<u>The Pin Lock Reference Manual for Prosthetists</u>

By Richard Krosin
Prosthetics Resident, 2004-2005
Hanger Prosthetics & Orthotics

Table of Contents

Introduction

Choosing the appropriate prosthetic components for a patient presents prosthetists with a difficult task. This is largely attributable to the huge variety of components that a prosthetist must select from. Prosthetists must also consider many patient factors--including a patient's weight, activity level, amputation level, residual limb length, shape, and condition--before selecting components. Quite often, prosthetists experiment with a variety of components over a course of time, and depending on their success or failure with these components, and other factors, like price and availability of the components, they settle upon a limited selection of components that are used predominately in their practices. Times may arise, however, when components from this selection may not best suit the needs of a particular patient. Unfortunately, on many occasions prosthetists provide patients inappropriate components from this predetermined assortment of components.

Pin locks are one such category of prosthetics components that may prove difficult for prosthetists to choose from. Currently, there are well over one hundred pin locks available, and each year new pin locks are introduced on the market. It is imperative that I emphasize early on that *there is no one best pin lock*! Each pin lock has certain features that may be advantageous or disadvantageous for a specific patient.

This reference manual will provide prosthetists with a variety of information on the majority of pin locks currently available. This paper *does not* include lanyards. It is my hope that the following information will assist prosthetists in their selection of pin locks so that they may better serve their patients. Likewise, information from this paper can assist prosthetic students in their education and provide pin lock manufacturers with feedback so that they may perhaps make possible improvements to current pin lock models within their inventory.

General Advantages and Disadvantages of Pin Locks

Advantages:

1) Secure and simple primary or auxiliary method of suspending the prosthesis.

2) No need for a suspension sleeve when utilizing a pin lock. Suspension sleeves often bunch-up, especially in the popliteal fossa. This creates a nuisance for below knee amputees by inhibiting knee flexion, particularly during sitting. Also, patients with poor hand dexterity and/or

strength often have trouble donning suspension sleeves. Despite the drawbacks of suspension sleeves, they remain a good choice of auxiliary suspension in conjunction with a pin lock.

3) Pin locks are less cumbersome than several other forms of suspension, such as supracondylar cuffs, thigh corsets, silesian belts, and TES belts. Like suspension sleeves, these other forms of suspension are frequently used in conjunction with a pin lock for auxiliary suspension.

4) Donning and doffing a prosthesis with a pin lock is quick and easy. In contrast, donning and doffing a prosthesis that incorporates one of several forms of suction suspension (such as Otto Bock's Harmony® System) typically requires more time and effort because of the additional sleeves, gaiters, lotions, etc., that must be applied when donning and rolled-down when doffing. Sufficient hand dexterity to donn a locking liner is necessary, however.

5) Many pin locks produce audible feedback when engaging the locking mechanism, thereby reassuring the patient that the prosthesis is in fact securely attached to their limb. This is especially beneficial for blind patients, patients with poor sight, or patients who are insecure about their prosthesis remaining suspended.

6) The large variety of pin locks allows prosthetists to employ this form of suspension to a wide range of patients.

Disadvantages:

1) Distal tissue stretching, or "milking," and pistoning of the prosthesis are both associated with pin lock usage. Not only can milking permanently elongate distal tissue and augment pistoning, but it can lead to pain, particularly along the tibial crest and cut end of the tibia among transtibial amputees and cut end of the femur among transfemoral amputees. Distal tissue elongates as milking occurs during swing phase on the prosthetic limb. As a result, the subcutaneous tissue that pads the cut end of a bone or bony ridge is stretched, and padding is therefore reduced. The tissue may even be pulled taught over a bony ridge or cut end of a bone, which in itself can be painful. Excessive and prolonged milking may even create an invagination, typically along or near an anterior suture line, or in the worst case, reopen a suture line.

Distal tissue stretching and pistoning are actually the result of longitudinal stretching of a patient's locking liner, and both are therefore indirectly associated with pin lock usage. Over the past several years, several prosthetic manufacturers have improved liner matrices, limiting longitudinal stretching of liners. The result has been a reduction in the occurrence of distal tissue stretching and pistoning of the prosthesis.

2) Almost all locking liners incorporate a distal umbrella. Distal residual limb pain sometimes results from weight bearing upon the hard umbrella at the distal end of locking liners. This is particularly common if the distal end of a positive mold is excessively reduced during modification. A second problem is that continuous weight bearing upon an umbrella tends to wear out the distal end of a liner and, eventually, the rim of the umbrella can perforate a liner's gel. Umbrellas also make it difficult for prosthetists to achieve total contact fits, especially among patients with pointed, bony distal ends.[1] To ameliorate this problem, some companies, such as Ohio Willow Wood, have developed liners with smaller umbrellas, and some companies incorporate umbrellas with more flexibility and cushioning.

3) Although donning a prosthesis with a pin lock is typically quick and easy, some patients have trouble aligning the pin with the plunger pin hole. This is particularly common

[1] http://www.owwco.com/Content/OWW/en-US/pdf/Newsletter/PM2000_Fall.pdf

among patients with poor flexibility, strength, and/or manual dexterity.[2] Often, a patient forcefully slams his or her limb into the socket in an attempt to engage the pin with the pin lock. As a result, "the threaded metal insert in the distal umbrella can be forced out of the umbrella and into the liner (or perhaps even into the patient's limb!)."[3]

Several other reasons why it may be difficult to engage a pin with the locking mechanism include the following:

A) The locking mechanism is corroded or jammed with debris.

B) The pin is too short.

C) The liner provided to the patient has a very small umbrella, or no umbrella at all. This may result in a flaccid and wobbly distal end of the liner, which causes the pin to deflect away from the plunger pin hole and repeatedly crash into the distal end of the socket when the patient attempts to engage the pin lock.

D) If a patient has excessive redundant tissue, the end of the liner may be flaccid too.

E) The patient donns the liner incorrectly. Often, the patient donns the liner with the pin skewed. Also, it is common for patients to donn the liner with a large air pocket between the distal end of their limb and the liner. This also causes flaccidness in the distal end of the liner. A prosthetist must emphatically and often repeatedly explain to a patient how to properly donn a locking liner. The liner must be completely rolled out before the patient attempts to donn the liner, and once the liner is donned, the pin should not lay at an awkward angle. If the pin is excessively skewed, the patient should re-donn the liner. Some patients, however, have residual limbs that slant quite dramatically. It may be common in these situations for the pin to appear skewed, but in fact the pin is at an optimal angle for engaging the pin lock.

F) On occasion, it is difficult for a patient to engage a pin lock if their residual limb has increased in volume. The patient simply cannot get their limb down far enough into the socket to successfully slide into the pin lock.

Specific pin lock manufacturers now offer features on their pin locks and an assortment of components that make it easier for the patient to engage the pin with the pin lock. Perhaps the most common of these features are called guide grooves. These are radial grooves on the top of the pin lock that help direct/funnel the pin towards the plunger pin hole. Prosthetic Design, Inc. (PDI) and Bulldog Tools, Inc. both offer locks with guide grooves. PDI also offers a device called the Rendezvous® Plunger Pin, which is a self align-able plunger pin. It is essentially a rastered pin attached to a ball-and-socket/swivel joint. This device can interface with many popular silicone liners. Although the Rendezvous® Plunger Pin assists patients in engaging a pin lock, it adds ¾" to the distal end of the liner.[4]

Bulldog Tools, Inc. manufactures another device called the "Hole in One" that is used to help patients engage a pin with the pin lock. This device consists of a rastered pin with a hole at its distal end, and attached to this hole is a long, flexible, plastic rod. This plastic rod easily locates and inserts into the plunger pin hole, and once the pin is engaged, the plastic rod rests within the hollow cavity of the pylon. The flexible pin used with Fillauer's Gator Grip Lock is yet another device used to help patients easily engage a pin lock.

[2] http://www.virginiaprosthetics.com/files/30_37.pdf
[3] http://www.owwco.com/Content/OWW/en-US/pdf/Newsletter/PM2001B_Spring.pdf
[4] http://www.prostheticdesign.com/cms_attacs.html

4) Fabrication time and difficulty can increase with the incorporation of a pin lock. These two factors vary greatly depending on the complexity of the pin lock model and the fabrication method recommended by the manufacturer. In many cases, however, incorporating a pin lock into a prosthesis actually cuts down on fabrication time and complexity when compared to the incorporation of other suspension methods.

Although many pin locks can be incorporated into a prosthesis using a single/one-shot lamination, others require a double lamination. The benefit of a double lamination is the ability to incorporate alignment changes, particularly linear adjustments (discussed later), fairly easily into the prosthesis. The disadvantages of a double lamination are a significant increase in fabrication time, an increase in the amount of material needed to fabricate the socket, and an increase in the weight of the socket as a result of this additional lay-up material.

5) Pin locks range widely in price but can be fairly expensive. Unfortunately, many pin lock kits only come with one pin. Because most patients have at least two liners, the prosthetist must order an extra pin to be fitted with the second liner. Despite their simple appearance, pins can be expensive too; especially those that have extended wear characteristics or extra features that benefit certain patients. While choosing the best-suited components for a patient should be the principal factor in selecting a pin lock, cost is unfortunately a major factor for many prosthetists when choosing a pin lock.

6) Pin locks can emit undesirable noise, such as clicking, squeaking, or air expulsion, while the patient is ambulating. There are many techniques used to limit this noise, such as the placement of a foam washer over the pin or push button/latch pin. Several pin lock kits include foam washers that are specifically used to limit noise. Although controlling noise from a pin lock is typically easy, in some situations it can be very difficult to pinpoint undesirable noise coming from a pin lock.

7) Pin locks have several disadvantages in comparison to suction suspension. The advantages of suction suspension over pin locks include the following:

A) Suction increases proprioceptive feedback from the prosthesis. Patients who have tried both pin locks and suction suspension frequently express the opinion that a prosthesis suspended by suction suspension feels more intimately attached to their body when compared to a prosthesis suspended by a pin lock.

B) Because suction produces an intimate socket fit, a greater sense of stability within the socket is achieved, especially since pistoning and rotation of the socket—two problems associated with pin lock usage--are better controlled.

C) Although prostheses incorporating pin locks are often lighter when compared to prostheses incorporating suction suspension (Harmony®, in particular), patients often sense that a prosthesis suspended by suction feels lighter than a prosthesis suspended by a pin lock. This can also be attributed to the intimate fit and excellent weight distribution of the prosthesis created by suction suspension.

D) Suction suspension can decrease pain associated with pin lock usage by distributing the weight of the prosthesis over a broad area. This minimizes pressure and moments acting between the prosthesis and specific points on the patient’s residual limb. In contrast, the weight of a prosthesis suspended by a pin lock is more localized. Although some of the weight of a prosthesis with a pin lock is suspended over anatomical landmarks, much of the weight lies at the juncture between the patient’s liner and the pin lock, and therefore, the center of mass of the prosthesis is drawn distally (similar to a pendulum). This juncture may also act as a "pivot point" about which the prosthesis can rotate (in all planes), causing discomfort. As an example, a patient I recently saw that has tried both suction and pin lock suspension described wearing a prosthesis suspended by a pin as similar to having a weight tied around one's ankle. The patient explained that if the socket ever became loose, it rotated about the juncture of the liner and pin lock in the sagittal plane, resulting in distal tibial pressure. He did not experience any such rotation problems with his suction socket, and this prosthesis (although heavier than his pin lock prosthesis) felt much lighter because of the excellent weight distribution provided by suction.

E) Volume fluctuations of the residual limb are common among patients who wear a prosthesis with a pin lock. Stump socks and other volume reduction methods, such as padding specific areas of the residual limb, are often necessary for the patient. In contrast, some forms of suction suspension (once again, Harmony®, in particular), curtail volume fluctuations, reducing or eliminating the need for volume control management.

Over the past few years several locks combining both suction and pin lock suspension have appeared on the market. A few examples of these hybrid locks include the Coyote Air Lock™ , Fillauer Clutch Lock with Air Expulsion, and Ohio Willow Wood G-Lock. These hybrid locks, which combine the advantages of pin lock and suction suspension, will be discussed in further detail shortly.

8) Over time, pin locks deteriorate in various ways. Common problems include:

A) Rusting of the unit. Some pin locks are far more resistant to corrosion than others, however. There are even a handful of pin locks that are salt-water proof.

B) Jamming of the push/pull button (aka. latch pin, release button).

C) Wear of the plunger pin hole and/or lock mechanism. This is commonly referred to as "egging" of the lock. Most egging results from two types of motion:

1) Axial/longitudinal motion: When the patient attempts to engage the pin with the locking mechanism, the pin shears against the plunger pin hole, essentially replicating a sawing action. This is common along the posterior aspect of the plunger pin hole. Often, hairline fractures can be seen running along the egged-out portion of the plunger pin hole. Egging is most common with clutch locks. Since the serrations on a clutch pin are blunt and not sloped they can wear away the plunger pin hole quite significantly over time. Fortunately, many locks have reinforced plunger pin holes to prevent egging. New, stronger materials with improved wear characteristics are also increasingly being used to construct pin locks.

2) Deflection: Once the pin is partially or fully engaged in the pin lock, the pin deflects against the plunger pin hole. This abrasive motion can be likened to a pipe-reamer deburring the inner lip of a prosthetic pylon. A test can be performed on pin locks to indicate how much of an effect deflection will have on the longevity of a plunger pin hole. The examiner should place the pin one or two "clicks" into the locking mechanism. The pin lock body should be held firmly in place. For all of the pin locks, a specified amount of deflective force should be applied to the proximal aspect of the pin, as if pulling or pushing on a lever. The more the pin

deflects for a specific pin lock, the more significant and damaging effect deflection will most likely have on the plunger pin hole for that pin lock.

D) Pin Wear. This is associated with pins that have serrations along their length. Over time, one or more serrations may simply grind down. This can result in several problems, especially undesirable noise and pistoning of the prosthesis.

E) Improper function of the pin lock due to the accumulation of dust, dirt, and other debris within the lock.

F) The push/pull button may come loose, even when secured with loc-tite®.

