

Study on the Pathogenesis and Intervention Strategies of Oral Squamous Cell Carcinoma

Wenjie Zhang

Qilu Medical University, College of Stomatology, Zibo 255300, Shandong, China

Abstract: Oral squamous cell carcinoma is a common malignant tumor in the oral and maxillofacial region characterized by nonspecific early symptoms strong local invasiveness and a high risk of recurrence and metastasis. Its occurrence and progression are closely related to genetic variation abnormal molecular regulation chronic inflammation changes in the immune microenvironment unhealthy lifestyles and viral infection. Current clinical diagnosis and treatment still face problems such as insufficient early identification inadequate coordination of comprehensive treatment limited functional recovery and reduced quality of life after treatment. Therefore screening and risk prevention for high risk populations should be strengthened comprehensive intervention plans including surgery radiotherapy chemotherapy targeted therapy and immunotherapy should be optimized and rehabilitation management and long term follow-up mechanisms should be improved to enhance treatment outcomes and long term quality of life.

Keywords: oral squamous cell carcinoma; comprehensive treatment; rehabilitation management; risk prevention

1. Introduction

Oral squamous cell carcinoma is one of the common malignant tumors in the oral and maxillofacial region[1]. It mainly occurs in the tongue gingiva buccal mucosa and floor of the mouth. Its early symptoms are often not obvious and some patients may mistake it for common oral ulcers or inflammation which delays medical consultation and diagnosis[2]. As the disease progresses the tumor may show local invasion lymph node metastasis and postoperative recurrence. This not only affects oral functions such as chewing swallowing and speech but also significantly reduces patients quality of life[3]. In recent years with the development of molecular biology immunology and tumor treatment technologies understanding of the pathogenesis of oral squamous cell carcinoma has continued to deepen and related interventions have gradually shifted from single treatment to comprehensive management[4]. Therefore this paper analyzes the pathogenesis diagnostic and therapeutic problems and intervention strategies of oral squamous cell carcinoma aiming to provide reference for early prevention clinical treatment and rehabilitation management.

2. Overview of oral squamous cell carcinoma

2.1 Concept and clinical characteristics

Oral squamous cell carcinoma is a malignant tumor originating from squamous epithelial cells of the oral mucosa and represents one of the most common pathological types of oral malignancies[5]. It commonly occurs in the tongue gingiva buccal mucosa floor of the mouth and hard palate and is closely associated with long term chronic irritation of the oral mucosa genetic variation immune dysfunction and unhealthy lifestyle factors. The early clinical manifestations of this disease are usually nonspecific. Patients may present with oral leukoplakia erythema persistent non healing ulcers local induration pain or bleeding and some cases may initially be mistaken for ordinary inflammation or traumatic ulcers. As the tumor progresses the lesion may invade surrounding tissues leading to restricted mouth opening impaired chewing dysphagia and speech dysfunction and it may metastasize to cervical lymph nodes through the lymphatic system. Because the oral region has complex anatomical structures and is closely related to eating pronunciation facial appearance and social function oral squamous cell carcinoma is characterized not only by strong local destructive potential but also by a sustained impact on patients physiological function psychological status and quality of life.

2.2 Epidemiological features

Oral squamous cell carcinoma occurs worldwide and its incidence is strongly influenced by regional economic conditions lifestyle habits health conditions and access to medical resources[6]. In general this disease is more common among middle aged and elderly populations and the risk is usually higher in men than in women which is closely related to long term smoking alcohol consumption betel quid chewing and poor oral hygiene. In some regions where betel quid consumption is common the oral mucosa is exposed to prolonged mechanical and chemical irritation resulting in a more prominent disease

burden of oral squamous cell carcinoma. In terms of disease progression early stage cases tend to have a relatively favorable prognosis after standardized treatment whereas middle and advanced stage patients are often accompanied by local invasion or cervical lymph node metastasis which significantly increases treatment difficulty and recurrence risk. The epidemiological characteristics of this disease indicate that oral squamous cell carcinoma is not caused by a single factor alone but gradually develops after long term exposure to multiple risk factors. Therefore health education risk screening and early intervention for high risk populations form an important basis for reducing disease burden and improving prognosis.

3. Pathogenesis of oral squamous cell carcinoma

3.1 Genetic variation and abnormal molecular regulation

Genetic variation and abnormal molecular regulation are important bases for the development of oral squamous cell carcinoma. After long term exposure to tobacco alcohol chronic irritation and other factors oral mucosal epithelium may develop gene mutations chromosomal instability and epigenetic changes leading to imbalance in cell proliferation differentiation apoptosis and repair. Reduced function of tumor suppressor genes weakens the ability to eliminate and inhibit abnormal cells while abnormal activation of oncogenes promotes continuous cell proliferation and local invasion. Disorders of related signaling pathways may also enhance tumor cell migration anti apoptotic ability and immune escape allowing lesions to gradually progress from abnormal mucosal hyperplasia to malignant tumors. Therefore understanding its pathogenesis from genetic and molecular perspectives is helpful for identifying high risk lesions and formulating individualized intervention strategies.

