Weight of Prefabricated Transtibial Gel Prosthetic Liners A Standardized Sample

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ABSTRACT

The weight of prefabricated Transtibial/Below Knee (BK) Gel prosthetic liners of different models and Companies was the focus of this study. The various models were standardized in terms of length and weight by removing liner material in excess of 28 centimeters and weighing the liners. This paper examines the weight differences between BK prefabricated prosthetic liners which are 3mm, 6mm or 9mm in thickness and which possess the distal attachment ability for a locking pin system for a residual limb with a circumference of 28.5 centimeters as measured 6cm proximal of the distal end. Twenty-three BK prosthetic liners that met the physical requirements of this study were acquired from seven major companies. Each liner was measured distal to proximal and cut at the proximal end to be equal in length of 28 centimeters. Each liner was fitted with an insert attachment pin for a Fillauer original shuttle lock system (#125229) and an inch and a half plunger with M10 metric thread (#809725mm). All liners required adapters to accommodate the plunger. The completed liners were then weighted using a United Postal Service (UPS) postal scale (Mettler Toledo, Model Serial Number PS60-2722775-21C). A reference chart was created from the results indicating that all liners are of different weight.

Keywords: Amputee, Prosthetic Suspension, Trans-Tibial Suspension, Prefabricated BK Prosthetic liner, Silicone Elastomer, Silicone Gel, Urethane, Thermoplastic Elastomer.

INTRODUCTION

Companies generally document the weight of prefabricated pieces of equipment used in the building of below knee (BK) prosthetics. The weight of BK gel prosthetic liners has not been well documented. Prosthetic liner weight is a factor in the total weight of a prosthetic device. Prosthetic devices for below the knee amputees usually weigh about 1.59kg.¹ In this study, the average weight of the prosthetic liners was 446.3 grams. This is about 28 percent of the total weight of a 1.59kg BK prosthetic device.

Weight may well be an important factor in the description of prosthetic liner attributes. It is generally understood that the quality of being "dense", "close" or "thick" increases the weight of final product. This paper examines the weight differences between those BK prefabricated prosthetic liners which are 3mm, 6mm or 9mm in thickness with a distal attachment ability for a locking pin system and which have a residual limb circumference of 28.5 centimeters as measured 6cm proximal of the distal end.

The general attitude of Companies and Prosthetists toward BK liner weight appears to be that the isolated liner weight is not of significant consequence. Rather, they appear to be more concerned with the overall weight of the entire prosthesis with proper suspension and attachment of the prosthetic device taking precedence over weight. However, when working with an individual BK amputee clinical considerations when choosing a prosthetic liner include comfort, cushioning, skin-health, energy output, durability, stability, control, cosmetic appearance and low maintenance.

Amputees seek ease of ambulation. They must exert effort and energy to propel the prosthesis. Every bit of weight counts [4]. F=MA, (F for force, M for Mass, A for acceleration) hence the greater the mass (of the prosthesis) results in greater required amount of force to ambulation. Ideally, the effort exerted and the amount of energy lost at interface and articulation should be minimal.

The liner is the critical component interfacing the prosthetic socket and the amputee's residual limb. The liner must conform to the stump and form a secure suspension by dispersing peak pressures as well as absorption of shear forces created by the socket. Prosthetic liners also stabilize the distal soft tissue and distribute the force load over a large surface area and prevent distal soft tissue elongation by minimizing longitudinal stretch. Prosthetic liners should be fabricated out of material that is non-reactive and which, ideally, promotes skin health by reducing the occurrence of dermatological and mechanical irritation problems.