9) Difficulty in disengaging the pin from the pin lock. Stories of patients using a frying pan to smash in their push button to release the pin are not unheard of. The principal reason why a pin and push/pull button jam is because foreign material (mainly cloth) gets caught in the locking mechanism. This is common with patients that cut holes in stump socks which did not originally have holes.[5] It is important for prosthetists not only provides the patient with holed-stumped socks, but to instruct their patient how to properly donn stump socks over a locking liner so that this problem can be averted and so the patient can avoid the mistake of snagging and ripping their stump socks (an expensive mistake). This problem can be corrected easily by using pin locks with good serviceability.

Inability to release the pin from the pin lock is sometimes caused by over-tightening screws on the unit.

Sometimes, it may be difficult for a patient to disengage the pin when there is pressure on the gear/locking mechanism, when the mechanism is worn, or when the serrations on a pin have worn out. In some instances the patient must push some weight into the pin lock to ease doffing.

Also, geriatrics, patients with weak hand strength, arthritis, and/or poor flexibility may have trouble reaching or activating a push/pull button. Some companies offer oversized knobs that can be attached to the push/pull button to help these patients easily activate the button. Another solution is offered by Creative Components. Their Loc-n-Load™ pin locks incorporate a patented push button design that limits jamming and allows patients to easily activate the button to disengage the pin from the pin lock.

10) Faulty fabrication: In the event the pin lock is incorrectly fabricated into the prosthesis, several problems can arise. These include, but are not limited to, the following:

A) The push/pull button jams, making it difficult for the patient to engage or disengage the pin into or from the pin lock.

B) Undesirable noise.

C) If inadequate depth in the distal end of the socket is provided for the pin, the patient could literally weight bear directly onto the proximal end of the pin every time he or she took a step. It is critical that the prosthesist ensures a full length pin can slide completely down into the lock before the patient donns the prosthesis for the first time. If this is not achievable then either the lock must be removed so that a deeper hole can be drilled into the distal end of the socket to provide more space for the pin, or the pin must be reduced in length.

D) In a few cases the distal plate for the pin lock is manufactured in such a way that the practitioner or technician cannot always make their laminations strong enough.

E) Faulty performance of or breaking of the pin lock because of over-torqued screws.

[5] http://www.lists.ufl.edu/cgi-bin/wa?A2=ind0010&L=oandp-l&F=&S=&P=9343

11) While pin locks are able to offer a fairly secure and simple form of suspension, they do not provide good rotational control.

12) Alignment: Many pin locks restrict alignment changes after being fabricated into a socket. Linear adjustments are especially subject to limitation. Pin locks that incorporate a standard European 4-hole pattern exemplify how linear adjustments can be restricted. With these locks, the pin typically falls directly through the center of the pin lock, and then through a pyramid with a center hole. If a test socket is transferred into an alignment jig (Fig. 1), and then the prosthetist decides to make a linear adjustment in the sagittal plane, coronal plane, or both planes, the most conventional way to maintain the relationship between the distal end of the socket (where the pylon attaches to the pyramid) and the foot is by leaning the pylon (Fig. 2):

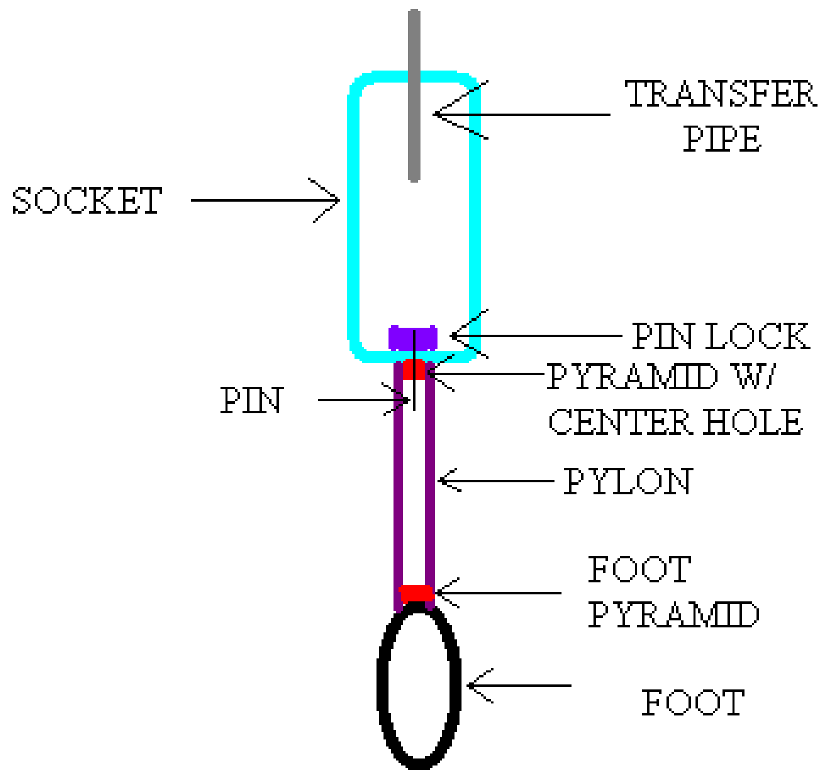


Fig.1: Prosthesis is set up in transfer.

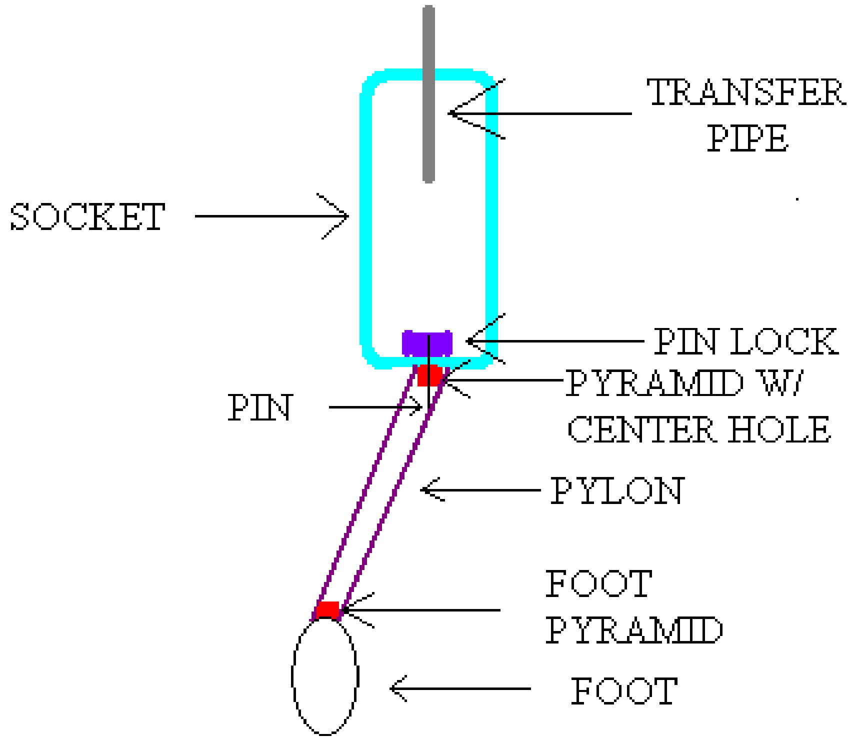


Fig. 2: If liner adjustment is desired, pylon must lean.

When a prosthetist utilizes a pin lock in which linear adjustments are not easily made, it is important that both the prosthetist and patient are completely satisfied with static and dynamic alignment before proceeding to a definitive socket. Luckily, if pin lock alignment problems arise a number of linear and angular adapters are available for purchase that can be fit with a variety of pin locks, including those that incorporate a standard European 4-hole pattern. Use of an eccentric/offset adapter is one method of making linear adjustments among prostheses incorporating a pin lock with a standard European 4-hole pattern, but this method is not without its disadvantages. Since the pin can no longer fall directly through both the plunger pin hole and the center hole of the pyramid, the pin must either be cut down so that it extends no further than the depth of the plunger pin hole, or an extra short pin must be ordered (Fig. 3). Drilling a hole in the pyramid adapter for the pin to pass through is *not* recommended because this may void the warranty on the adapter and/or weaken the structural integrity of the adapter.

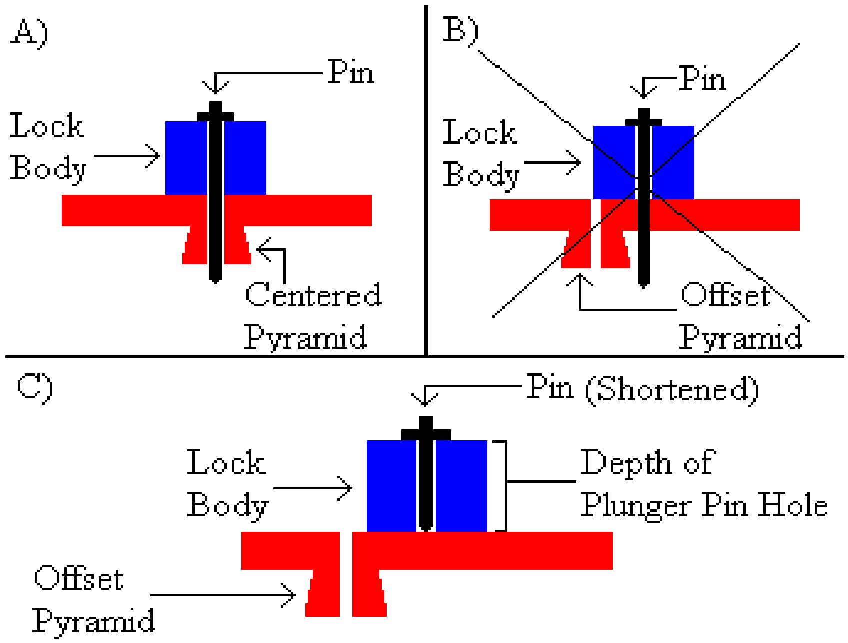


Fig. 3: In A) the pin passes freely through the center hole of the pyramid, which is itself centered directly below the plunger pin hole of the pin lock. If one attempts incorporating an offset pyramid, as in B), the pin can pass freely through the plunger pin hole, but can no longer pass through the pyramid. In this situation, an offset pyramid could *not* be used. If, however, the pin is shortened (or an extra short pin is ordered) so that its maximum length is no longer than the depth of the plunger pin hole, as in C), then an offset pyramid can be utilized.

In contrast, pin locks that do not have pins that fall through a pyramid with a center hole may allow slight linear changes. To correct this problem the prosthetist can (a) transfer the socket into an alignment jig (Fig. 4); (b) perform a first/primary lamination and place the socket back into the alignment jig (Fig. 5); and (c) make a small linear change and then bond a pronged pyramid adapter to the distal end of the pin lock (Fig. 6). The result is that no lean in the pylon is required to accommodate the linear adjustment.

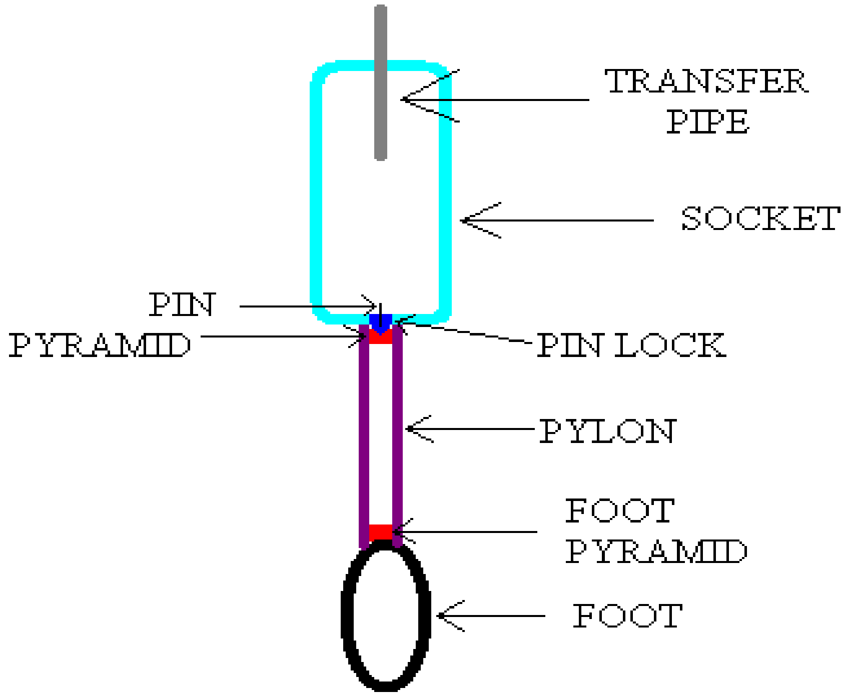


Fig. 4: Socket is placed into transfer

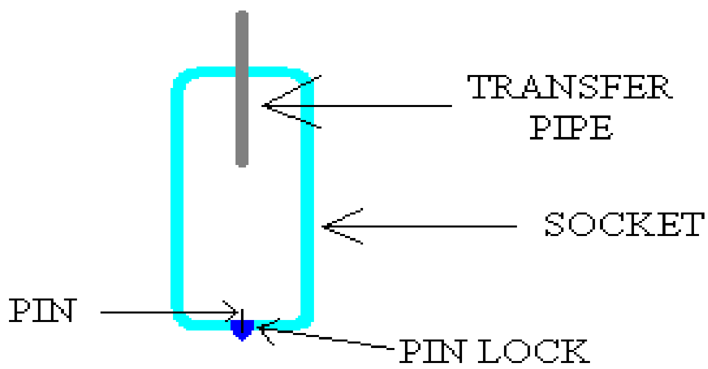


Fig. 5: Socket placed back into transfer after first/primary lamination

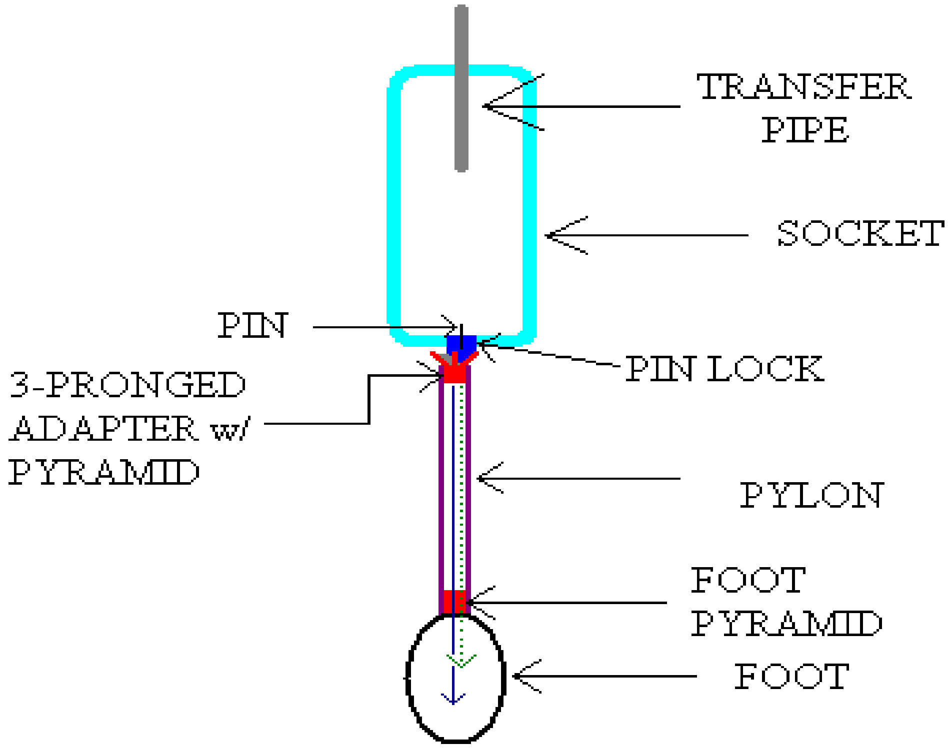


Fig. 6: Pin lock bonded to 3-pronged adapter w/slight linear adjustment. Pylon remains vertical. Dotted vertical arrow represents center of pin lock/socket and solid vertical arrow represents center of pylon. Space in between two lines represents distance of linear adjustment.