3.2 Chronic inflammation and changes in the immune microenvironment

Chronic inflammation and changes in the immune microenvironment are important promoting factors in the development and progression of oral squamous cell carcinoma. When the oral mucosa is exposed to long term mechanical irritation infection and poor oral hygiene local tissues may remain in a persistent inflammatory state. Inflammatory cell infiltration and the release of inflammatory mediators can damage the mucosal barrier and induce cell injury and abnormal repair. Persistent inflammatory responses may also promote oxidative stress and genetic damage creating conditions for tumor formation. During tumor progression the immune microenvironment gradually changes. The antitumor function of some immune cells decreases while tumor cells may weaken the body ability to recognize and eliminate abnormal cells through immune escape mechanisms. The interaction between inflammatory stimulation and immune imbalance can promote tumor cell proliferation invasion and metastasis allowing lesions to gradually progress from local mucosal injury to malignant tumors.

3.3 Effects of unhealthy lifestyles and viral infection

Unhealthy lifestyles and viral infection are important external factors in the development of oral squamous cell carcinoma. Long term smoking and alcohol consumption expose the oral mucosa to various carcinogenic substances weaken local barrier function and increase the risk of cell injury and gene mutations. Betel quid chewing can cause mucosal fibrosis and chronic injury through mechanical friction and chemical irritation further increasing the risk of malignant transformation. Poor oral hygiene and long term irritation from unsuitable dental restorations may also aggravate local inflammatory responses and promote abnormal proliferation of the oral mucosa. Certain viral infections can interfere with cell cycle regulation and immune recognition making abnormal cells more likely to evade immune surveillance. The long term accumulation of multiple risk factors jointly disrupts oral mucosal homeostasis and promotes the progression from chronic injury to precancerous lesions and malignant tumors.

4. Problems in the diagnosis and treatment of oral squamous cell carcinoma

4.1 Insufficient early identification and diagnosis

Insufficient early identification and diagnosis is an important problem affecting the treatment outcome of oral squamous cell carcinoma. The early symptoms of this disease are often mild and may present as oral mucosal ulcers erythema leukoplakia local pain or slight discomfort which can easily be confused with common oral inflammation traumatic ulcers and other conditions. Some patients lack awareness of oral cancer prevention and do not pay enough attention to long lasting mucosal lesions resulting in delayed medical consultation. Primary medical institutions may also have limited capacity in oral mucosal lesion screening imaging examination and pathological diagnosis which may prevent high risk lesions from being detected in time. Because of insufficient early diagnosis some patients have already progressed to middle or advanced stages at the time of confirmation leading to expanded treatment scope increased postoperative functional impairment and higher risks of recurrence and metastasis thereby affecting overall prognosis.

4.2 High risk of recurrence and metastasis

The high risk of recurrence and metastasis is a major challenge in the clinical treatment of oral squamous cell carcinoma. This disease is characterized by strong local invasiveness and tumor cells may spread along submucosal tissues muscles nerves and lymphatic vessels which means that microscopic residual lesions may still remain after surgical resection. Some patients already have cervical lymph node metastasis at the time of diagnosis indicating more active tumor biological behavior and a significantly increased risk of subsequent recurrence. During treatment tumor heterogeneity and drug resistance may also weaken the effects of radiotherapy chemotherapy and targeted therapy allowing some residual tumor cells to continue growing and spreading. Once recurrence or metastasis occurs patients often require repeated surgery or comprehensive treatment which increases treatment difficulty physical burden and limits the possibility of improving prognosis.

4.3 Limited functional recovery and quality of life after treatment

Limited functional recovery and quality of life after treatment are important problems faced by patients with oral squamous cell carcinoma. Since tumors often involve key areas such as the tongue gingiva floor of the mouth and buccal mucosa surgical resection may cause tissue defects and structural changes affecting chewing swallowing speech and facial appearance. Radiotherapy and chemotherapy may also lead to adverse reactions such as dry mouth mucosal injury taste reduction and restricted mouth opening which interfere with daily eating and communication. Some patients may develop anxiety low self esteem and social avoidance after treatment further weakening rehabilitation outcomes. If postoperative reconstruction rehabilitation training nutritional support and psychological intervention are insufficient patients may complete tumor treatment but still have difficulty restoring oral function and social adaptability to an ideal level.