Many prosthetic liner products are available with differing physical properties. Companies and users claim they vary in performance. Only three published studies were found which compare the properties of prosthetic liner materials. Comparative shear/compressive and shear/friction testing at high stress levels and compressive, frictional, shear, and tensile loading conditions have been studied and revealed information regarding liner strength and failure properties.^{2,3,4}

These studies report that the physical properties of silicone elastomer and silicone gel are quite similar to one another. They indicate that silicone elastromeric products generally do better across groups than do silicone gel liners. Elastomer products are often preferred because of their wide range of compressive shear and tensile stiffness values and urethane liners demonstrate the highest coefficient of friction of any liner tested.^{2,3,4}

Product assessment from the above studies can be of qualitative or quantitative value for clinicians. Qualitative differences in the behavior of liner materials can often be correlated with amputee and clinical preference. Prosthetic liner material properties data and response groupings can provide quantitative information on similarities and differences among products and have the potential to be useful in prosthetic fitting. Data regarding prosthetic liner material can also be used in the development of material models for potential use in prosthetic engineering and design.

The data derived from the standardized measurement of BK prosthetic liners' weight used in this paper will add to existing material property data. It is hoped that it will be useful to the amputee, prosthetist, and the manufacturing community.

METHOD

Twenty-three Below Knee (BK) prosthetic liners acquired from seven major companies met the physical requirements of this study. BK prefabricated prosthetic liners of 3mm, 6mm or 9mm in thickness, which possess the distal

attachment ability for a locking pin system and had residual limb circumference of 28.5 centimeters when measured 6cm proximal of the distal end were included in the collected data. An attempt was made to acquire all BK liners that met the physical requirements of this study, however, OSSUR and MEDI-USA declined to participate in this study. Each liner was weighed and measured for length three times for a total of 126 measurements performed, 63 measurements for weight and 63 for length.

The liner materials that were available for this study urethane, silicone and thermoplastic elastomer. The thermoplastic elastomer is a gel composed of a copolymer bock and mineral oil. Silicone liners were of two types, silicone elastomer and silicone gel. The difference between the two silicones is their cross-linking and fluid retention.⁴ Silicone elastomers are significantly cross-linked and contain little free polydimethylsiloxane (PDMS) fluid. Silicone gels have gently cross-linked polysiloxane networks, swollen with PDMS fluid. Since the PDMS fluid is not chemically bound to the network in silicone gels, fluid can bleed out of the gels.⁴ Attempts were made to obtain liners of similar thickness. However the thickness varied when measured at the proximal, where the cuts where made, from 1.5 mm to 9 mm because of commercial product design variations. Each liner was weighed and measured three times. The liners were commercially manufactured and were obtained in 2005. **Table 1** displays the name of the company that manufactured the liner, the model, material and thickness of each prefabricated liner studied.

Each liner was measured distal to proximal and cut at the proximal end to be equal in length to the shortest liner, 28cm. Each liner was fitted with an insert attachment pin for a Fillauer original shuttle lock system (#125229) and an inch and a half plunger with M10 metric thread (#809725mm). The completed liners were then weighted using a United Postal Service postal scale (Mettler Toledo, Model Serial Number PS60-2722775-2lC at the UPS Store La Jolla, CA).⁵ The Fillauer original shuttle lock system (#125229) and an inch and a half plunger with M10 metric thread (#809725mm) added approximately 2 grams to the completed liner. A standardized reference chart was made from the results. See **Table 2**.

Fillauer Original Lock System



Plungers





RESULTS

Table 2 and **Table 3** display the standard weight of each of the twenty-three

 prefabricated liners. The weight and length data documented in these tables

 represents the mean of three measurements. Prefabricated BK prosthetic liners

of standard length do not weigh the same. The heaviest liner was the 9mm ALPS Thermo Locking Liner Firm (TFDT28-9 F) at 722 grams and the lightest was the Ohio Willow Wood, Original Alpha 3mm uniform medium plus at 202 grams. In this study, the heaviest liner weighed 3.5 times as much as the lightest liner.

The mean weight for the 3mm liners group was 407 grams. (Table 4A) The mean weight for the 6mm liners group was 447.7 grams, (Table 4B) while the mean weight for the 9mm liners group was 526 grams. (Table 4C) In the three liner thickness groups studied, the heaviest 9 mm liner weighed approximately 2 times as much as the lightest 9mm liner and in the 3 and 6 mm samples the heaviest liners were over two and a half times heavier that their respective lightest liner.

