利用共振頻率作爲鎳鈦合金根管銼週期性疲勞非破壞性檢測方式

Nondestructive Test of Endodontic NiTi Rotary Instruments Cyclic Fatigue with Resonance Frequency

中文摘要

鎳鈦合金根管銼由於本身極佳的金屬特性因此已經被廣泛的應用在製造根管治療器械上。但不幸的是，在臨床治療的過程當中，常常會有不可預期的器械斷裂發生。而就目前而言並沒有一個很適當的方式能夠在器械斷裂前偵測出，因此本實驗的目的是去找到一種可檢測器械疲勞狀態的方式。自然頻率分析法是一種已經被廣泛使用的非破壞性檢測方式，它會受到物質本身的質量，彈性係數以及邊界條件所影響。當鎳鈦根管銼在旋轉疲勞斷裂產生時，在金屬上會有微裂痕的產生，此時金屬的彈性係數會有所降低，因此在本身質量以及周圍的邊界條件不變下，器械的自然頻率應該會隨著本身剛性係數的下降而有所改變。在本試驗中，利用一市售的共振頻率分析儀(IMPLOMATES®)來測量 Profile 在接受動態模擬臨床週期性疲勞破壞後之不同時期之共振頻率。初步的結果發現，週期性疲勞破壞會造成鎳鈦合金根管銼在其達到使用壽命的 77%~85%時發生自然頻率下降。而頻率的下降量約爲 400Hz 到 950Hz，平均爲 558+146Hz。此外，在臨床檢測上，也顯示出使用過三個月的鎳鈦合金根管銼之自然頻率之值約 8800Hz 至 9300Hz(平均 9271+220Hz)，相較全新的鎳鈦合金根管銼自然頻率在 10000Hz 至 11000Hz 之間(平均 10054+252Hz)，具有顯著性的差異 ($p<0.05$)。此結果顯示利用自然頻率爲參數，偵測鎳鈦合金根管銼在受週期性疲勞破壞後造成結構完整性改變的構想具有可行性與未來在臨床上的應用性。

英文摘要

Ni-Ti alloy instruments are extensively used in the endodontic treatment due to their outstanding mechanical property. Unfortunately, the nickel titanium rotary file separates unexpectedly during the treatment procedure. There is no proper method to detect the instrument fracture in advance so far. The purpose of this study is to develop a device for checking the fatigue status of the instrument. Resonance frequency analysis is a method wildly applied in the nondestructive tests. It is affected by alerting mass, elastic modulus and boundary conditions of a structure.When Ni-Ti alloy rotary instruments have crack, there will be some micro-crack over the metal. And the elastic modulus will decrease, so when the mass and the boundary condition is fixed, the resonance frequency will change with the decreased elastic modulus of the instruments.In this investigation, modal testing was performed by a commoditized device, IMPLOMATES®, to monitor the frequency responses of the profiles used clinically. Our preliminary results demonstrated that the cyclic loading on the profile

results in decreasing the natural frequency. The frequency significantly decreased with a value of about 400 Hz ~ 950 Hz (558+146 Hz)when the test profiles preceded 77 % to 85 % of total life spam. In addition, our in vivo experiments also revealed that the resonance frequencies of the three-month used nickel titanium rotary files (8800 Hz~ 9300 Hz, average= 9271+220 Hz) are significantly lower than the new files (10000 Hz ~11000 Hz, average= 10054+252 Hz, $p < 0.05$) These results showed that resonance frequency can be treated as an effective parameter in the fracture status evaluation of nickel titanium rotary instruments subjected to a series of cyclic loadings.