Fabricating a pin lock into a transfemoral socket can be particularly challenging for prosthetists if there are length offset (linear adjustment) conflicts and/or if the patient has a flexion contracture. One ingenious solution to this problem is the flexion lock adapters and RapidFit® Flexion Integrated Lock manufactured by Bionix® Prosthetic solutions. The RapidFit® Flexion Integrated Lock incorporates length offset and preset flexion angle into the design of the lock, both of which help to place the pin lock in a suitable position beneath the socket. Prosthetists can chose from one of three preset angles when purchasing the RapidFit® Flexion Integrated Lock: 5º, 10º, and 15º (Fig. 7).[6] The AK Loc-n-Load™ by Creative Components is another pin lock that addresses length offset and flexion contractures alignment problems associated with transfemoral sockets. This lock is preflexed at 4.5º and has a posterior offset of 5/8” (15 mm) to facilitate alignment of the leg.[7]

[6] http://www.bionixps.com/Pages/ProsFrameset.html
[7] http://www.spsco.com/press/09-13-02b.html

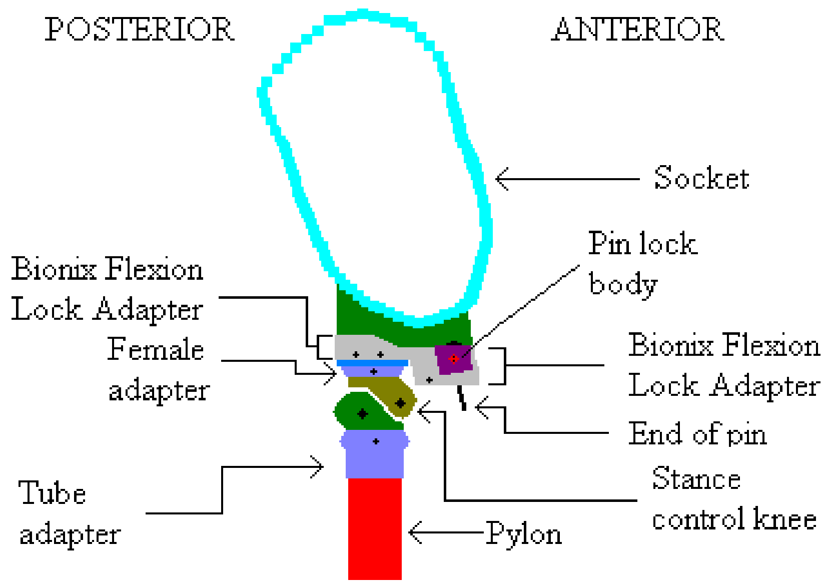


Fig. 7: Schematic diagram of AK prosthesis setup utilizing Bionix® Prosthetics Solution's Flexion Integrated Lock for AK Sockets.

Bulldog Tools, Inc., PDI, and several other manufacturers also provide various flexion and/or offset mounting plates to facilitate alignment of their pin locks when incorporating them into an AK socket or the socket of a patient with a flexion contracture.

13) A serious problem with pin locks is inadvertent release of the pin from the pin lock. If the prosthesis falls off the patient may be embarrassed if they are around other people, and/or might be injured if they fall or trip. Accidental disengagement is rarely the result of the patient overpowering the pin lock, thereby ripping the pin from the pin lock. Rather, unintentional release typically occurs when the patient accidentally knocks against the push button.

Several companies offer pull buttons to be used with specific pin lock models from their inventory. Pull buttons minimize inadvertent release of a pin from a pin lock since knocking against them will not release the pin. Bulldog Tools, Inc. also offers a patented push button safety feature on its ball bearing locks to prevent accidental disengagement of a pin from a pin lock. Once the pin is engaged with the pin lock the patient turns the push button 90º. The push button locks and the pin is held firmly in place 360º by 8 ball bearings.

On some occasions a patient may even prefer that the push button be incorporated into the lateral, rather than medial side of the socket to minimize the risk of inadvertent release of the pin from the pin lock. This is especially important if the patient is involved in activities where a medially mounted push button increases the risk of inadvertent release, such as riding a horse. This approach may reduce cosmesis, however, because push buttons tend to be hidden slightly better when fabricated into the medial side of the socket.

A worn pin also can result in accidental disengagement from the pin lock. It is important that a prosthetist replace a patient's pin if it exhibits excessive wear.

14) Serviceability: Serviceability is arguably the most important factor when choosing a pin lock. Pin locks range widely in serviceability. Some pin locks are completely serviceable and most or all of their components can be easily replaced. For example, *top loading* pin locks allow effortlessly access for repairs or replacements. *Modular* pin locks (pin locks that are mounted outside of the socket that usually incorporate a standard European 4-hole pattern) are another example of pin locks with good serviceability characteristics.

Some pin locks are partially serviceable and can only be partially replaced, and some are, unfortunately, hardly serviceable at all. It may be necessary to fabricate an entirely new socket in situations where a poorly serviceable pin lock malfunctions or wears out.

15) Clearance: Pin locks can add significant length to the distal end of a socket, and therefore, clearance problems can arise if the prosthetist does not select appropriate componentry.

Pin locks are not commonly used among patients with knee disarticulations or Symes amputations because prosthetists typically opt to suspend the prosthesis over the anatomy of the patient, such as the malleoli or femoral condyles. But in situations where the patient's amputation is just proximal to the disarticulation level, or where bony prominences utilized for suspension have been shaved off, such as a Gritti-Stokes amputation, prosthetists must carefully select a pin lock if they decide to use this form of suspension.

There are a number of pin locks that remain an excellent choice when fitting a patient with a long residual limb. Some pin locks incorporate 3 or 4-pronged adapters that accommodate the end of long residual limbs well, and many pin locks have extremely low profiles. One lock in particular, the Coyote Summit Lock™, does not even attach to the distal end of the socket, but rather along the lateral or anterior aspect of the socket. The Summit lock resembles a roller blade buckle or ski buckle assembly rather than a traditional pin lock. Because the Summit Lock™ does not attach to the distal end of the socket, clearance is irrelevant with this lock.

Another new and innovative form of suspension that adds very little length to the distal end of a socket is Keep it Simple Suspension, or KISS®. With KISS®, a velcro strap attached to the distal end of a liner feeds through a short docking base at the distal end of a socket and then out of the socket. Then, the strap feeds through a buckle that is also attached to the liner, but more proximally. A hole is cut in the proximolateral aspect of the socket for the buckle to exit. Through a pulley action, the patient pulls him or herself into the prosthesis and then fastens the velcro. Although KISS® is by no means a pin lock, it is worth mentioning because of its slight resemblance to a Summit Lock™. KISS®, which up to this point has been developed mainly for transfemoral amputees, provides an easy and secure form of suspension that virtually eliminates pistoning and socket rotation.

16) Cosmesis: Although a foam cover can usually conceal a pin lock, pin locks with long push/pull buttons may protrude undesirably through the side of the cosmetic cover. Certain pin locks offer push/pull buttons that can be sanded or cut down to reduce this protrusion, but many pin locks do not, thereby jeopardizing cosmesis. In contrast, push buttons that are too short can create an indention in the prosthetic skin. To reduce this divot, one can glue a round foam piece to the end of the push button to make the push button more flush with the contours of the cosmetic cover.

Several manufacturers offer knob extenders and a variety of push button lengths, both of which can be useful in obtaining an optimal push button length.

17) Weight: All pin locks add weight to the prosthesis. The weight range for pin locks varies widely--from a few dozen grams to a few hundred grams. Heavier locks tend to be more rugged than lighter locks, but this is not always the case.

Pin Styles

Pins, also known as plungers or lock rods, come in several main styles (Fig. 8). When ordering a pin for a pin lock, the prosthetist must bear in mind that pins for one specific pin lock often come in a variety of lengths (sometimes referred to as "barb length") and widths. Selecting a shorter pin length may be necessary when clearance is an issue for the patient. In situations where a shorter pin is not available, cutting a longer pin and shaping its distal end or burrowing a deeper hole in the distal end of the socket to accommodate the pin remain optional. With many locks, however, pin length, regardless of how long the pin is, does not present a problem. Rather, the pin passes directly through the pin lock, socket, and adapter on the distal end of the socket (i.e. pyramid adapter, female adapter, etc.). Any extra length of pin simply protrudes into the hollow cavity of the pylon.

When selecting a pin, there may be one of several thread specifications to choose from (i.e. metric vs. standard English measurements) in order for the pin to appropriately screw into a liner. The most common thread measurement currently being used is 10 mm. ¼" is another common thread measurement. If the wrong thread specification is ordered for a pin, it is possible to order pin adapters from some companies that can reduce or increase the thread measurements.

While many pins appear as if they can be used with a variety of pin locks, prosthetists should only use a pin with the pin lock that it was specifically manufactured for. Sometimes a pin may look as if it will adequately fit a pin lock, when in fact it varies slightly from the manufacturer-recommended pin. These slight differences can substantially affect the fit of the pin with the pin lock and wear of the pin lock.

Pins are constructed of various materials, including stainless steel, chrome-flashed steel, titanium, and acetyl. Certain materials help reduce wear of both the lock and/or the pin. The following types of pins are commonly used:

1) Rastered Pin (aka. ratchet or shuttle pin): Rastered pins have sloped serrations along their shaft. They are used with shuttle locks.

2) Clutch Pin (aka. geared pin): Clutch pin also have serrations, but they are not sloped. Rather, the serrations lay perpendicular to the longitudinal axis of the pin's shaft. Clutch pins are used with clutch locks.

3) Smooth Pin (aka. plain pin): Smooth pins have no serrations along their shaft. They are used with smooth locks.

4) Ball Bearing Pin: Ball bearing pins are similar to rastered pins in that they have sloped serrations, but the serrations on a ball bearing pin are not as pronounced. These pins are used for ball bearing locks, which will be considered a subgroup of shuttle locks throughout this manual (with the exception of gator grip locks).

5) Gator Grip Pins: Fillauer offers two types of pins to be used with their Gator Grip locks: a smooth pin and flexible pin. The smooth pin is unique in that it has an indentation towards the end of the pin that produces one audible "click" when the patient engages the pin lock; therefore, this pin combines the advantages of a smooth pin and a specific advantage of rastered pins: audible indication that the pin has engaged the locking mechanism. The flexible pin is also exclusive to the Gator Grip Lock. Similar to other ball bearing pins, this pin has small

serrations along its length to accommodate the ball bearings within the locking mechanism. This pin is a good choice for patients that may have difficulty engaging the pin lock because the pin's flexibility allows it to easily access the plunger pin hole.

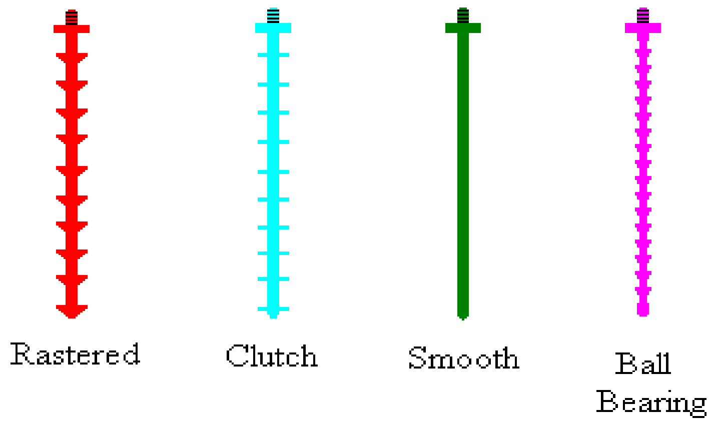


Fig. 8: Various pin styles

<u>Pin Lock Styles</u>

Pin locks come in several main styles, but the specific designs for locks within each of these main styles differ significantly. Many pin locks include various adapters—such as pyramids, 4-hole adapters, 3 and 4-pronged lamination adapters, and mini-pyramids—on their distal or proximal ends. Some manufacturers include these adapters as part of the off-the-shelf/standard model, and some manufacturers provide the option of adding one or more of these adapters to a pin lock upon purchase. Prosthetists should keep in mind that the addition of such adapters will add to the weight and height of the pin lock. Also, the addition of adapters can raise the price of the pin lock and influence its weight limit.

1) Shuttle locks (aka. ratchet lock, push-in lock, or push lock): Shuttle locks are the most prevalent style of pin locks. When a rastered pin enters the locking mechanism, the sloped distal edged of a serration pushes aside the locking mechanism. Once the entire serration has moved past the locking mechanism, the mechanism springs back into its original position. The flat, proximal edge of a serration cannot push aside the locking mechanism as the angled edge can, and therefore, the pin is inhibited from lifting up through the locking mechanism. Only when the push/pull button is engaged will the locking mechanism again move aside to release the pin (Fig. 9).