Several liners did not meet the typical thickness of 3, 6, or 9mm these included: ALPS's 28cm Clear Pro (1.5mm) which weighted 272 grams, Otto Bock's Silicone Gel (2mm) which weighted 462 grams, Otto Bock's Technogel (3.5mm) which weighted 442 grams, SILIPOS's Medium + Uniform Flesh (3.5mm) which weighted 222 grams and Otto Bock's Sirona (8.0mm) which weighted 662 grams. These data reflect large differences in prefabricated liner weight due to each liner's thicknesses of cross-linked polysiloxane matrix and PDMS fluids as well as materials of the durable fabrics that help broaden the life of the liner and make donning and doffing easier for the amputee.^{1,4,6}

DISCUSSION

Up until this time a standard measure for prefabricated BK liners did not exist. Information from manufacturers describing their products has been incomplete and it has been difficult for the clinician/patient to compare and contrast makes and models of prefabricated BK liners. The thickness of a liner does not automatically translate into weight. The mean weight for the 3mm liner group was 407 grams, with the lightest being 202 grams and the heaviest being 552 grams. The mean weight for the 6mm liners group was 447.7 grams, the lightest being 252 grams and the heaviest being 632 grams, while the mean weight for the 9mm liners group was 526 grams, the lightest being 372 and the heaviest being 722 grams. **(Table 4)**

The literature is sparse concerning the descriptive attributes of prefabricated BK liners and their desirability for specific amputee populations. Studies have suggested that a stiffer liner may be more desirable for amputees with high activity levels. Durometer (or hardness) is associated with strength but is better understood as stiffness. There appears to be no relationship between durometer and tear strength for prefabricated liners.² It has also been reported that tensile stiffness properties are related to the liner's suspension during the swing phase. Heavier weighted Silicone Gel liners were shown to have lower shear and tensile stiffness compared to lighter weight Silicone elastomer liners. A liner with lower shear stiffness allows the residual limb to sink deeper distally into the socket during weight bearing at mid-stance.⁴

Data concerning weight as well as the thickness of the prefabricated liners could be useful when researching BK prostheses giving added data. For example, the affect of liner weight and thickness on hip flexor fatigue could be studied. Over time and distance the total weight of a prosthesis, which includes the liner, affects muscle fatigue and the efficiency of movement of the affected leg. The duration of both limbs of a below knee amputee's swing is determined by mass moment of inertia.⁷ The muscles that are in action for this significant part of gait are the hip flexors (iliopsoas and rectus femoris). These two small muscles begin to lift the limb and swing it forward by concentric contraction.

Since the limb acts like a pendulum through much of the swing phase, the initial contraction of the hip flexors needs to be as efficient and effortless as possible. The length of stride depends on the length of the free-swinging limb, the prosthetic pendulum. The heavier the prosthetic the shorter the stride and the more work the hip flexors must do in terms of weight and increased number of strides to cover a distance, increasing the probability of fatigue.^{7,8}

Fatigue is a huge factor on both ends of the BK amputee spectrum. The K, Level 1 population often complains of being too tired to walk, that their prosthesis is too heavy, etc. and the K, Level 4 is often hypersensitive to minute changes in prosthetic performance. With the added data that this study provides, weight and thickness of BK liners could be studied to see if they have any significant relationship to fatigue in the various BK populations.

CONCLUSION

All prefabricated BK liners have of different weights. Liner weight should be taken into consideration in selecting the components of a prosthetic device. Total weight is a factor in the performance of prosthetic devices. More study is needed to determine whether the variations in liner weight observed in this study are associated with significant variation in the performance of the liner and the prosthetic device. Weight does matter and the prosthetist needs to consider the weight of a liner when trying to concentrate on the total weight of the prosthetic limb.

