

CHOOSING BEST COMPONENTS FOR AN AMPUTEE. A Methodology For The Best Decision-making

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Summary

The objective of this study is to verify and confirm the process of decision-making for four different trans-tibial prostheses with suspension systems: Hypobaric(A), PIN(B), Classic Suction(C) and Vacuum Active –VASS(D) according data provided by gait efficiency ($\text{mlO}_2/\text{kg}/\text{m}$) imagiology (*pistonning*) and amputee perception

Introduction

The harmony between the stump and the prosthesis is critical to allow it to fulfill its function enabling an efficient gait. A well fitted socket, with an efficient and comfortable suspension, allows the amputee to continue their daily living activities, maintaining the stump functional, making this correlation between socket and suspension very important in the functionality of the prosthesis, mobility and overall satisfaction with the device^{1,2}. Of our knowledge, the quantitative correlation between all of these factors as not yet been assessed.

Methodology

For this case-study, with a 23 years old individual, the functional performance that each different suspension system allows was assessed with physiological data provided by:

- Gait efficiency ($\text{mlO}_2/\text{kg}/\text{m}$) from a breath-by-breath analyzer - *Quark PFT Ergo-COSMED* in a treadmill *H/P/Cosmos (R) Mercury* according Lin-Chan (2003)³ in which a lower value is a better value.



Fig. 1 – Breath-by-breath analysis in a treadmill during Lin-Chan protocol.

- The *pistonning* measure (image of axial displacement of the stump in mm, was measured by indirect conversion of image acquisition system model *MultixPro/Top Siemens* according Narita (1997)⁴.

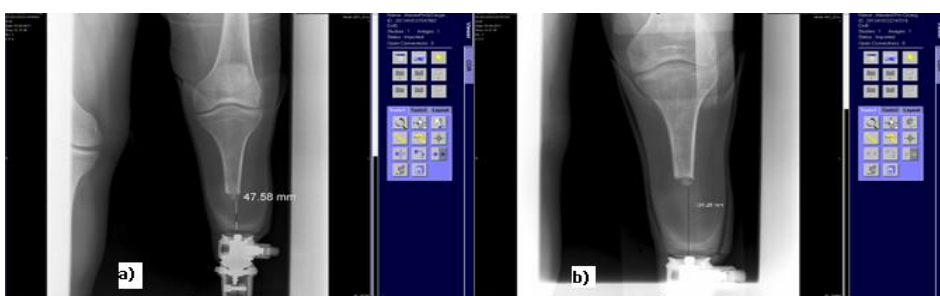


Fig. 2 - Image of the prosthesis with suspension PIN; a) in the standing position ; b) with traction 5kg



Fig. 3 - tensile test at 5Kg imaging room with platform at 30°

- Perception data was provided by *Prosthesis Evaluation Questionnaire (PEQ)*⁵. This will analyze the perception of the subject, as well as the functionality and the quality of life provided by each of the prostheses (component) tested.