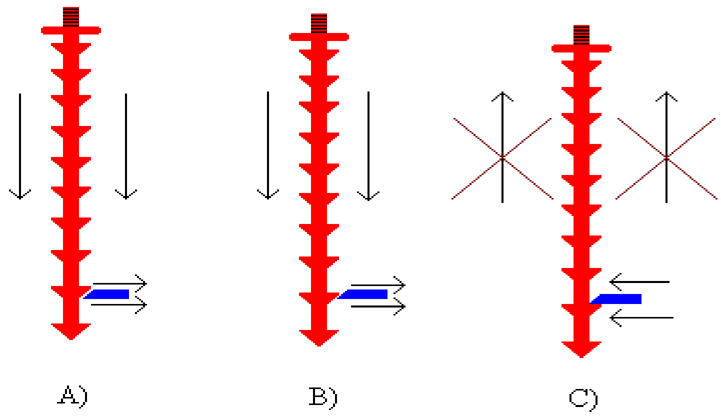


Fig 9: The sloped distal end of a serration on a rastered pin pushes aside the locking mechanism (blue) in A) & B). The locking mechanism springs back into place above the serration in C), prohibiting the pin from moving proximally.

The advantages of shuttle locks include the following:

A) They produce an audible “click” when a patient engages the pin lock. This is a strong advantage for patients that desire the confidence of knowing that they are locked securely in the pin lock.

B) No key is required to help the patient wind down fully into the lock.

C) Widest variety among pin locks to choose from.

The disadvantages of shuttle locks include the following:

A) There is sometimes slippage/play between two of the serrations. This can result in slight pistoning of the prosthesis and undesirable noise. Often, this results when one or more of the serrations wear out over time.

B) The serrations on the pin replicate a sawing action every time the patient engages the pin lock. This results in a slow, gradual wear of the plunger pin hole (egging).

C) Undesirable noises, like clicking, rushing air, or squeaking, are sometimes emitted while the patient ambulates, even if the pin is in good condition.

2) Clutch locks (aka. geared lock, pull-in lock, or pull lock): Clutch locks incorporate a one-way gear mechanism to help engage and lock the pin in place. When the pin enters the gear mechanism, the cogs at one end of the mechanism align with the serrations on the pin, similar to how gears on a clock interconnect with one another (Fig. 10). The gear mechanism is encircled by several adjacent bushings lined with roller bearings (aka. linear bearings), or a combination of rotary and linear bearings. These linear bearings allow the gear mechanism to rotate freely in one direction, but disallow rotation in the opposite direction because some of the bearings have canted surfaces (Fig. 11). Since the gear mechanism only rotates in one direction the pin cannot lift from the mechanism until the push/pull button is engaged. This moves the gear mechanism away from the pin.

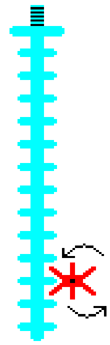


Fig. 10: Gear at end of gear mechanism engaging a geared pin. The gear mechanism only rotates in one direction, prohibiting the pin from lifting up and out of the pin lock. Only when the push/pull button is operated will the gear mechanism slide away from the pin.

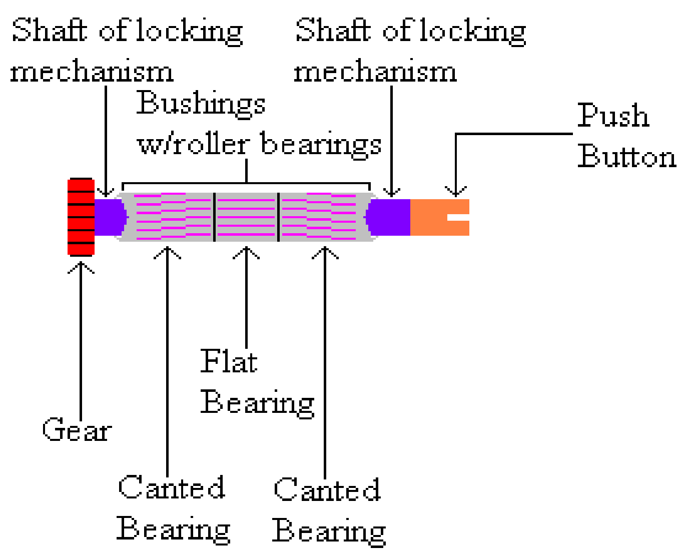


Fig. 11: Gear mechanism and surrounding bushings with roller bearings.

The advantages of clutch locks include the following:

A) Infinitely adjustable.

B) A patient can engage the pin with the pin lock in a sitting position by using a key or a coin. The ability to wind the limb into the socket is also helpful for patients with excess residual tissue.[8]

The disadvantages of clutch locks include the following:

A) With many clutch locks, there is no audible feedback when the patient engages the pin lock.

B) Clutch lock cartridges (aka. gear, lock, locking, or clutch mechanism) tend to rust easily and therefore should not be exposed to wet environments.

C) Compared to shuttle locks, there is generally a higher rate of maintenance with clutch locks because they fail fairly quickly once gunk and grime accumulate in and around the locking mechanism.

D) The serrations on the pin can actually replicate a sawing action every time the patient engages the pin lock. This results in a slow, gradual wear of the plunger pin hole. A clutch pin tends to wear out a plunger pin hole more *quickly* than a rastered pin does.

3) Smooth locks: Smooth locks typically incorporate a locking mechanism with ball bearings. Several ball bearings lay within channels that gradually slope outwards (away from the center of the plunger pin hole) as you move distally along their lengths. When the pin engages the locking mechanism, the ball bearings rest at the bottom of these channels and, therefore, as far away as possible from the center of the plunger pin hole and outer edge of the pin. When one attempts to lift the pin up from the locking mechanism, however, the pin draws the ball bearings upwards to the narrower section of their corresponding channels. This causes the ball bearings to place a tighter "grip" on the pin, preventing the pin from lifting up and out of the locking mechanism. Only when the push/pull button is engaged will the pin lift out of the lock. The push/pull button allows the ball bearings to rest at the bottom of their channels, even while the pin is being lifted up and out of the locking mechanism. Other locking mechanisms exist, however, such as a clamping mechanism that releases when the push/pull button is pressed.

Advantages of smooth locks include the following:

A) The pin silently engages the lock. Some patients prefer no noise when engaging a pin lock. While this may be seen as an advantage by some, others consider it a disadvantage because of the lack of audible feedback.

B) They are infinitely adjustable once engaged in the locking mechanism.

C) Because smooth pins lack serrations they do not produce a sawing action against the pin lock when the patient donns the prosthesis. Egging is therefore minimal and often completely absent with smooth pin locks.

D) Also, because they lack serrations there is no slippage/play along the length of a pin—another problem associated with rastered pins.

E) Undesirable noise is rarely encountered when the patient ambulates.

F) No additional key is required to wind the pin into the lock.

G) They provide "Gentle unlocking, which is ideal for geriatrics."[9]

---

[8] http://www.easyliner.com/sections/sec-locks/locks_s496t.htm

[9] http://eurointl.chainreactionweb.com/catalog/default.php?cPath=141_147&osCsid=aa96de6047a5f993f434a2100eb518aa

The disadvantages of smooth locks include the following:

A) No audible feedback to ensure the patient that they are locked into the socket.

B) Smooth lock cartridges tend to rust easily and therefore should not be exposed to wet environments.

C) Compared to shuttle locks, there is generally a higher rate of maintenance with smooth locks because they fail fairly quickly once gunk and grime accumulate around and in the locking mechanism.

4) Miscellaneous: Several varieties of locks fall within the miscellaneous category. These include suction/pin lock hybrids (i.e. Coyote Air Lock™), Fillauer's Gator Grip locks, and other specific locks that cannot be classified as a shuttle, clutch, or smooth lock (i.e. Coyote's Summit Lock™). These miscellaneous pin locks use a variety of locking mechanisms to secure the pin in place (ie. or buckle in the case of the Summit Lock™), such as shuttle and ball bearing locking mechanisms. Suction/pin lock hybrids typically incorporate a valve within the locking mechanism to help expel air from the socket. Once the air is expelled, the pin forms an intimate fit with the plunger pin hole, prohibiting air from re-entering the socket. Sometimes the pin itself forms this intimate fit, and in some cases, such as with Ohio Willow Wood's G-Lock, a small rubber ring is placed on the proximal end of the pin to create a seal after the pin has fully engaged the pin lock. The advantages of miscellaneous locks include the following:

A) Excellent suspension: Suction/pin lock hybrids and Gator Grips locks both offer remarkable suspension.

B) Because suction/pin lock hybrids incorporate suction suspension, pistoning of the socket is limited. Also, because suction/pin lock hybrids incorporate pin suspension, the need for a suspension sleeve may not be necessary for patients who desire not to wear one. Doing this, however, may jeopardize the suction suspension capabilities of the lock by allowing air to leak into the socket.

C) Excellent durability: Some of the locks within the miscellaneous category are extremely durable. Gator Grip locks, for example, can be exposed to many harsh environments--including freshwater, saltwater, muck, and grime—and still function exceptionally.

D) Volume management: Pin locks incorporating suction may, but not always, decrease the need for volume management since suction suspension can help reduce volume fluctuations.

E) It is possible to completely remove or replace the valve/seal on several suction/pin lock models. This gives the prosthetist the option of suspending the patient's prosthesis with either pin lock suspension only or a combination of suction and pin lock suspension.

The disadvantages of miscellaneous locks include, but are not limited to the following

A) They are frequently, but not always, comprised of more components, making their designs more complex.

B) Fabrication can be more difficult with some of the miscellaneous locks because of their complex designs. For instance, when fabricating a suction/lock hybrid into a socket, the socket must be fabricated very carefully to prevent air leaks. If not, suction capabilities could be jeopardized.

Criteria for Choosing a Lock

Before choosing a pin lock, the practitioner should consider the following:

1) The patient's weight: Most pin locks have weight limitations. Some manufacturers, however, have assigned no weight limitations to specific pin lock models in their inventory because they consider those pin locks to be non-weight bearing components. Several pin locks, most notably those manufactured by Prosthetic Design, Inc., have more than one weight limitation depending on the specific activity level of the patient.

2) The patient's activity level: Active patients place more stress upon a pin lock; therefore, it is important that the practitioner choose a pin lock with good wear characteristics when selecting components for an active patient. If the patient is involved in sports, the practitioner may want to consider a pin lock that is both light and durable in order to keep the prosthesis as light as possible, but able to withstand the demands placed on it by athletics.

3) Patient's hobbies and/or occupation: If the patient is active in harsh environments where the pin lock may be exposed to water, mud, chemicals, and/or other caustic elements, the practitioner should choose a lock with the ability to withstand these destructive elements, yet still function properly. Also, if the patient is involved in activities where accidentally engaging the push button is a risk factor, such as riding a motorcycle, it may be wise to purchase a pin lock with a pull button or a locking push button.

4) The patient's age: When fitting a child with a pin lock a practitioner should bear in mind that there are a handful of pin locks designed for pediatrics. These locks are smaller in circumference and conform well to the small distal end of a child's residual limb. Adolescents, teenagers, and adults have an abundance of pin locks to be fitted with since most pin locks are designed for full-grown adults.

While many geriatric patients are extremely active, practitioners should choose a light pin lock for elderly patients that are inactive and have weak musculature. Elderly patients with poor vision will specifically benefit from a shuttle lock because of the audible feedback produced when the rastered pin engages the pin lock. This will reassure them that they are safely locked into the socket.

5) The patient's amputation level: Many pin locks can be used for a variety of amputation levels, but a number of pin locks are optimal for a specific level of amputation. As an example, the AK Loc-n-Load™ by Creative Components is designed for transfemoral amputees. The lock incorporates a 5/8" posterior offset and is pre-flexed at 4.5º to facilitate alignment of the leg.[10] Several pin locks are also designed specifically for upper extremity amputees.

6) Residual limb length, distal limb circumference and limb shape: Clearance must be considered when choosing a pin lock for patients with long residual limbs. Pin locks can be over 2" in height, and therefore, can significantly affect clearance. In order to fit selected componentry under a pin lock, the prosthetist may have to choose a pin lock with a short body. Fortunately, pin locks with extremely low heights do exist. Coyote's Summit Lock™ is also a good choice when clearance is an issue since it does not add any length to the end of the socket.

Distal limb circumference and limb shape must also be considered carefully when choosing a pin lock. Only a handful of pin locks, such as the AK and BK Loc-n-Load™, come in several circumferences. A pin lock with an inappropriate circumference can jeopardize cosmesis and comfort.

---

[10] http://www.spsco.com/press/09-13-02b.html

Pin locks incorporating proximal 3 and 4-pronged lamination adapters (i.e. Otto Bock's 6A20=20 Shuttle lock) are often a good option for patients with long residual limbs or large distal limb circumferences. After an initial lamination, the prongs of these adapters can be adjusted (with a bending iron) to conform intimately to the distal end of the primary lamination. The adapter can then be bonded to the socket, followed by a second lamination.

7) Flexion contracture(s): If the patient has a flexion contracture the prosthetist may want to consider using a pin lock with flexion incorporated into its design to accommodate the contracture. The AK Loc-n-Load™ and Bionix® Prosthetics Solution's Flexion Integrated Lock for AK Sockets both integrate flexion into their designs. The AK Loc-n Load™ is another good choice for transtibial amputees with a knee flexion contracture. This pin lock must, however, be rotated 180º in order to accommodate a knee flexion contracture.

Many pin locks can be fit with various adapters to make angular or linear adjustments. Bulldog® Tools, Inc. and Prosthetic Design™, Inc. offer a number of flexion, extension, abduction, adduction, and offset adapters that can be used with any lock that accepts a standard European 4-hole adapter. Bionix® Prosthetics Solutions offers two more lock adapters that can be used for a patient with a contracture. The Rapidfit® 12 Hole Lock Adapter comes with three discs that allow the prosthetist to raise the flexion, extension, abduction, or adduction angle to 3º, 5º or 7º. The Rapidfit® Flexion Lock Adapter for AK Sockets can be chosen in either 5º, 10º or 15º of flexion. Once again, both of these adapters can be used with a variety locks from several companies. Many of these adapters place the pin lock in an optimal position for patients with not only flexion contractures, but other alignment issues such as valgus and varus of a residual limb.