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Company	Model	Material	Thickness
ALPS [9]	28CM CLEAR PRO 1.5MM	Silicone Elastomer	1.5mm
	28CM CLEAR PRO 3.0MM	Silicone Elastomer	3.0mm
	EASYLINER HIGH PERFORMANCE LOCKING LINER	Gel w/fabric backing	6.0mm
	THERMO PRE-FORM LOCKING LINER FIRM	Thermoformable Gel w/fabric backing	6.0mm
	THERMO PRE-FORM LOCKING LINER FIRM	Thermoformable Gel w/fabric backing	9.0mm
	THERMO PRE-FORM LOCKING LINER SOFT	Thermoformable Gel w/fabric backing	6.0mm
DAW [10]	COOL LINER UNIFORM MEDIUM + 20/28 3MM	Thermoplastic Elastomer w/fabric backing	3.0mm
	COOL LINER UNIFORM MEDIUM + 20/28 6MM	Thermoplastic Elastomer w/fabric backing	6.0mm
	COOL LINER UNIFORM MEDIUM + 20/28 9MM	Thermoplastic Elastomer w/fabric backing	9.0mm
ESP [11]	P [11] AEGIS STREAMLINE length 20cm CIRCUM 24CM Silicone		3.0mm
	AEGIS ULTIMATE, MEDIUM, 8", LOCKING LINER	Silicone Gel w/fabric backing	6.0mm
EURO INTER	PERFECT LINER UNIFORM 3MM LARGE	Silicone w/fabric backing	3.0mm
[12]	PERFECT LINER UNIFORM 9MM LARGE	Silicone w/fabric backing	9.0mm
OTTO BOCK	SILICONE GEL	Silicone Gel w/fabric backing	2.0mm
[13]	TECHNOGEL	Polyurethane w/fabric backing	3.5 mm
	SIRONA UNIFORM	Urethane w/fabric backing	8.0 mm
OWW [14]	ORIGINAL ALPHA 3MM UINFORM MEDIUM PLUS	Thermoplastic Elastomer w/fabric backing	3.0mm
	ORIGINAL ALPHA 6MM UINFORM MEDIUM PLUS	Thermoplastic Elastomer w/fabric backing	6.0mm
	ORIGINAL ALPHA 9MM UINFORM MEDIUM PLUS	Thermoplastic Elastomer w/fabric backing	9.0mm
SILIPOS [15]	MEDIUM + UNIFORM Flesh	Gel w/fabric backing	3.5mm
	MEDIUM + UNIFORM Flesh	Gel w/fabric backing	6.0mm
	MEDIUM + UNIFORM Flesh	Gel w/fabric backing	9.0mm

Table 1: Prefabricated Liner Manufacturers, Models, Material and Thickness Studied