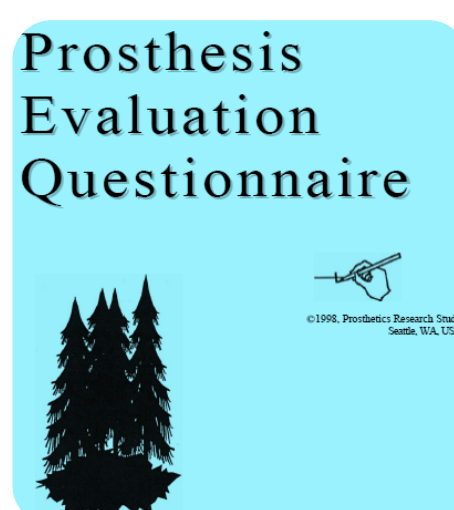


Fig. 4 – PEQ – Prosthesis Evaluation Questionnaire

Results

Velocity (m/min)	Time	Prosthesis A		Prosthesis B		Prosthesis C		Prosthesis D		Distance (m)
		VO ₂ (ml/min/Kg)	Efficiency (ml/Kg/m)	VO ₂ (ml/min/Kg)	Efficiency (ml/Kg/m)	VO ₂ (ml/min/Kg)	Efficiency (ml/Kg/m)	VO ₂ (ml/min/Kg)	Efficiency (ml/Kg/m)	
0	0 min.	4,84		8,08		7,69		8,07		
53,64	0/4 min.	14,34	0,27	11,68	0,22	14,65	0,26	14,37	0,27	211±9m
67,05	4/8 min.	15,00	0,22	16,04	0,24	14,45	0,22	17,19	0,26	478±3m
80,46	8/10,30 min.	15,70	0,20	16,18	0,20	17,58	0,22	16,13	0,20	712m
80,46	8/12 min.	16,12	0,20			16,88	0,21	18,61	0,23	799±9m
93,87	12/12,45 min.	17,15	0,18			18,64	0,20	17,79	0,19	882m
93,87	12/13,30 min.	18,71	0,20					18,38	0,20	939m
93,87	12/15,30 min.							18,46	0,20	1102m
107,28										

Table 1 – Comparison between O₂ consumption, efficiency and walked distance

Results showed that for this patient, the Vacuum Active Suspension System (VASS), presented the best results with the total walking distance of 1102 meters in 15'30" (maximum speed of 93,87m/min in last stage of four minutes). Gait efficiency was the lowest value (0.20 ml/kg/m) with highest VO₂ in last stage of 18,47ml/min/kg.

SUSPENSION SYSTEM	With 5 Kg of traction	Without traction	Pistonning
Suspension with hypobaric membranes (A)	NS	NS	NS
PIN Suspension System (B)	101,26mm	47,58mm	53,68mm
Classic Suction (C)	124,88mm	52,33mm	72,55mm
Suspension by VASS (D)	106,87mm	58,96mm	47,91mm

Table 2 – Results of the Pistonning in the various suspension systems

Pistonning, showed better results for VASS with 47,91mm. According amputee perception by the PEQ, the VASS presented the best scores in all the 9 validated scales.

SCALES	Objective	Prosthesis A	Prosthesis B	Prosthesis C	Prosthesis D	Best	Worst
Utility Scale	Easy walk in general, in reduced spaces, on stairs and ramps, in the urban space and on slippery surfaces	82	33,38	75,38	94,13	Prost. D	Prost. B
Residual Limb Health Scale	Sweat, smell, volume change, skin rash and blisters	92,75	55,25	89,50	98,83	Prost. D	Prost. B
Ambulation Scale	Adjusting and fitting the socket, weight, comfort standing, sitting comfort, imbalance, energy, feelings, ease in putting the prosthesis	97,25	33,25	90,63	98,25	Prost. D	Prost. B
Appearance Scale	Aspect of the prosthesis, damage to the clothing, cosmetic damage, choosing shoes	89	93,25	95,75	97,25	Prost. D	Prost. A
Sounds Scale	Frequency of sounds, discomfort of sounds	98	7	98	98	Prost. D	Prost. B
Frustration Scale	Frequency of frustration, degree of frustration	98	98	98	99	-	-
Perceived Response Scale	Prevent reactions from strangers, the partner's reaction, affecting the relationship, family reaction, reaction of other family members	93	88,8	94,80	96,40	Prost. D	Prost. B
Social Burden Scale	Prosthesis has been a burden to your partner or family, prevented from living your social life, take care of someone else	98	99	99	99	Prost. D	Prost. A
Well Being Scale	Degree of satisfaction since the amputation, degree of quality of life	94,5	47	76,5	83,5	Prost. A	Prost. B
						9 in 10	7 in 10

Table 3 – Results of application variables of the PEQ

According amputee perception by the PEQ, the VASS presented the best scores in all the 9 validated scales.

Conclusion

The use of this protocol with several objective and subjective data as proven the best evidence for analyzing differences in results of various suspension systems, and it seems that this is a viable tool in the evaluation and decision-making process within a rehabilitation with a prosthesis. Also through the analysis of results was clear that the VASS suspension system is, for this case-study, the one that provides greater functionality and satisfaction.

References

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