Pin locks that can be bonded to the socket following an initial lamination are also good choices for accommodating flexion contractures since the socket can be flexed a desired amount in the alignment jig and then bonded to the lock.

8) Cosmesis: Many patients are very concerned about the cosmetic appearance of their prosthesis. Although most pin locks can be easily concealed by a foam cover or other various forms of cosmesis, a pin lock with too large a circumference, or with an un-modifiable push/pull button that is too long or short may reduce cosmesis. Ordering a pin lock with an appropriate circumference, and with a modifiable push/pull button is favorable in these situations.

9) Hand strength and dexterity: Patient's lacking hand strength and dexterity may benefit from a pin lock that allows easy pin disengagement. A number of companies offer locks that can be fitted with an oversized or extended push/pull button, and there are several locks with push/pull buttons that are specifically designed to limit jams. Both of these can benefit a patient with poor hand strength and dexterity.

It is also important to remember that some patients, especially those with stubby or thick fingers, may have difficulty completely pushing in a push button that is surrounded by a button shield simply because they cannot fit their finger(s) within the button shield. A prosthetist should consider ordering a pin lock without a button shield or grinding down the button shield if this situation is likely to present itself.

10) The patient's definitive prosthesis: What is the design for the definitive prosthesis? Will the socket be laminated or thermoformed, or is the patient receiving an exoskeletal prosthesis? Certain pin locks can be used for all of these applications, while others cannot. It is important that a prosthetist know the applications for which a pin lock can be used before making his or her purchase.

Background on the Pin Lock Chart

The following chart includes a variety of data concerning pin locks. Although the list includes the majority of locks currently available on the market, there is a good possibility that a handful of models have been excluded. All efforts have been taken to include as many pin locks as possible and to ensure that the information concerning these locks is accurate. Pin lock models that are discontinued are *not* included on the chart, nor are lanyards. The following are descriptions of the data that is included on the chart:

1) **Model:** This is the manufacturer's name for the pin lock. Model purchase numbers/codes are *not* included, but in some instances the model purchase number/code happens to be synonymous with the manufacturer's name for the pin lock. Also included in the **Model** column are any specific adapters or features that accompany the lock. These extra features are parenthesized. In several situations, however, certain adapters or features are actually part of the model's name. An example is the "Fillauer Modular Shuttle Lock with Titanium Pyramid." If the adapter or any other special feature is included in the manufacturer's name for the pin lock, then the features are not parenthesized.

2) **Pin Lock Style:** There are several categories of pin lock styles that I have arranged pin locks into for this chart. They include the following:

A) Shuttle
B) Clutch
C) Smooth
D) Miscellaneous: this includes pin lock/suction hybrids, Fillauer's Gator Grip locks, and other miscellaneous styles of pin lock suspension that do not fit appropriately into the shuttle, clutch, or smooth styles of pin locks.

3) **Weight:** This is the weight of the standard/base model *without* the pin. The term standard/base model requires some clarification. Many pin locks include pyramids and other various adapters as part of their standard/base (off-the-shelf) model. For example, the ALPS S496 T has a 4-hole mounting plate as part of its standard/base model. In this situation, the weight listed is the weight of the pin lock, including the 4-hole mounting plate. In contrast, some specific pin locks provide the option of adding on certain componentry to the standard/base model, such as a 4-hole adapter, pyramid, or mini-pyramid. As an example, Ossur's Icelock® 400 can be bought in its standard form, or purchased with one of several components added to the standard/base model, including a 4-hole mounting plate, pyramid, or mini-pyramid. These add-ons obviously increase the weight of the standard/base model. Therefore, in this specific situation the weight listed would be the standard Icelock® 400 without any optional componentry.

Manufacturers usually give the weight of their lock in either ounces or grams. In the chart, the weight of the lock is provided in both ounces and grams. The calculated weight is listed in parenthesis next to the stated weight.

Finally, in a few situations the manufacturers have not established the exact weight of the lock, but rather the maximum weight of the lock. If this is the case then it is indicated with a less than symbol (<) next to the pin lock weight.

4) **Height:** This is the height of the standard/base model. If the pin lock's standard/base model includes a pyramid or another adapter, the height provided is from the top of the lock (rim of the body) to the bottom of the pyramid or other adapter. If the pin lock model includes a proximal 3 or 4-pronged adapter, then the height listed is from the top surface of the *adapter* (not

from the top of one of the prongs, but rather the flat surface of the adapter that makes contact with the very distal end of the socket) to the bottom of lock, pyramid, or other adapter.

Manufacturers usually give the height of their lock in either inches or millimeters. In a few instances, they give the height a lock in both inches and millimeters. In the chart, the height of the lock is provided in both inches and millimeters. Since manufacturers typically only give the height of their lock in one unit of measurement, again, the calculated height for the alternative unit of measurement is shown in parenthesis.

5) **Housing/Body**: This is the material of which the housing/body is made.

6) **Plunger Pin Hole (aka. guide bushing, liner, or pin guide):** In many situations manufacturers reinforce the plunger pin hole of their locks with certain materials--including stainless steel, bronze, anodized aluminum, brass, or titanium—that differ from the material(s) composing the pin lock housing/body. This is done to prevent the pin from wearing out (egging) the plunger pin hole.

The **Plunger Pin Hole** column indicates what reinforcing material is used for the plunger pin hole. The plunger pin hole does *not* refer to the locking mechanism, but rather the hole that the pin goes through to reach the locking mechanism. In many circumstances the plunger pin hole and pin lock housing/body are continuous with one another, and are therefore made of the same material. If this is the case for a pin lock in the chart, it is indicated with **"None"** in the **Plunger Pin Hole** column.

It must be emphasized that a plunger pin hole may still have excellent wear characteristics even though it is not reinforced with a specific material. As an example, consider a pin lock whose housing/body is made of anodized aluminum, but whose plunger pin hole is also made of anodized aluminum. Even though the plunger pin hole is not reinforced with a particular material, anodized aluminum exhibits excellent wear characteristics. Therefore, the prosthetist should not be led to believe that the plunger pin hole has poor wear characteristics simply because he or she sees **"None"** in the **Plunger Pin Hole** column.

There are a few exceptions to the aforementioned guidelines: If the pin lock housing/body is comprised of two or more materials, the *one* specific material reinforcing the plunger pin hole will be indicated in the **Plunger Pin Hole** column, even if that one specific material also happens to be one of the materials comprising the pin lock housing/body. For instance, if the body of the lock is made of both Delrin® and titanium, and the plunger pin hole is reinforced with titanium, "Titanium" is recorded in the **Plunger Pin Hole** column for that specific lock.

It is also possible to replace the plunger pin hole reinforcement bushing on a number of pin locks. This is convenient if the reinforcing material wears out. If the companies indicated this option within their literature, then it is specified in the **Plunger Pin Hole** column.

7) **Application:** This refers to the optimal uses for the lock. Applications include, but are not limited to the following:

Chart Symbol		Application
AK	→	Above knee sockets
BE	→	Below Elbow sockets (excluding other upper extremity levels)
BK	→	Below knee sockets
EX	→	Exoskeletal prostheses
L	→	Lamination
PE	→	Pediatrics
T	→	Thermoforming
UE	→	Upper Extremity sockets

Some locks have specific recommendations for usage that are not listed directly above. If this is the case, those specific recommendations are indicated in the chart.

8) **Weight Limit:** This is the manufacturer's recommended weight limit for the pin lock. The value given is in both pounds and kilograms. In some instances the manufacturer has more than one weight limit for the pin lock to correspond with the patient's activity level. Such instances are noted. In addition, several manufacturers consider some of their locks to be non-weight-bearing components. Therefore, the manufacturers consider these locks to have no weight limit. If this is the case, it is indicated.

9) **Price:** This is the suggested retail price of the pin lock. Many companies receive discounts when buying from specific manufacturers or if they buy in bulk. The price of the lock will fall into one of ten categories:

$ → $50-75.99	$$$$→ $126-150.99	$$$$$$$→ $201-225.99	$$$$$$$$$$ → $276-300
$$ → $76-100.99	$$$$$→ $151-175.99	$$$$$$$$→ $226-250.99	
$$$→$101-125.99	$$$$$$ → $176-200.99	$$$$$$$$$ → $251-275.99	

The Pin Lock Chart

MODEL	STYLE	WEIGHT of STANDARD/ BASE MODEL	HEIGHT of STANDARD/ BASE MODEL	HOUSING/ BODY	PLUNGER PIN HOLE	APPLICATIONS	WEIGHT LIMIT	COST
Alps S496 T (with aluminum 4-hole mounting plate).	Clutch	143 g (5.04 oz.)	45 mm (1 ¾”)	Glass reinforced nylon	None	L, T, AK, BK	None (non-weight bearing component according to Alps)	$$$
Alps S496 W	Clutch	107 g (3.77 oz.)	40 mm (1 9/16”)	Glass reinforced nylon	None	L, T, AK, BK	None (non-weight bearing component according to ALPS)	$$
Alps S498 P (with pyramid).	Clutch	194g (6.84 oz.)	65 mm (2 9/16”)	Glass reinforced nylon	None	L, AK, BK	220 lbs (100 kg)	$$$$
Bauerfeind PI-02 01 70-NEU (salt water proof).	Smooth	94 g (3.32 oz.)	30 mm (1 3/16”)	Delrin®	None	L, AK, BK	265 lbs (120 kg)	$$$$$ $
Bauerfeind PI-02 01 91-NEU	Smooth	N/A	N/A	Delrin®	None	T, AK, BK	265 lbs (120 kg)	$$$$$ $$$
Bauerfeind PI-02 01 92-NEU	Smooth	N/A	N/A	Delrin®	None	L, T, AK, BK	265 lbs (120 kg)	$$$$$ $$$
Bauerfeind ShL1	Smooth	78 g (2.75 oz.)	23 mm (15/16”)	Titanium	None	L, AK, BK	265 lbs (120 kg)	N/A

Bauerfeind ShL2/PI-02 01 07K (optional: 4-pronged pyramid; pyramid adapter; square 4-hole mounting plate; circular 4-hole mounting plate).	Clutch	99 g (3.49 oz.)	38 mm (1 ½”)	Delrin®	None	T, AK, BK	265 lbs (120 kg)	$$$
Bauerfeind ShL3A-1/PI-02 01 07	Shuttle	75g (2.65 oz.)	38 mm (1 ½”)	Delrin®	None	L, T, AK, BK	265 lbs (120 kg)	$$$
Bauerfeind ShL3A-2/PI-02 01 07-see (salt water proof).	Shuttle	86 g (3.03 oz.)	38 mm (1 ½”)	Delrin®	None	L, T, AK, BK	265 lbs (120 kg)	N/A
Bauerfeind ShL3A-3/PI-02 01 07 1	Shuttle	70 g (2.47 oz.)	37 mm (1 7/16”)	Delrin®	None	L, T, AK, BK	265 lbs (120 kg)	N/A
Bauerfeind ShL3B/PI-02 01 07-NEU	Shuttle	60 g (2.12 oz.)	32 mm (1 ¼”)	Delrin®	None	L, AK, BK	265 lbs (120 kg)	$$$
Bauerfeind ShL3C/PI-02 01 07-ARM	Shuttle	30 g (1.06 oz.)	26 mm (1”)	Delrin®	None	L, UE	265 lbs (120 kg)	N/A
Bauerfeind ShL4A/PI-02 01 07-ALU-70 (modular).	Smooth	195 g (6.88 oz)	38 mm (1 ½”)	Aluminum	None	L, AK, BK	265 lbs (120 kg)	$$$$$
Bauerfeind ShL4B/PI-02 07-ALU (modular).	Clutch	210 g (7.41 oz.)	42 mm (1 5/8”)	Aluminum	None	L, AK, BK	265 lbs (120 kg)	$$$$

Bauerfeind ShL4C/PI-02 01 07-ALU-5 (modular).	Shuttle	230 g (8.11 oz.)	42 mm (1 5/8")	Aluminum	None	L, AK, BK	265 lbs (120 kg)	$$$$
Bauerfeind ShL5A/PI-02 01 06-70 (with 3-pronged adapter. Optional: 4-pronged adapter; short 4-pronged adapter).	Smooth	145 g (5.11. oz.)	35 mm (1 3/8")	Titanium	None	L, AK, BK	265 lbs (120 kg)	N/A
Bauerfeind ShL5B/PI-02 01 06 (with 3-pronged adapter Optional: 4-pronged adapter; short 4-pronged adapter).	Clutch	126 g (4.44 oz.)	40 mm (1 9/16")	Aluminum	None	L, AK, BK	265 lbs (120 kg)	$$$$$ $
Bauerfeind ShL5C/PI-02 01 06-MK2 (with 3-pronged adapter. Optional: 4-pronged adapter; short 4-pronged adapter).	Shuttle	113 g (3.99 oz.)	40 mm (1 9/16")	Aluminum	None	L, AK, BK	265 lbs (120 kg)	$$$$
Bionix® Prosthetic Solutions RapidFit® Flexion Integrated Lock Kit (available in 5º, 10º, 15º flexion).	Misc.	257g (9.07 oz.)	68 mm (2 11/16")	Delrin®	None	L, T, AK only (this product consists of a Shuttle lock [shuttle/suction hybrid available too] and lock adapter with length offset and preset flexion angle)	350 lbs (159 kg)	$$$$$ $$$$$