COMPANY and CODE			Org/Std*	Original	Original	Standard	Standard**	Standard Weight** plus Plunger And
ALPS	MODEL	Product Serial Number	Thickness	Length	Weight	Length	Weight	Adapter***
TFDT28-6 F	THERMO LOCKING LINER FIRM	7 13980 15004 6 BAR CODE 402661 LOT #	6.0 mm	45.2 cm	910 g	28.0 cm	630 g	632 g
TFDT28-9 F	THERMO LOCKING LINER FIRM	7 13980 15030 5 BAR CODE 400263 LOT #	9.0 mm	44.6 cm	1140 g	28.0 cm	720 g	722 g
ELDT28-3 HP	EASYLINER HIGH PERFORMANCE LOCKING LINER	7 13980 13198 4 BAR CODE 402735 LOT#	3.0 mm	44.6 cm	740 g	28.0 cm	530 g	532 g
ELDT28-6 HP	EASYLINEK HIGH PERFORMANCE LOCKING LINER	7 13980 13199 1 BAR CODE 402339 LOT#	6.0 mm	44.6 cm	890 g	27.9 cm	630 g	632 g
SSA28-1.5	28CM CLEAR PRO 1.5MM	7 13980 03125 3 BAR CODE 402248 LOT #	1.5 mm	36.3 cm	320 g	28.0 cm	270 g	272 g
SSA28-3.0	28CM CLEAR PRO 3.0MM	7 13980 03126 0 BAR CODE 402553 LOT #	3.0 mm	36.3 cm	490 g	28.0 cm	400 g	402 g
TFDT28-6 S	THERMO LOCKING LINER SOFT	7 13980 15051 0 BAR CODE 402728 LOT #	6.0 mm	45.7 cm	920 g	27.9 cm	630 g	632 g
DAW								
NA	COOL LINER UNIFORM MEDIUM + 20/28 3MM	T4PJ28	3.0 mm	46.1 cm	440 g	28.0 cm	240 g	242 g
NA	COOL LINER UNIFORM MEDIUM + 20/28 6MM	T4PK09	6.0 mm	46.3 cm	640 g	28.0 cm	370 g	372 g
NA	COOL LINER UNIFORM MEDIUM + 20/28 9MM	T4PK09	9.0 mm	45.7 cm	800 g	28.0 cm	470 g	472 g
ESP								
BK24-8S	AEGIS STREAMLINE length 20cm CIRCUM 24CM	NA	3.0 mm	38.7 cm	320 g	28.1 cm	550 g	552 g
BK-U-M-8L	AEGIS ULTIMATE, MEDIUM, 8", LOCKING LINER	NA	6.0 mm	38.9 cm	730 g	27.9 cm	250 g	252 g
EURO IN	TERNATIONAL							
NA	PERFECT LINER UNIFORM 3MM LARGE	NA	3.0 mm	45.6 cm	740 g	28.0 cm	510 g	512 g
NA	PERFECT LINER UNIFORM 9MM LARGE	NA	9.0 mm	45.3 cm	990 g	27.9 cm	600 g	602 g
OWW								
NA	ORIGINAL ALPHA 3MM UINFORM MEDIUM PLUS	731894756	3.0 mm	51.3 cm	420 g	28.0 cm	200 g	202 g
NA	ORIGINAL ALPHA 6MM UINFORM MEDIUM PLUS	732006399	6.0 mm	48.8 cm	610 g	28.1 cm	320 g	322 g
NA	ORIGINAL ALPHA 9MM UINFORM MEDIUM PLUS	731976497	9.0 mm	50.6 cm	880 g	27.7 cm	460 g	462 g
OTTO BC	CK							
6Y70=280	SILICONE GEL	NA	2.0 mm	38.8 cm	570 g	28.1 cm	460 g	462 g
6Y60	TECHNOGEL	NA	3.5 mm	38.1 cm	550 g	28.0 cm	440 g	442 g
6Y533=265	SIRONA UNIFORM	NA	8.0 mm	40.7 cm	920 g	28.0 cm	660 g	662 g
SILIPOS	1	1	1	1	1	1		1
18007	MEDIUM + UNIFORM Flesh	24767DOM1004	3.5 mm	38.5 cm	320 g	27.9 cm	220 g	222 g
18009	MEDIUM + UNIFORM Flesh	24767DOM1204	6.0 mm	39.8 cm	420 g	28.0 cm	290 g	292 g
18011	MEDIUM + UNIFORM Flesh	025382DOM1204	9.0 mm	38.5 cm	520 g	28.0 cm	370 g	372 g

TABLE 2: Total Sample of Prefabricated BK Liners: Identification and Specifications

*The manufacturer determined thickness **Standard Weight was determined by using a "Mettler Toledo" Scale, Model Serial Number: PS60-2722775-21C. Date Calibrated: 1/15/2005; Date Liners Weighed: 5/21/2005 *** Weight of Adapter 1/4-20 US standard threads to 10mm and 1 1/2" Plunger with M10 metric thread is 2 grams.

TABLE 3: Company, Code, Model Thickness and Standard Weight* Of Total Sample BK Prefabricated Liners *Standard Weight = Weight of BK Prefabricated Liner Cut to 28cm+ Weight of Adapter and Plunger (The adapter and plunger in this study added to 2grams in weight.)

