

BAMBOO PYLON FOR BELOW KNEE INTERIM PROSTHESIS

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INTRODUCTION

In Malaysia, limitation of materials, resources and skilled personnel have constantly become the reasons of costly prosthetic legs. Therefore, patients continuously look forward for a prosthetic leg subsidy from the Department of Welfare to support them. Nevertheless this process often takes 2 to 3 years which delayed the rehabilitation of the individual to stand upright and walk. Recently, a low cost interim prosthesis was developed using socket fabrication in hydro cast system and substituted metal pylon to domestic plant, bamboo. The objective of this paper is to evaluate the mechanical properties of bamboo and to assess transtibial patients gait using bamboo pylon, a continuation of the project by H N Shasmin et al [1].

METHODS

Bamboo materials tested belonged to the species *Bambusa Heterostachya* which is grown abundantly in Malaysia. This bamboo was cut into several culms and oven-dried for two days. The average moisture content was 180 percent in the green condition and about 12 percent in dry condition. Each bamboo culms was then coated with vinyl urethane adhesive. The tensile, compressive and flexural properties of the bamboo were investigated under modified tests from ASTM D3410 standards (Figure 1). All mechanical tests were estimated on Instron 1195 Universal Testing Machine with a crosshead speed of 1mm min^{-1} . Load displacement curves were generated for each test.

With approval from the ethics committee at University of Malaya Medical Centre, seven unilateral below knee patients were recruited. Full gait assessments were constructed by using three-dimensional Vicon motion analysis system with Kistler force platforms. The data were recorded and analysed under NEXUS 1.03.9 software. Data of pressure distribution between stump and socket was also accumulated on Tekscan Pressure Mapping system. Then, descriptive statistics were calculated by using analysis of variance to verify the difference between the two pylons in gait efficiency. The significance level was set at 0.05.

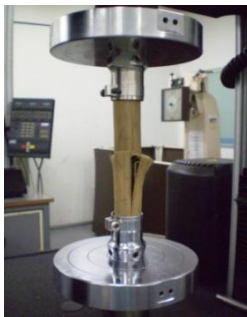


Figure 1: Compression test set-up satisfied ASTM D3410 standards.

RESULTS AND DISCUSSION

Table 1 shows the results of bamboo mechanical properties. The bamboo tested in the study was soaked into hot steam to make them soft enough so that the shape could be altered as well as to carbonize the strips.

Table 1: Mechanical properties of bamboo and aluminum.

Material	Tensile	Compressive	Flexural
	Modulus, GPa	Modulus, GPa	Modulus, GPa
Bamboo	49.5 ± 6.9	43.8 ± 1.5	18.2 ± 2.0
Aluminum	70.0 ± 1.8	68.2 ± 3.3	52.0 ± 1.1

Throughout gait analysis, the subjects had greater mass when wearing stainless steel as opposed to when wearing bamboo components. The results indicated that there is no significant difference of stride time in steel pylon ($0.64 \pm 2.3\text{s}$) and bamboo pylon ($0.71 \pm 5.1\text{s}$). It was expected that if bamboo components were to make any changes in the gait, the stride length would have changed considerably, because it is known to be a sensitive variable for evaluating an amputee's gait [2]. There were also no consistent differences in the kinematic and kinetic factors. Figure 2 shows the average in vertical ground reaction force for one subject.

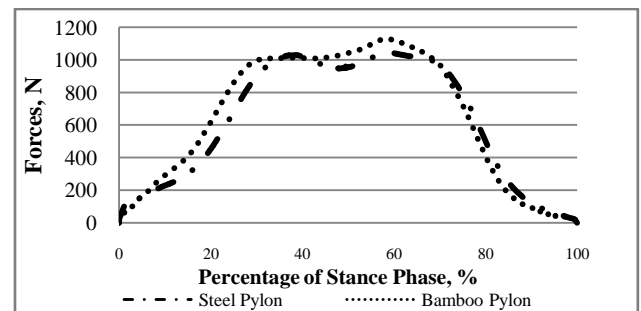


Figure 2: Vertical ground reaction force during stance phase of affected limb.

CONCLUSIONS

Bamboo is a natural composite which possessed high strength in physical properties. The major constraint of this wood-based material is the lifetime. Nevertheless, the lifespan of industrialized bamboo usually can be improved with chemical treatments.

REFERENCES

1. H N Shasmin, et al. Proceedings of ISB XXI, Taipei, Taiwan, Abstract 40, 2007.
2. S J Lin Chan, et al., *Arch Phys Med Rehabil.* **84**:1865-71, 2003.