5. Intervention strategies for oral squamous cell carcinoma

5.1 Strengthening early screening and risk prevention

Strengthening early screening and risk prevention is an important measure to reduce the disease burden of oral squamous cell carcinoma. In clinical practice people with long term smoking alcohol consumption betel quid chewing chronic oral mucosal injury and a history of precancerous lesions should be included in key management. Regular oral examinations mucosal lesion assessment and necessary pathological examination can improve the detection rate of high risk lesions. Primary medical institutions should improve their ability to identify abnormal manifestations such as long lasting non healing ulcers leukoplakia erythema and local induration in order to reduce misdiagnosis and missed diagnosis. Risk prevention also requires guiding residents to improve lifestyle habits reduce exposure to tobacco alcohol and betel quid maintain good oral hygiene and promptly manage chronic irritation factors such as residual roots residual crowns and unsuitable dental restorations thereby reducing the risk of malignant transformation at its source.

5.2 Optimizing comprehensive treatment and individualized intervention

Optimizing comprehensive treatment and individualized intervention is an important approach to improving the treatment outcomes of oral squamous cell carcinoma. Clinical treatment should be formulated according to tumor location stage pathological type lymph node metastasis and the general condition of the patient rather than relying on a single treatment method. For early stage patients tissue damage should be minimized while ensuring complete tumor resection. For middle and advanced stage patients surgery radiotherapy chemotherapy targeted therapy and immunotherapy should be combined to improve local control and reduce the risk of recurrence. During treatment attention should also be paid to the patient age underlying diseases nutritional status and treatment tolerance. Treatment intensity should be dynamically adjusted so that antitumor effects and functional preservation can remain relatively balanced thereby improving the overall quality of treatment.

5.3 Improving rehabilitation management and long-term follow-up

Improving rehabilitation management and long term follow-up is an important part of improving the prognosis of patients with oral squamous cell carcinoma. After treatment rehabilitation training for chewing swallowing speech and mouth opening should be carried out according to the surgical extent responses to radiotherapy and chemotherapy and the degree of functional impairment. For patients with tissue defects or changes in facial appearance reconstructive repair and oral prosthetic treatment may be combined to improve daily living ability and social adaptation. Follow-up management should focus on local recurrence cervical lymph node metastasis nutritional status and psychological condition and should establish a regular review and risk assessment mechanism. The continuous connection of rehabilitation training nutritional support psychological intervention and recurrence monitoring can help patients gradually shift from disease treatment alone to long term health management.

6. Conclusion

The occurrence and progression of oral squamous cell carcinoma result from the combined effects of genetic variation abnormal molecular regulation chronic inflammation changes in the immune microenvironment and unhealthy lifestyles. This disease is characterized by nonspecific early manifestations strong invasiveness and a high risk of recurrence and metastasis. In current clinical diagnosis and treatment insufficient early identification inadequate coordination of comprehensive treatment and incomplete rehabilitation management and long term follow-up still affect patient prognosis and quality of life. In response to these problems prevention and control should be moved forward by strengthening screening of high risk populations and identification of abnormal oral mucosal lesions in order to improve early diagnosis and treatment. During treatment comprehensive plans should be formulated according to tumor stage pathological features and individual patient conditions while balancing tumor control and functional preservation. After treatment rehabilitation training nutritional support psychological intervention and recurrence monitoring should be strengthened to promote the transition from disease treatment to long term health management. Overall only by establishing a whole process intervention model that connects prevention screening diagnosis treatment rehabilitation and follow-up can the harm of oral squamous cell carcinoma be more effectively reduced and patients long term quality of life be improved.

References

- [1] Warnakulasuriya S.Global epidemiology of oral and oropharyngeal cancer[J].Oral Oncology,2008,45(4):309-316. DOI:10.1016/j.oraloncology.2008.06.002.
- [2] Monika R,Sylwia H,Marek N, et al.Oral cancer: The first symptoms and reasons for delaying correct diagnosis and appropriate treatment[J].Advances in clinical and experimental medicine : official organ Wroclaw Medical University,2020,29(6):735-743. DOI:10.17219/acem/116753.
- [3] Yunhan T,Zhihan W,Mengtong X, et al.Oral squamous cell carcinomas: state of the field and emerging directions[J]. International journal of oral science,2023,15(1):44-44. DOI:10.1038/S41368-023-00249-W.
- [4] Ambika C,S A G,P U S, et al.Overview of oral cavity squamous cell carcinoma: Risk factors, mechanisms, and diagnostics[J].Oral oncology,2021,121105451-105451. DOI:10.1016/J.ORALONCOLOGY.2021.105451.
- [5] Martina B I,Giacomo P,Igor P, et al.Oral Cavity Squamous Cell Carcinoma: An Update of the Pharmacological Treatment[J].Biomedicines,2023,11(4). DOI:10.3390/BIOMEDICINES11041112.
- [6] D K S,Jacques F,Ahmedin J, et al.The global incidence of lip, oral cavity, and pharyngeal cancers by subsite in 2012[J]. CA: a cancer journal for clinicians,2017,67(1):51-64. DOI:10.3322/caac.21384.