Company	CODE	MODEL	THICKNESS	STANDARD WEIGHT*
ALPS	SSA28-1.5	28CM CLEAR PRO 1.5MM	1.5 mm	272 g
OTTO BOCK	6Y70=280	SILICONE GEL	2.0 mm	462 g
OWW	NA	ORIGINAL ALPHA 3MM UNIFORM MEDIUM PLUS	3.0 mm	202 g
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 3MM	3.0 mm	242 g
ALPS	SSA28-3.0	28CM CLEAR PRO 3.0MM	3.0 mm	402 g
EURO	NA	PERFECT LINER UNIFORM 3MM LARGE	3.0 mm	512 g
ALPS	ELDT28-3 HP	EASYLINER HIGH PERFORMANCE LOCKING LINER	3.0 mm	532 g
ESP	BK24-8S	AEGIS STREAMLINE length 20cm CIRCUM 24CM	3.0 mm	552 g
SILIPOS	18007	MEDIUM + UNIFORM Flesh	3.5 mm	222 g
ОТТО ВОСК	6Y60	TECHNOGEL	3.5 mm	442 g
ESP	BK-U-M-8L	AEGIS ULTIMATE, MEDIUM, 8", LOCKING LINER	6.0 mm	252 g
SILIPOS	18009	MEDIUM + UNIFORM Flesh	6.0 mm	292 g
OWW	NA	ORIGINAL ALPHA 6MM UINFORM MEDIUM PLUS	6.0 mm	322 g
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 6MM	6.0 mm	372 g
ALPS	TFDT28-6 F	THERMO LOCKING LINER FIRM	6.0 mm	632 g
ALPS	ELDT28-6 HP	EASYLINER HIGH PERFORMANCE LOCKING LINER	6.0 mm	632 g
ALPS	TFDT28-6 S	THERMO LOCKING LINER SOFT	6.0 mm	632 g
OTTO BOCK	6Y533=265	SIRONA UNIFORM	8.0 mm	662 g
SILIPOS	18011	MEDIUM + UNIFORM Flesh	9.0 mm	372 g
OWW	NA	ORIGINAL ALPHA 9MM UINFORM MEDIUM PLUS	9.0 mm	462 g
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 9MM	9.0 mm	472 g
EURO	NA	PERFECT LINER UNIFORM 9MM LARGE	9.0 mm	602 g
ALPS	TFDT28-9 F	THERMO LOCKING LINER FIRM	9.0 mm	722 g

					Difference
Company	CODE	MODEL	Thickness	Weight	From Mean
ALPS	SSA28-1.5	28CM CLEAR PRO 1.5MM	1.5 mm	272	-174
OTTO BOCK	6Y70=280	SILICONE GEL	2.0 mm	462	-16
OWW	NA	ORIGINAL ALPHA 3MM UNIFORM MEDIUM PLUS	3.0 mm	202	-244
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 3MM	3.0 mm	242	-204
ALPS	SSA28-3.0	28CM CLEAR PRO 3.0MM	3.0 mm	402	-44
EURO	NA	PERFECT LINER UNIFORM 3MM LARGE	3.0 mm	512 g	+66
ALPS	ELDT28-3 HP	EASYLINER HIGH PERFORMANCE LOCKING LINER	3.0 mm	532 g	+86
ESP	BK24-8S	AEGIS STREAMLINE length 20cm CIRCUM 24CM	3.0 mm	552 g	+106
SILIPOS	18007	MEDIUM + UNIFORM Flesh	3.5 mm	222 g	-244
OTTO BOCK	6Y60	TECHNOGEL	3.5 mm	442 g	-4
ESP	BK-U-M-8L	AEGIS ULTIMATE, MEDIUM, 8", LOCKING LINER	6.0 mm	252 g	-194
SILIPOS	18009	MEDIUM + UNIFORM Flesh	6.0 mm	292 g	-154
OWW	NA	ORIGINAL ALPHA 6MM UINFORM MEDIUM PLUS	6.0 mm	322 g	-114
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 6MM	6.0 mm	372 g	-74
ALPS	TFDT28-6 F	THERMO LOCKING LINER FIRM	6.0 mm	632 g	+186
ALPS	ELDT28-6 HP	EASYLINER HIGH PERFORMANCE LOCKING LINER	6.0 mm	632 g	+186
ALPS	TFDT28-6 S	THERMO LOCKING LINER SOFT	6.0 mm	632 g	+186
OTTO BOCK	6Y533=265	SIRONA UNIFORM	8.0 mm	662 g	+216
SILIPOS	18011	MEDIUM + UNIFORM Flesh	9.0 mm	372 g	-74
OWW	NA	ORIGINAL ALPHA 9MM UINFORM MEDIUM PLUS	9.0 mm	462 g	+16
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 9MM	9.0 mm	472 g	+26
EURO	NA	PERFECT LINER UNIFORM 9MM LARGE	9.0 mm	602 g	+156
ALPS	TFDT28-9 F	THERMO LOCKING LINER FIRM	9.0 mm	722 g	+276

