

◆ A24-159 ◆

Štoi-骨骨管家

Štoi-Bone Manager

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現為成功大學生物醫學工程學系教授兼成大研究發展基金會副執行長，擔任臺灣奈米生醫學會、光健康醫療科技創新發展協會及臺灣創新植體學會理事。投入前瞻性醫療器材的開發與教育，指導團隊曾獲102與104年度國科會創新創業激勵計畫創業傑出獎與兩百萬創業獎金、第十六到第十八屆國家新創獎與未來科技獎。

研究領域

轉譯奈米醫學、高值醫療器材新創開發

◆ 作品摘要 ◆

Štoi骨骨管家，細心管理矯正狀況，讓矯正後的身形S到I。

臺灣目前對於青少年原發性脊椎側彎的主要治療方法是穿戴脊椎矯正背架 (Thoracic Lumbar Sacral Orthotic, TLSO)。這種矯正方法是通過背架在脊椎彎曲處施加適度的壓力，在三個回推點引導脊椎在生長過程中逐漸改善彎曲角度，其效果顯著性取決於患者長期穿戴的穩定性和持續性。在TLSO介入治療的實務中，許多患者因順應性不佳或穿戴方法不正確，導致矯正效果降低，錯失了青少年生長發育的黃金矯正期。因此，確保正確且持續地穿戴TLSO是提升治療效果的關鍵。

骨骨脊背架壓力偵測系統透過壓力感測技術與數據模型分析，提高背架穿戴的正確性，並記錄穿戴時長，如圖一。核心技術包括陣列式壓力感測器的分佈設計、濾除節律性呼吸與步伐的壓力變化演算法，以及建構三組壓力感測貼片所偵測壓力峰值變動的數據庫，如圖二。

系統中的陣列式壓力感測器能夠測量矯正背架在使用者身體不同部位所施加的壓力。感測器分佈於三塊貼片上，實時監測使用者在穿戴過程中的壓力變化，並記錄尖峰區域。這樣的設計不僅可以捕捉到壓力的分佈情況，還能識別出受力不均的情形。為了排除因呼吸和步伐等節律性活動所引起的壓力變化，系統內嵌了一套演算法，從而識別並濾除這些節律性壓力變化，使系統能夠專注於監測由姿勢變化或矯正背架位置不當所引起的壓力變動，提高壓力數據的準確性，確保每一次測量結果都具有高可靠性。

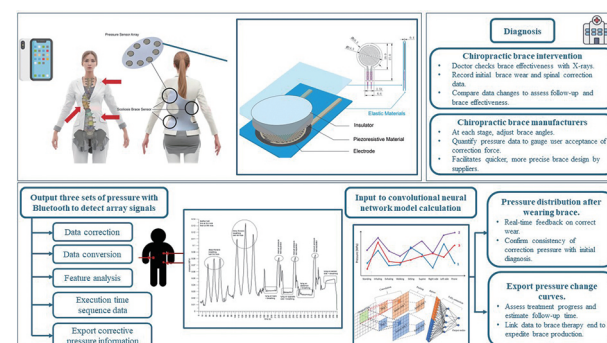
系統還包括一個基於三組壓力感測貼片所偵測的壓力峰值變化數據庫，記錄並分析長期穿戴矯正背架的壓力值，以評估當前穿戴是否正確。例如，通過對壓力數據

的分析，記錄矯正背架的穿戴時長，同時確保使用者按照醫囑正確穿戴。當偵測到壓力異常時，系統會即時提醒使用者進行調整，以達到最佳的矯正效果。同時評估青少年成長階段的身形變化，是否適合當前背架。根據長期壓力數據的變化趨勢，系統將自動生成回診建議，提醒使用者定期前往醫療機構調整背架。

在此，也特別感謝成功大學吳炳慶教授、杜翌群教授、鄭國順教授以及何俊亨教授，在研究過程中給予的指導與建議。



圖一 系統介面模擬圖。



圖二 系統架構圖。

◆ Abstract ◆

Statistics affects 3-5% of the population, with 6% of cases occurring in adolescents. A Cobb's angle > 40 degrees is recommended as the surgical threshold. Adolescent idiopathic scoliosis often occurs after the age of 10, with a male-to-female ratio of about 1:1.44. The Scoliosis Research Society (SRS) does not recommend spinal brace treatment for adult patients, emphasizing the importance of timely intervention to prevent missing the optimal treatment window for scoliosis.

Adolescent Idiopathic Scoliosis (AIS) is a polygenic disorder with lateral spine deviation, vertebral rotation, and rib asymmetry. The SRS diagnosis AIS with a Cobb's angle > 10°, often in the thoracic and lumbar regions. Early AIS is usually asymptomatic, but untreated cases can worsen, especially during adolescence, which is the optimal treatment period when the curvature can rapidly increase by over 20 degrees.

For AIS, an effective treatment plan must be tailored to the patient's curvature and skeletal maturity to ensure optimal correctional outcomes. Adolescence is the critical treatment window for patients with curvatures ranging from 25 to 40 degrees, with corrective bracing as the predominant treatment. Research demonstrates that braces effectively prevent progression in atypical curvature, thereby avoiding surgical treatments and addressing spinal pain. Studies also indicate that bracing for 23 hours daily significantly enhances treatment success rates. Designs of scoliosis braces should be adjusted to the patient's curve angle, employing a 3-point pressure system for correction. Regular examination with X-ray imaging confirmation and brace adjustments every six months are crucial. Our study reveals a significant issue in the treatment of scoliosis: insufficient patient compliance with bracing, which is critical for such corrective therapies.

The aim of this project is to develop a pressure detection system patch to address challenges faced in TLSO correction. Firstly, the system combines pressure sensors, analog amplifiers, and filtering circuits to accurately capture pressure signals from three support points, ensuring that the braces are worn correctly by patients (Figure 2,3). Secondly, utilizing low-power Bluetooth technology, the pressure signals are wirelessly transmitted to a smartphone. In cases of uneven or incorrect pressure, the system alerts for adjustments to optimize correction

effectiveness. Thirdly, the system records pressure changes over time, aiding healthcare professionals in evaluating correction progress and predicting follow-up appointments. Lastly, the system records bracing duration, providing caregivers and healthcare professionals with a basis for assessing treatment progress (Figure 4).

As AIS is common, conservative treatments, mainly TLSO braces, are prevalent in Taiwan. These braces apply pressure to key points to gradually correct spinal curvature during skeletal growth. Treatment effectiveness depends on consistent and long-term bracing. However, poor patient compliance or incorrect brace application often extends treatment duration to one to one and a half years, leading to missed corrective opportunities. Establishing a pressure detection system for braces can expedite the corrective outcomes of spinal bracing by ensuring:

- Real-time monitoring and adjustment.
- Precise correction.
- Caregivers can access real-time data for accurate follow-ups, ensuring timely and effective treatments that collectively maximize corrective monitoring and prediction.



Fig. 3 Patch attachment confirmation detection system.

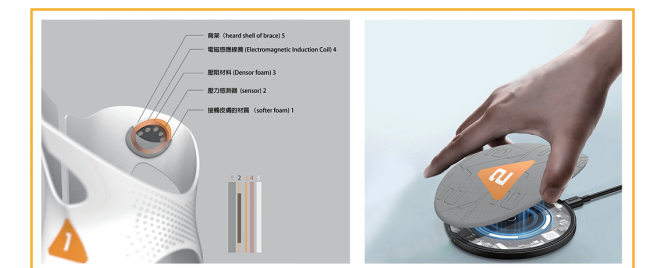


Fig. 4 Pressure sensing array soft patch design.