as an irritating erythematous plaque on eyelids may cause cicatricial ectropion or madarosis as permanent sequelaes.

The incidence of IBD's ocular manifestations, is reported to be between 4%-10% and they are more common in crohn's disease than ulcerative colitis. Episcleritis, anterior uveitis, scleritis, conjunctivitis, marginal keratitis, orbital inflammatory disease, optic neuritis, retinitis and retinal vascular occlusion can occur as ocular complications of IBD. The most common IBD's ocular complication is episcleritis. It's association with active session of crohn's disease, made it a good indicator for active bowel disease. In contrast, scleritis, as a rare complication with severe visual morbidities, can also occur in inactive form of IBD. Uveitis is another common manifestation of IBD and presents with blurred vision, photophobia and ocular pain. If left untreated it may cause keratopathy, glaucoma, cataract, cystoid macular oedema, posterior synechiae and vision loss.

It is notable that, bowel resection in IBD patients may cause malabsorption and hypovitaminosis A which causes nyctalopia and dry eye syndrome. Prior to IBD diagnosis, corneal involvement as a complication is not a common finding; however, if exists, patients present with eye irritation, pain and foreign body sensation, which may or may not be accompanied by decreased vision. IBD associated keratopathy is a subepithelial keratopathy categorized into two forms of small grey epithelial or subepithelial dots in anterior cornea and lamellar nebulous subepithelial infiltrates or scarring.

Of note, in autoimmune disorders, not only the disease itself but also its medication can cause ophthalmic side effects. Drug related ocular complications may happen during the course of treatment with adalimumab, infliximab and cyclosporine, causing diffuse retinopathy and immune infiltrates of cornea, thrombosis of retinal vein and anterior optic neuropathy

respectively. Using corticosteroids in both topical and systemic forms may result in glaucoma, cataract, and retinopathy. Antimalarial medications such as chloroquine at usual and even lower dosages may cause macular diseases and visual alterations. Chloroquine in particular, would commonly cause corneal epithelial deposits like corneal verticillate and vortex keratopathy which rarely affects the vision.

Corneal biomechanics changes in connective tissue disorders

The anterior part of the corneal stroma is thought to be responsible for corneal shape stability. Several factors including advanced age, corneal pathologies such as keratoconus and altered hydration could lead to changes in the corneal stromal properties in which the loss of stromal lamellar organization, alters the corneal biomechanical properties. It seems that the rich corneal connective tissue, especially the biomechanical properties of the cornea, are vulnerable in the context of connective tissue disorders. Based on different studies, patients with systemic autoimmune diseases had a statistically significant lower corneal stiffness compared to healthy controls and disease duration seems to be correlated with these changes.

In RA, the disease process causes tissue changes both in corneal epithelium and stroma. investigated the *in-vivo* confocal microscopy in RA patients and found a higher amount of hyperreflective activated keratocytes, indicating an inflammatory process. There were changes in both the corneal extracellular matrix and collagen, which might have caused a structural weakening. The inflammatory process and ultrastructural alterations in corneal stroma led to a decrease in Corneal Hysteresis (CH) among RA patients. However, there was no significant difference between active and non-active RA patients for developing corneal disease. This shows that the ultrastructural cornea changes that occur in the context of ra, are tenacious and irreversible, in spite of a decline in disease activity. Several other studies have reported a thinner cornea in RA patients than those in healthy controls. Furthermore, the corneal thickness and volume in RA patients with dry eye were significantly lower than those in RA patients without dry eye. However, no decrease in corneal thickness was found among non-RA patients with dry eyes. Type IV collagenases MMP-9 and MMP-2 are essential for corneal Langerhans Cells (LCs) migration and are produced by activated LCs in RA patients. Thus, chronic degradation of type IV collagen in the cornea by type IV collagenases produced by activated LCs may explain the underlying mechanism of corneal thinning of RA patients. Moreover, activated Dendritic Cells (DCs) may trigger a chronic NK-cell-promoted pathogenic Th17 response, resulting in corneal thinning.