TABLE 4: Weight Difference from the Mean Weight of Total Sampleof BK Prefabricated Liners (Mean Weight: 10266/23 = 446 grams)

TABLE 4A: Weight Difference from the Mean Weight of 3.0 mm Sampleof BK Prefabricated Liners (Mean Weight: 2442/6 = 407 grams)

Company	CODE	MODEL	Thickness	Weight	Difference
· ·					From Mean
OWW	NA	ORIGINAL ALPHA 3MM UNIFORM MEDIUM PLUS	3.0 mm	202 g	-205
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 3MM	3.0 mm	242 g	-165
ALPS	SSA28-3.0	28CM CLEAR PRO 3.0MM	3.0 mm	402 g	-5
EURO	NA	PERFECT LINER UNIFORM 3MM LARGE	3.0 mm	512 g	+105
ALPS	ELDT28-3 HP	EASYLINER HIGH PERFORMANCE LOCKING LINER	3.0 mm	532 g	+125
ESP	BK24-8S	AEGIS STREAMLINE length 20cm CIRCUM 24CM	3.0 mm	552 g	+145

Company	CODE	MODEL	Thickness	Weight	Difference From Mean
ESP	BK-U-M-8L	AEGIS ULTIMATE, MEDIUM, 8", LOCKING LINER	6.0 mm	252 g	-196
SILIPOS	18009	MEDIUM + UNIFORM Flesh	6.0 mm	292 g	-156
oww	NA	ORIGINAL ALPHA 6MM UINFORM MEDIUM PLUS	6.0 mm	322 g	-126
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 6MM	6.0 mm	372 g	-76
ALPS	TFDT28-6 F	THERMO LOCKING LINER FIRM	6.0 mm	632 g	+184
ALPS	ELDT28-6 HP	EASYLINER HIGH PERFORMANCE LOCKING LINER	6.0 mm	632 g	+184
ALPS	TFDT28-6 S	THERMO LOCKING LINER SOFT	6.0 mm	632 g	+184

TABLE 4B: Weight Difference from the Mean Weight of 6.0 mm Sampleof BK Prefabricated Liners (Mean Weight: 3134/7 = 447.7 grams)

TABLE 4C: Weight Difference from the Mean Weight of 9.0 mm Sampleof BK Prefabricated Liners(Mean Weight: 2630/5 = 526 grams)

Company	CODE	MODEL	Thickness	Weight	Difference From Mean
SILIPOS	18011	MEDIUM + UNIFORM Flesh	9.0 mm	372 g	154
OWW	NA	ORIGINAL ALPHA 9MM UINFORM MEDIUM PLUS	9.0 mm	462 g	64
DAW	NA	COOL LINER UNIFORM MEDIUM + 20/28 9MM	9.0 mm	472 g	54
EURO	NA	PERFECT LINER UNIFORM 9MM LARGE	9.0 mm	602 g	-76
ALPS	TFDT28-9 F	THERMO LOCKING LINER FIRM	9.0 mm	722 g	-196

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