Bulldog® Tools 55 mm Child's Ball Bearing Push Lock (NOTE: *most* bulldog locks are made of an injection molded plastic, which is 35% stronger than Delrin®. 55 mm 4-hole pattern).	Shuttle	(85 g) 3.01 oz.	(21 mm) 13/16"	Injection molded plastic	None	L, T, PE, patients with tapered/conical distal limbs	265 lbs (120 kg)	$$$
Bulldog® 55 mm Child's Ball Bearing Push Lock with Guide Grooves (55 mm 4-hole pattern).	Shuttle	(84 g) 2.96 oz.	(21 mm) 13/16"	Injection molded plastic	None	L, T, PE, patients with tapered/conical distal limbs	265 lbs (120 kg)	$$$$
Bulldog® 55 mm Child's Ball Bearing Push Lock with Safety (55 mm 4-hole pattern).	Shuttle	(85 g) 3.01oz.	(21 mm) 13/16"	Injection molded plastic	None	L, T, PE, patients with tapered/conical distal limbs	265 lbs (120 kg)	$$$
Bulldog® 55 mm Child's Ball Bearing Push Lock with Safety & Guide Grooves (55 mm 4-hole pattern).	Shuttle	(84 g) 2.95 oz.	(21 mm) 13/16"	Injection molded plastic	None	L, T, PE, patients with tapered/conical distal limbs	265 lbs (120 kg)	$$$$
Bulldog® Ball Bearing lock without safety (all other Bulldog® locks include standard 4-hole pattern).	Shuttle	(122 g) 4.29 oz.	(21 mm) 13/16"	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$$$$

Bulldog® Ball Bearing lock without safety, with guide grooves	Shuttle	(120 g) 4.23 oz.	25 mm (1”)	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$$$$$
Bulldog® Ball Bearing Safety Lock	Shuttle	(122 g) 4.29 oz.	25 mm (1”)	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$$$$
Bulldog® Ball Bearing Safety Lock with Guide Grooves	Shuttle	(120 g) 4.23 oz.	25mm (1”)	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$$$$$
Bulldog® 3rd Generation Genesis A (All Genesis locks come with a top loading option).	Shuttle	< 80 g < (2.82 oz.)	25mm (1”)	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$
Bulldog® 3rd Generation Genesis AG (with guide grooves).	Shuttle	< 80 g < (2.82 oz.)	25mm (1”)	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$
Bulldog® Genesis AR	Shuttle	(123 g) 4.32 oz.	25 mm (1”)	Injection molded plastic	Bronze	L, T, AK, BK	350 lbs (159 kg)	$$$
Bulldog® Genesis ARG (with guide grooves).	Shuttle	(120 g) 4.24 oz.	25 mm (1”)	Injection molded plastic	Bronze	L, T, AK, BK	350 lbs (159 kg)	$$$
Bulldog® Genesis B (with safety feature).	Shuttle	N/A	25 mm (1”)	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$
Bulldog® Genesis BG (with safety feature and guide grooves).	Shuttle	N/A	25 mm (1”)	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$

Bulldog® Genesis BR (with safety feature).	Shuttle	(122 g) 4.31 oz.	25 mm (1")	Injection molded plastic	Bronze	L, T, AK, BK	350 lbs (159 kg)	$$$$
Bulldog® Genesis BRG (with guide grooves).	Shuttle	(120 g) 4.24 oz.	25 mm (1")	Injection molded plastic	Bronze	L, T, AK, BK	350 lbs (159 kg)	$$$$$
Bulldog® Genesis C (with pull lock).	Clutch	(141 g) 4.96 oz.	25 mm (1")	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$$$
Bulldog® Genesis CG (with pull lock and guide grooves).	Clutch	(139 g) 4.92 oz.	25 mm (1")	Injection molded plastic	None	L, T, AK, BK	350 lbs (159 kg)	$$$
Bulldog Genesis CR (with pull lock).	Clutch	(124 g) 4.37 oz.	25 mm (1")	Injection molded plastic	Bronze	L, T, AK, BK	350 lbs (159 kg)	$$$
Bulldog® Genesis CRG (with pull lock guide grooves).	Clutch	(122 g) 4.31 oz.	25 mm (1")	Injection molded plastic	Bronze	L, T, AK, BK	350 lbs (159 kg)	$$$$
Bulldog® Style I (top loaded. **NOTE:** all Bulldog style locks can be purchased with guide grooves. "Style" locks made of Delrin®).	Shuttle	(117 g) 4.12 oz.	25 mm (1")	Delrin®	None	L, T, AK, BK	350 lbs (159 kg)	$$$$
Bulldog® Style JG (with guide grooves; top loaded).	Shuttle	(124 g) 4.38 oz.	25 mm (1")	Delrin®	Bronze	L, T, AK, BK	350 lbs (159 kg)	$$$$$ $

Bulldog® Style K (top loaded).	Clutch	(120 g) 4.23 oz.	25 mm (1”)	Delrin®	None	L, T, AK, BK	350lbs (159 kg)	$$$$
Bulldog Style L (top loaded).	Clutch	(125 g) 4.42 oz.	25 mm (1”)	Delrin®	Bronze	L, T, AK, BK	350 lbs (159 kg)	$$$$$
Bulldog Style Q (top loaded).	Shuttle	(97 g) 3.41 oz.	25 mm (1”)	Delrin®	None	L, T, AK, BK	220 lbs (100 kg)	$$$
Bulldog Style R (top loaded).	Shuttle	(101 g) 3.55 oz.	25 mm (1”)	Delrin®	Bronze	L, T, AK, BK	220 lbs (100 kg)	$$$$
Bulldog Style S (no 4-hole pattern).	Shuttle	(48 g) 1.68 oz.	22 mm (7/8”)+	Delrin®	None	L, T, UE, light PE	50 lbs (22.7 kg)	$$$
Cascade ProAdvantage ® IRS-150-AK	Shuttle	39 g (1.38 oz.)	(38 mm) 1 1/2”	Delrin®	None	L,T, EX, PE, UE	N/A	$$
Cascade ProAdvantage® IRS-200-AK	Shuttle	91 g (3.21 oz.)	(41 mm) 1 5/8”	Delrin®	None	L,T, EX, AK, BK, PE	175 lbs (79 kg)	$$
Cascade ProAdvantage® IRS-600-AK	Clutch	105 g (3.70 oz)	(41 mm) 1 5/8”	Delrin®	None	L,T, EX, AK, BK	175 lbs (79 kg)	$$$
Cascade ProAdvantage® IRS-600-AKT	Clutch	144 g (5.08 oz.)	(41 mm) 1 5/8”	Aluminum	Titanium	L,T, EX, AK, BK	175 lbs (79 kg)	$$$$
Cascade ProAdvantage® IRS-600-AKTP (with pyramid).	Clutch	192 g (6.77 oz.)	(64 mm) 2 1/2”	Aluminum	Titanium	L,T, EX, AK, BK	175 lbs (79 kg)	$$$$$ $$$

Cascade ProAdvantage® IRS-650-AK-T (modular).	Clutch	116 g (4.09 oz.)	(19 mm) 3/4"	Aluminum	Stainless steel	T, AK, BK	225 lbs (102 kg)	$$$$$
Cascade ProAdvantage® IRS-650-AK-L (modular).	Clutch	116 g (4.09 oz.)	(19 mm) 3/4"	Aluminum	Stainless steel	L, AK, BK	225 lbs (102 kg)	$$$$
Coyote Air Lock™ (water resistant).	Misc. (Shuttle/ suction)	96 g (3.39 oz.)	(Max of 51 mm) Max of 2"	Acetyl	None	L, T, EX, AK, BK	Lamination: 265 lbs (120 kg) Thermoform: 220 lbs (100 kg)	$$$
Coyote Small Air Lock™ (water resistant).	Misc. (Shuttle/ Suction)	50 g (1.76 oz.)	(Max of 48 mm) Max of 1 7/8"	Acetyl	None	L, T, EX, BK, AK, PE, (optimal for smaller limb shapes and UE [both BE & AE] applications)	220 lbs (100 kg)	$$
Coyote Summit Lock™	Misc.	29 g (1.02 oz.)	None. No clearance required. Lock does not attach to distal end of socket	Urethane primarily	None	L, T, primarily AK; some BK patients with previous difficulty using pin locks; UE; great for long limbs where clearance is an issue	265 lbs (120 kg)	$
Coyote Grommet™ Lock (water resistant).	Shuttle	27 g 0.952 oz.	(35 mm -- can be modified to 14mm]) 1 3/8"--can be modified to 9/16".	Acetyl	None	Lower limb PE, BE, can be used for other UE applications too.	132 lbs (60 kg)	$$

Creative Components AK Loc-n-Load™ (available in 3 circumferences: small [3”], medium [3 ½”], and large [4”]. With standard 4-hole pattern).	Shuttle	245 g (8.64 oz.)	22 mm 7/8”	Anodized aluminum	Replaceable Delrin® bushing	L, T, EX possible if modifications are made to the lock; primarily AK amputees; BK amputees with a flexion contracture (must turn lock 180º for this application). This lock incorporates a 5/8” posterior offset and is pre-flexed at 4.5º to facilitate AK alignment.	300 lbs (136 kg)	$$$$$ $$
Creative Components BK Loc-n-Load™ (available in 3 circumferences: small [2 ½”], medium [3 ¼”], and large [3 ½”]. With standard 4-hole pattern).	Shuttle	170 g (6.00 oz.)	15 mm - 28 mm (9/16”- 1 1/8”)	Anodized aluminum	Replaceable Delrin® bushing	L, T, EX possible if modifications are made to the lock.	300 lbs (136 kg)	$$$$$
Endolite Socket Lock (aka. Neat Little socket Lock).	Shuttle	70 g (2.47 oz.)	(38 mm) 1 ½”	Delrin	None	L, T, AK, BK	265 lbs (120 kg)	$$$$
Euro International Clutch lock # 101	Clutch	58 g (2.05 oz)	23 mm (15/16”)	Injection molded Shock/heat resistant plastic	Stainless steel	L, T, EX, AK, BK, PE, UE	None	$$$$

Euro International Shuttle Lock # 102	Shuttle	56 g (2.05 oz.)	23 mm (15/16”)	Injection molded Shock/heat resistant plastic	Stainless steel	L, T, EX, AK, BK, PE, UE	None	$$$
Euro International Easy Lock # 103	Smooth	60 g (2.12 oz.)	23 mm (15/16”)	Injection molded Shock/heat resistant plastic	Anodized aluminum	L, T, EX, AK, BK, PE, UE	None	$$$$$ $
Euro International Clutch Lock # 15S1	Clutch	95 g (3.35 oz.)	23 mm (15/16”)	Anodized aluminum	Stainless steel	L, T, EX AK, BK, PE, UE	None	$$$$
Euro International Shuttle Lock # 15S2	Shuttle	90 g (3.17 oz.)	23 mm (15/16”)	Anodized aluminum	Stainless steel	L, T, EX AK, BK, PE, UE	None	$$$
Euro International Easy Lock # 15S3	Smooth	85 g (3.00 oz.)	23 mm (15/16”)	Anodized aluminum	None	L, T, EX AK, BK, PE, UE	None	$$$$$ $
Euro International Clutch Lock # 201 (modular).	Clutch	188 g (6.63 oz.)	30 mm (1 3/16”)	Anodized aluminum	Stainless steel	L, T (must order ring adapter), AK, BK	275 lbs (125 kg)	$$$$$
Euro International Shuttle Lock # 202 (modular).	Shuttle	172 g (6.07 oz.)	30 mm (1 3/16”)	Anodized aluminum	Stainless steel	L, T (must order ring adapter), AK, BK	275 lbs (125 kg)	$$$$
Euro International Easy Lock # 203 (modular).	Smooth	178 g (6.28 oz)	30 mm (1 3/16”)	Anodized aluminum	None	L, T (must order ring adapter), AK, BK	275 lbs (125 kg)	$$$$$ $

Euro International Clutch Lock # 301	Clutch	77 g (2.72 oz)	30 mm (1 3/16”)	Injection molded shock/heat resistant plastic	Stainless steel	L, T, EX, AK, BK	220 lbs (100 kg)	$$$$$
Euro International Shuttle Lock # 302	Shuttle	82 g (2.89 oz.)	30 mm (1 3/16”)	Injection molded shock/heat resistant plastic	Stainless steel	L, T, EX, AK, BK	220 lbs (100 kg)	$$$$$
Euro International Easy Lock # 303	Smooth	80 g (2.82 oz.)	30 mm (1 3/16”)	Injection molded shock/heat resistant plastic	Anodized aluminum	L, T, EX, AK, BK	220 lbs (100 kg)	$$$$$ $
Euro International Clutch Lock # 401 (with 3-pronged adapter).	Clutch	158 g (5.57 oz.)	33 mm (1 5/16”)	Anodized aluminum	Stainless steel	L, T, optimal for AK & BK sockets with large distal circumferences	276 lbs (125 kg)	$$$$$ $
Euro International Shuttle Lock # 402 (with 3-pronged adapter).	Shuttle	147 g (5.19 oz.)	33 mm (1 5/16”)	Anodized aluminum	Stainless steel	L, T, optimal for AK & BK sockets with large distal circumferences	276 lbs (125 kg)	$$$$$ $$
Euro International Easy Lock # 403 (with 3-pronged adapter).	Smooth	136 g (4.80 oz.)	33 mm (1 5/16”)	Anodized aluminum	None	L,T, optimal for AK & BK sockets with large distal circumferences	276 lbs (125 kg)	$$$$$ $$
Euro International Clutch Lock #501 (with pyramid).	Clutch	170 g (6.00 oz.)	37mm (1 7/16”)	Anodized aluminum	Stainless steel	L, T, AK, BK	276 lbs (125 kg)	$$$$$ $$$
Euro International Shuttle Lock #502 (with pyramid).	Shuttle	162 g (5.71 oz.)	37mm (1 7/16”)	Anodized aluminum	Stainless steel	L, T, AK, BK	276 lbs (125 kg)	$$$$$ $