In patients with SLE there are some reports about differences in scleral and corneal thicknesses. reported that scleral thickness had a greater reading in SLE patients without active scleritis than those in healthy individuals. So, the thicker scleral measurements in the SLE group may suggest subclinical inflammation and collagen tissue involvement. This result shows that the effect of SLE on connective tissue is independent of disease activity and disease year. So far, the available studies have not shown any significant change in Central Corneal Thickness (CCT), endothelial Cell Density (CD) and Coefficient of Variation (CV) in SLE patients. However, patients with SLE, present with lower CH, Corneal Resistance Factors (CRF) and Intra Ocular Pressure (IOP) readings (measured with the optiwave refractive analysis) than age matched controls. These corneal biomechanical properties should be taken into account when determining IOP values and planning corneal refractive surgery for these patients.

According to study, in AS patients CCT and CH were significantly lower than healthy controls. reported that in the active stage of AS, patients present with higher levels of corneal biomechanical parameters with thicker corneas than inactive form of the disease. In addition, they have impaired Tear Breakup Time (TBUT) and schirmer test results, indicating dry eye. CCT in scleroderma has been subjected to debate because of conflicting reports. In one study, mean CRF and Goldmann-related IOP values of patients with scleroderma were higher than those of age-matched healthy control. However, Ahyan, and both reported no significant changes in CCT in these patients compared with healthy individuals. Although, demonstrated the significant correlation between excessive matrix deposition in the skin, which is assessed by modified Rodnan Skin Score (mRSS) and ORA parameters (CH, CRF). This finding showed that corneal biomechanical parameters may be predictors for disease severity in SSc patients (Table 2).

Table 2: Corneal biomechanics in connective tissue disorders.

Year	Disease	Scleral Thickness	CCT	CV	CD	Corvis parameters	ORA parameters
2020	SLE	Thicker	B	β	β		
2020	RA, AS	-	-	-		Mean velocity values of applanation 1 (A1V) and 2 (A2V)[α], deformation amplitude (DA)[α], corvis biomechanical	

						index (CBI)$^{\alpha}$, applanation (SPA1)$^{\alpha}$ lower in AS and RA patients compared with healthy cotnrols	
2019	SSc	-	B	-	-	-	-
2015	RA	-	-	-	-	-	Active phase: CH$^{\alpha}$, IOPcc lower$^{\alpha}$ Remission phase: CH$^{\alpha}$, IOPcc lower$^{\alpha}$ (Compared with healthy controls)
2013	RA	-	Lower$^{\alpha}$ compared with healthy controls RA with dry eye lower than RA without dry eye$^{\alpha}$	-	-	-	-
2013	AS	-	Lower than healthy controls$^{\alpha}$	-	-	-	-
2011	SLE	-	-	-	-	-	CH lower$^{\alpha}$ CRF lower$^{\alpha}$ Mean IOPg lower$^{\alpha}$ (Compared with healthy controls)
2011	SSc	-	β	-	-	-	-
2010	SSc	-	-	-	-	-	CH$^{\beta}$, CRF$^{\alpha}$, $IOP_g{}^{\alpha}$, $IOP_{cc}{}^{\beta}$ higher compared with healthy controls

Note: RA-Rheumatoid Arthritis; SSc-Systemic Sclerosis; AS-Ankylosing spondylitis; SLE-Systemic Lupus Erythematosus; CCT-Central Corneal thickness; CV-Corneal Volume, CD-Corneal Densitometry; ORA-Ocular Response Analyzer; CH-Corneal Hysteresis, CF-Corneal Resistance Factor; α: P<0.05, statistically significant; β: P>0.05, statistically non-significant

CONCLUSION

Given that the release of various cytokines induced by systemic autoimmune disorders, could lead to destructive corneal consequences, the need for early diagnosis prior to any CRS sounds imperative. Although procedures like LASIK and PRK are commonly performed in patients with autoimmune disorders, precautionary plans must be kept in mind, should any possible ocular complications arise post-surgery, if any. The decisive contraindications to CRSs for any autoimmune disorder is yet to be confirmed by future studies.

DISCLOSURE

Declarations of interest none.

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