Euro International Easy Lock #503 (with pyramid).	Smooth	160 g (5.64 oz.)	37mm (1 7/16")	Anodized aluminum	None	L, T, AK, BK	276 lbs (125 kg)	\$\$\$\$\$ \$\$\$\$
Euro International Shuttle Lock #602 (with standard 4-hole pattern).	Shuttle	78 g (2.75 oz.)	17 mm (11/16")	Injection molded shock/heat resistant plastic	None	L, T, EX, AK, BK, PE, some UE (i.e. short transhumeral)	287 lbs (130 kg)	\$\$
Fillauer 4-Hole Cylindrical Clutch Lock	Clutch	121 g (4.27 oz.)	(29 mm) 1 1/8"	Aluminum/ injection molded plastic	Stainless steel	L, T, AK, BK	300 lbs (136 kg)	\$\$\$
Fillauer Clutch Lock with Air Expulsion	Misc. (Catridge only)	36 g (1.27 oz.)	(19 mm) ¾"	Aluminum	N/A	Fits all clutch lock housings	N/A	N/A
Fillauer Clutch Lock with Air Expulsion & Delrin housing	Misc. (Clutch/ Suction)	75 g (2.65 oz.)	(64 mm) 2 ½"	Delrin®	Stainless steel	L, T, EX, AK, BK	300 lbs (136 kg)	\$\$
Fillauer Clutch Lock with Air Expulsion & Titanium pyramid	Misc.	155 g (5.47 oz.)	(60 mm) 2 3/8"	Aluminum/ titanium	Stainless steel	L, AK, BK	300 lbs (136 kg)	\$\$\$\$
Fillauer Gator Grip Lock with Cylindrical Housing (smooth rigid or flexible pin).	Misc.	133 g (4.69 oz.)	(32 mm) 1 ¼"	Aluminum/ injection molded plastic	Stainless steel	L, T, AK, BK	300 lbs (136 kg)	\$\$\$\$
Fillauer Gator Grip Lock with Delrin® Housing (smooth rigid or flexible pin; water resistant).	Misc.	72 g (2.54 oz.)	(29 mm) 1 1/8"	Delrin®	Stainless steel	L, T, EX, AK, BK	300 lbs (136 kg)	\$\$\$

Fillauer Gator Grip Lock with Hard Anondized Aluminum Housing with Titanium Pyramid (smooth rigid or flexible pin; water resistant).	Misc.	136 g (4.80 oz.)	(54 mm) 2 1/8”	Aluminum/ titanium	Stainless steel	L, T, AK, BK	300 lbs (136 kg)	$$
Fillauer Gator Grip Lock with Pyramid Housing (smooth rigid or flexible pin; water resistant).	Misc.	136 g (4.80 oz.)	(54 mm) 2 1/8”	Aluminum/ titanium	Stainless steel	L, T, AK, BK	300 lbs (136 kg)	$$$$
Fillauer Mighty Mite® Cylindrical Housing Modular Shuttle Lock	Shuttle	84 g (2.96 oz.)	(25 mm) 1”	Aluminum/ plastic	None	L, T, AK, BK	132 lbs (59.9 kg)	$$$$
Fillauer MightyMite® Pyramid Housing Modular Shuttle Lock	Shuttle	79 g (2.79 oz.)	(44 mm) 1 ¾”	Aluminum	None	L, T, AK, BK	132 lbs (59.9 kg)	$$$$
Fillauer Modular Shuttle Lock with 4-Hole Housing	Shuttle	100 g (3.53 oz.)	(33 mm) 1 5/16”	Aluminum	Stainless steel	L, T, AK, BK	300 lbs (136 kg)	$$
Fillauer Modular Shuttle Lock with Cylindrical Housing	Shuttle	96 g (3.39 oz.)	(25 mm) 1”	Aluminum/ injection molded plastic	Stainless steel	L, T, AK, BK	300 lbs (136 kg)	$$$$
Fillauer Modular Shuttle Lock with Delrin® Housing	Shuttle	55 g (1.94 oz.)	(51 mm) 2”	Delrin®	Stainless steel	L, T, EX, AK, BK	None	$

Fillauer Modular Shuttle Lock with Titanium Pyramid	Shuttle	113 g (3.99 oz.)	(54 mm) 2 1/8”	Aluminum	Stainless steel	L, T, AK, BK	300 lbs (136 kg)	$$
Fillauer Original Shuttle Lock	Shuttle	58 g (2.05 oz.)	(32 mm) (48 mm) fabricated 1 ¼” 1 7/8” fabricated	Delrin®	Stainless steel	L, T, EX, AK, BK	None	$
Fillauer Original Shuttle lock with Unitized housing (with pyramid).	Shuttle	117 g (4.13 oz.)	(57 mm) 2 ¼”	Aluminum/ titanium	Stainless Steel	L, T, AK, BK	220 lbs (100 kg)	$$$
Fillauer Pyramid Clutch Lock	Clutch	155 g (5.47 oz.)	(60 mm) 2 3/8”	Aluminum/ titanium	Stainless steel	L, AK, BK	300 lbs (136 kg)	$$$$
Fillauer Small Modular Shuttle Lock with Delrin® Housing	Shuttle	35 g (1.23 oz.)	(44 mm) 1 ¾”	Delrin®	None	L, T, EX, Light BK, UE	132 lbs (59.9 kg)	$
Fillauer Small Shuttle Lock	Shuttle	35 g (1.23 oz.)	(44 mm) 1 ¾”	Delrin®	None	L, T, EX, BK, UE	None	$
Medex Shuttle Lock with Distal Adjustment Pyramid System (with 3-pronged adapter. **NOTE**: Soon to be discontinued).	Clutch	265 g (9.35 oz.)	N/A	Plastic (exact type unknown)	Aluminum/ stainless steel	L, AK, BK	220 lbs (100 kg)	$$

Medex Shuttle Lock with Distal Adjustment Screws (with 3-pronged adapter. **NOTE:** Soon to be discontinued.)	Clutch	185 g (6.58 oz.)	N/A	Plastic (exact type unknown)	Aluminum/ stainless steel	L, AK and BK patients with long residual limbs	220 lbs (100 kg)	$$
Medex Shuttle Lock with Plunger Pin. (**NOTE:** Soon to be discontinued).	Clutch	130 g (4.59 oz.)	N/A	Plastic (exact type unknown)	Aluminum/ stainless steel	L, T, AK, BK	220 lbs (100 kg)	$$
Ohio Willow Wood Alpha® Lock (modular. Optional: pyramid).	Misc. (Clutch/ Suction)	200 g (7.05 oz.)	36 mm (1 7/16")	Aluminum	316 Stainless steel	L, T, AK, BK	250 lbs (113 kg)	$$$$$
Ohio Willow Wood Alpha® Lamination Lock (with 4-hole mounting plate).	Clutch	200 g (7.05 oz.)	29 mm (1 1/8")	Aluminum	316 stainless Steel	L, EX, AK, BK	250 lbs (113 kg)	$$$$
Ohio Willow Wood G-Lock (Improved version of older "Grubbs Lock". With standard 4-hole pattern).	Misc. (Shuttle/ Suction)	140 g (4.94 oz.)	26 mm (1")	Delrin® & aluminum	316 stainless Steel	L, T, AK, BK	250 lbs (115 kg)	$$$
Ortho Europe 3LK 105 ECO™ Clutch Lock (with pyramid).	Clutch	214 g (7.55 oz.)	61 mm (2 3/8")	Aluminum	None	L, AK, BK	220 lbs (100 kg)	$$$$$ $$$
Ortho Europe 3LK 106 ECO™ Shuttle Lock (with pyramid).	Shuttle	214 g (7.55 oz.)	61 mm (2 3/8")	Aluminum	None	L, AK, BK	220 lbs (100 kg)	$$$$$ $$

Ortho Europe 3LK 108 ECO™ Thermoplastic Lock (with pyramid).	Shuttle	304 g (10.7 oz.)	N/A	Aluminum	None	T, AK	220 lbs (100 kg)	N/A
Ortho Europe 3LK 201 ECO™ System Shuttle Lock	Shuttle	50 g (1.76 oz.)	36 mm (1 7/16”)	Acetyl	None	L, T, light activity AK and BK, PE, UE	220 lbs (100 kg)	$
Ortho Europe 3LK 204 ECO™ System Shuttle Lock	Shuttle	70 g (2.47 oz.)	50 mm (1 15/16”)	Acetyl	None	L, T, light activity AK and BK	220 lbs (100 kg)	$$
Ortho Europe 3LK 405 Premier™ Clutch Lock (with pyramid).	Clutch	214 g (7.55 oz.)	61 mm (2 3/8”)	Aluminum	Titanium	L, AK, BK	275 lbs (125 kg)	$$$$$ $$$$
Ortho Europe 3LK 406 Premier™ Shuttle Lock (with pyramid).	Shuttle	214 g (7.55 oz.)	61 mm (2 3/8”)	Aluminum	Titanium	L, AK, BK	275 lbs (125 kg)	$$$$$ $$$
Ortho Europe 3LK 603 Premier™ Plain Lock 36 mm	Shuttle	50 g (1.76 oz.)	36 mm (1 7/16”)	Acetyl	None	L, T, light activity AK and BK, PE, UE	220 lbs (100 kg)	N/A
Ortho Europe 3LK 604 Premier™ Plain Lock 50 mm	Shuttle	70 g (2.47 oz.)	50 mm (1 15/16”)	Acetyl	None	L, T, light activity AK and BK	220 lbs (100 kg)	N/A
*Ossur Icelock® Ratchet TP 122 (with titanium pyramid).	Shuttle	104 g (3.67 oz.)	22 mm (7/8”)	Aluminum	Stainless steel	L, AK, BK	265 lbs (120 kg)	$$$$
Ossur Icelock® Ratchet SP 123 (with stainless steel pyramid).	Shuttle	115 g (4.06 oz.)	22 mm (7/8”)	Aluminum	Stainless steel	L, AK, BK	220 lbs (100 kg)	$$$

Ossur Icelock® Clutch 211 (Optional: pyramid adapter).	Clutch	78 g (2.75 oz.)	21 mm (13/16”)	Aluminum	Stainless steel	L, T, AK, BK	With pyramid→ 365 lbs (166 kg)	$$
Ossur Icelock® Clutch 4H 214 (modular).	Clutch	186 g (6.56 g)	25 mm (1”)	Aluminum	Stainless steel	L, T, AK, BK	265 lbs (120 kg)	$$$$
Ossur Icelock® 400 (aka. “The Pin”. Optional: 4-hole mounting plate).	Smooth	95 g (3.35 oz.)	32 mm (1 ¼”)	Delrin®	None	L, T, AK, BK	N/A	$$$$
Ossur Icelock® Ratchet 621 (Optional: Titanium or stainless steel pyramid, titanium or aluminum 4-hole mounting plate).	Shuttle	59 g (2.08 oz.	15 mm (9/16”)	Aluminum	Stainless steel	L, AK, BK (optimal for firm limbs)	With pyramid or 4-hole adapter →365 lbs	$$
Ossur Icelock® Smooth 651 (Optional: Titanium or stainless steel pyramid, titanium or aluminum 4-hole mounting plate).	Smooth	68 g (2.40 oz.)	15 mm (9/16”)	Aluminum	Stainless steel	L, AK, BK (optimal for fleshy limbs)	Pyramid or 4-hole adapter →365 lbs (166 kg)	$$$$
Ossur Icelock® 700 Series Small (Optional: stainless steel pyramid, aluminum 4-hole mounting plate).	Shuttle	20 g (0.705 oz.)	13 mm (1/2”)	Aluminum	Stainless steel	UE, Lower extremity PE	With pyramid → 100 lbs (45.4 kg)	$$$$

Otto Bock 14A1 Lock Set	Clutch	62 g (2.19 oz.)	(16 mm) 5/8”	Aluminum	None	L, UE	None (not indicated for lower extremity patients)	$$$$$
Otto Bock 6A20=10 (with 3-pronged adapter).	Clutch	182 g (6.42 oz.)	(44 mm) 1 ¾”	Aluminum/ stainless steel thread	Aluminum	L, AK, BK	275 lbs (125 kg)	$$$$$ $
Otto Bock 6A20=20 (with 3-pronged adapter and distal female adapter).	Clutch	212 g (7.48 oz.)	(57 mm) 2 ¼”	Aluminum, stainless steel thread	Aluminum	L, AK, BK with long residual limbs	275 lbs (125 kg)	$$$$$ $
Otto Bock 6A20=30 (with 3-pronged adapter and pyramid).	Smooth	192 g (6.77 oz.)	(38 mm) 1 ½”	Aluminum/ stainless steel thread	Aluminum	L, AK, BK	220 lbs (100kg)	$$$$$ $
Otto Bock 6A30=10	Clutch	114 g (4.02 oz.)	(44 mm) 1 ¾”	Aluminum	None	L, AK, BK	None	$$$$
Otto Bock 6A30=20 (salt water resistant).	Clutch	130 g (4.59 oz.)	(44 mm) 1 ¾”	Plastic (type unknown)	Aluminum	L, T, AK, BK	None	$$
Prosthetic Design™ P-PSH-PLUS (all Prosthetic design locks come with a top loading option and incorporate a standard 4-hole pattern).	Shuttle	133 g (4.69 oz.)	13 mm 1/2”	Delrin®	None	L, T, AK, BK, Lower activity level patients	K1 & K2 → 264 lbs (120 kg)	$$$

Prosthetic Design™ X-PED (with pull release).	Shuttle	92 g (3.25 oz.)	13 mm 1/2”	Delrin®	Brass	L, T, specifically for pediatric AK & BK applications	K1, K2, K3 → 180 lbs (82 kg) K4 → 150 lbs (68 kg)	$$$$$
Prosthetic Design™ X-PSH-PLUS (with guide grooves).	Shuttle	110 g (3.88 oz.)	13 mm 1/2”	Delrin®	None	L, T, AK, BK	K1, K2, K3 → 330 lbs (150 kg) K4 → 264 lbs (120 kg)	$$$$$
Prosthetic Design™ X-PSH-R-OMIII4-6R (with guide grooves).	Shuttle	130 g (4.59 oz.)	13 mm 1/2”	Delrin®	None	L, T, AK, BK, Hosts Ossur’s Modular III 2-hole pattern for functional levels 4-6	K1, K2, K3 → 400 lbs (180 kg) K4 → 330 lbs (150 kg)	$$$$$ $$$$
Prosthetic Design™ X-PSH-R-OMIII7-9R (with guide grooves).	Shuttle	116 g (4.09 oz.)	13 mm 1/2”	Delrin®	None	L, T, AK, BK, Hosts Ossur’s Modular III 2-hole pattern for functional levels 7-9	K1, K2, K3 → 400 lbs (180 kg) K4 → 330 lbs (150 kg)	$$$$$ $$$$
Prosthetic Design™ X-PUL-PLUS (with guide grooves; with pull release).	Shuttle	109 g (3.84 oz.)	13 mm 1/2”	Delrin®	None	L, T, AK, BK	K1, K2, K3→330 lbs (150 kg), K4→264 lbs (120 kg)	$$$$$
Prosthetic Design™ X-SM-TL (with guide grooves).	Shuttle	109 g (3.84 oz.)	13 mm 1/2”	Delrin®	Brass	L, T, AK, BK, a small diameter lock for people with small distal end circumferences	K1, K2, K3 → 264 lbs (120 kg) K4→ 220 lbs (100 kg)	$$$$$
Prosthetic Design™ X-TI-PLUS (with guide grooves).	Shuttle	112 g (3.95 oz.)	13 mm 1/2”	Delrin®	Titanium	L, T, AK, BK	K1, K2, K3 → 400 lbs (180 kg) K4 → 330 lbs (150 kg)	$$$$$ $$

Rehab Tech Low Profile, Lightweight Shuttle Lock Kit, Stainless Steel Bushing (modular; with standard 4-hole pattern).	Shuttle	226 g (7.97 oz.)	10 mm (5/16”)	Plastic (type unknown)	Stainless steel	L, T, AK, BK	N/A	N/A
Seattle Limb Systems Littig Master Lock™ (with 4-hole mounting plate).	Clutch	207 g (7.30 oz.)	1 3/8”	Aluminum	Titanium	Primarily T, some L, AK, BK	220 lbs (110 kg)	$$$$
Seattle Limb Systems Master Lock™	Clutch	102 g (3.60 oz.)	(41 mm) 1 5/8”	Delrin®	None	L, EX, AK, BK	300 lbs (136 kg)	$$
Seattle Limb Systems Master Lock™ w/Titanium Pyramid	Clutch	142 g (5.01 oz.)	(64 mm) 2 ½”	Delrin®	None	L, AK, BK	176lbs (80 kg)	$$$$$
Seattle Limb Systems Modular Master Lock™	Clutch	166 g (5.86 oz.)	(19 mm) ¾”	Aluminum	Delrin®	L, AK, BK	220 lbs (100 kg)	$$$
Seattle Limb Systems Short Shuttle Lock	Shuttle	96 g (3.39 oz.)	(22 mm) 7/8”	Delrin®	None	L, T, AK, BK	220 lbs (100 kg)	$$
Seattle Limb Systems Aluminum Master Lock with Titanium Pyramid	Clutch	161 g (5.68 oz.)	(57 mm) 2 1/4”	Aluminum	Stainless steel	L, AK, BK	220 lbs (100 kg)	$$$$
Seattle Limb Systems Standard Shuttle Lock (Optional: pyramid, 4-hole adapter).	Shuttle	58 g (2.05 oz.)	(38 mm) 1 ½”	33% Glass reinforced nylon composite	None	L, AK, BK	300 lbs (136 kg)	$$

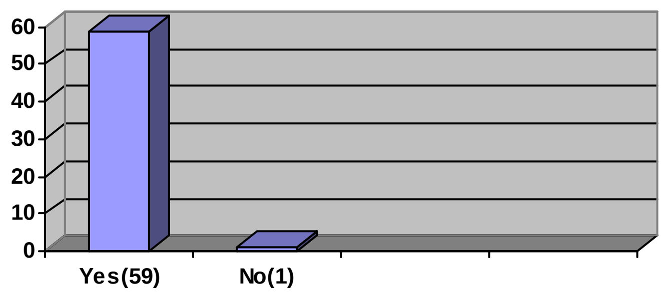
SPS Ratchet Style Shuttle Lock/SPS-200-AK (Optional: pyramid adapter, modular [4-hole adapter] ring).	Shuttle	95 g (3.35 oz.)	41 mm (1 5/8”)	Delrin®	None	T, L, EX, AK, BK, PE	N/A	$
SPS Delrin Clutch Lock/SPS-500-AK	Clutch	118 g (4.16 oz.)	41 mm (1 5/8”)	Delrin®	Stainless steel	T, L, EX, AK, BK	N/A	$$
SPS Square Modular Clutch Lock/SPS-550-AK-T	Clutch	210 g (7.41 oz.)	40 mm (1 9/16”)	Aluminum	Stainless steel	T, AK, BK	220 lbs (100 kg)	$$$
SPS Square Modular Clutch Lock/SPS-550-AK-L	Clutch	212 g (7.48 oz.)	40 mm (1 9/16”)	Aluminum	Stainless steel	L, AK, BK	220 lbs (100 kg)	$$$
TiMED TS-325 (with 4-pronged adapter and pyramid).	Clutch	207 g (7.30 oz.)	(64 mm) 2 ½”	Titanium with Delrin® insert	Titanium surrounded by Delrin®	L, AK, BK, PE	325 lbs (147 kg)	$$$$$ $
TiMED TS-425 (with female adapter).	Clutch	248 g (8.75 oz.)	(67 mm) 2 5/8”	Titanium with Delrin® insert	Titanium surrounded by Delrin®	L, AK, BK, PE	325 lbs (147 kg)	$$$$$ $

Survey Results

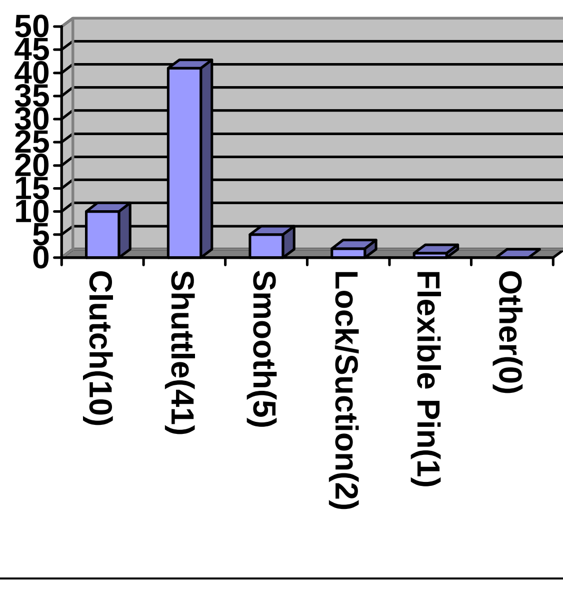
The survey was sent to one hundred certified prosthetists throughout the United States. The sample population was completely random and included prosthetists from seventy-two companies. Six of the surveys were undeliverable because of a change in address or because the practitioner no longer worked at the facility. The practitioners had approximately 2 ¼ months to respond to the survey. Sixty of the surveys were completed and returned.

The survey was designed to determine: (1) how many prosthetists use pin locks in their practices, and if so, what style of pin locks are being used most frequently and infrequently, (2) which pin lock manufacturers are particularly popular among prosthetists, (3) what prosthetists find to be the greatest disadvatages of pin locks, (4) prosthetists' opinions on a variety of issues concerning pin locks—including cost, weight, height, durability, patient complications, fabrication, and alignment, and (5) how frequently prosthetists use pin locks on several various levels of amputation.

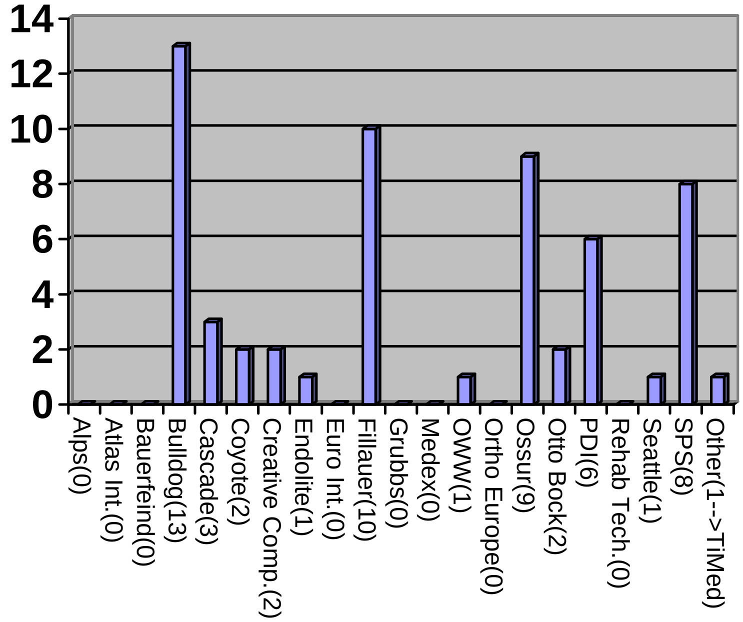
Does the prosthetist use a pin lock?



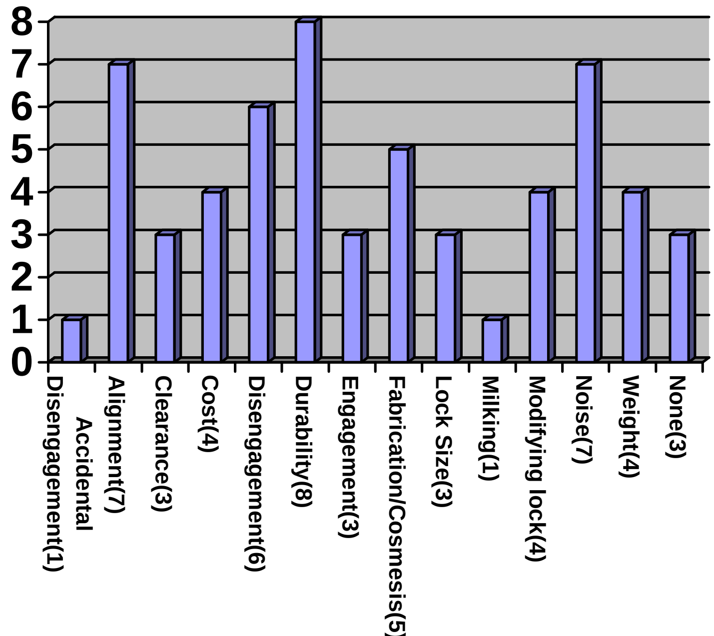
What type of pin lock does the prosthetist use most often?



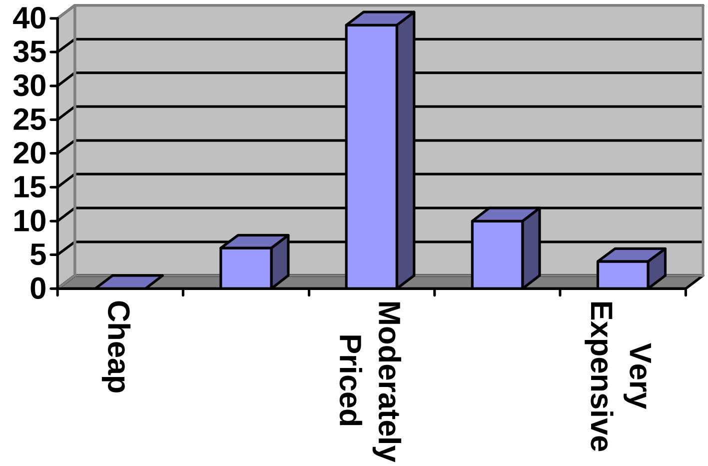
From what company does the prosthetist most frequently buy pin locks?



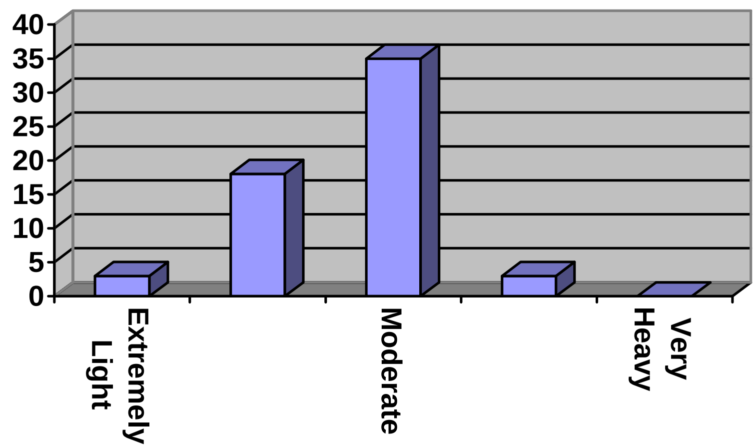
What did the prosthetist consider to be the greatest disadvantage of the pin lock they most commonly used?



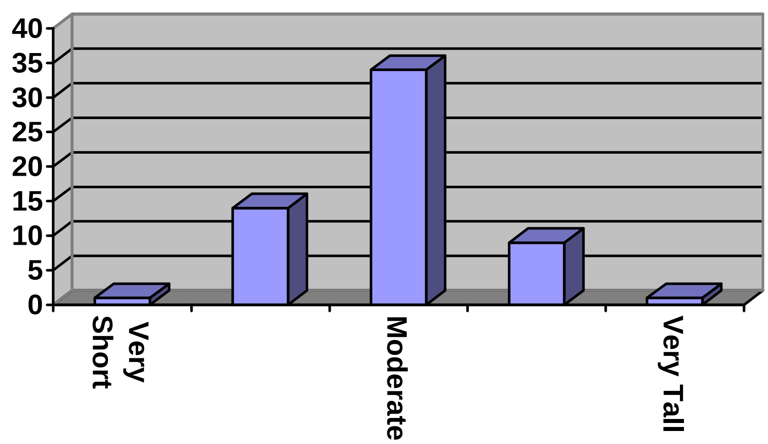
How much did the pin lock cost?



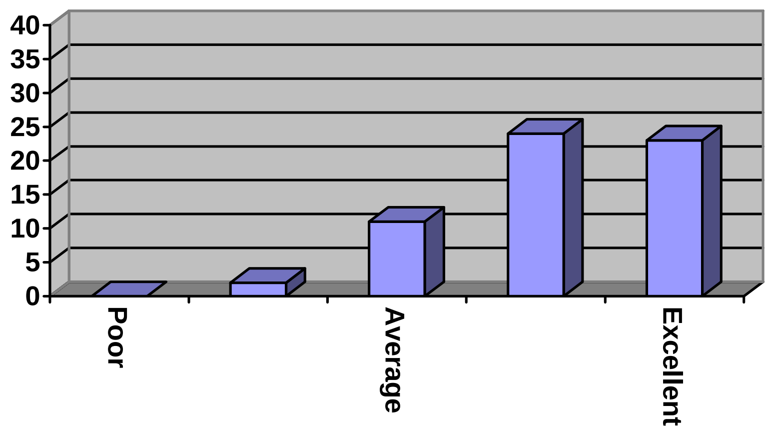
How much did the pin lock weigh?



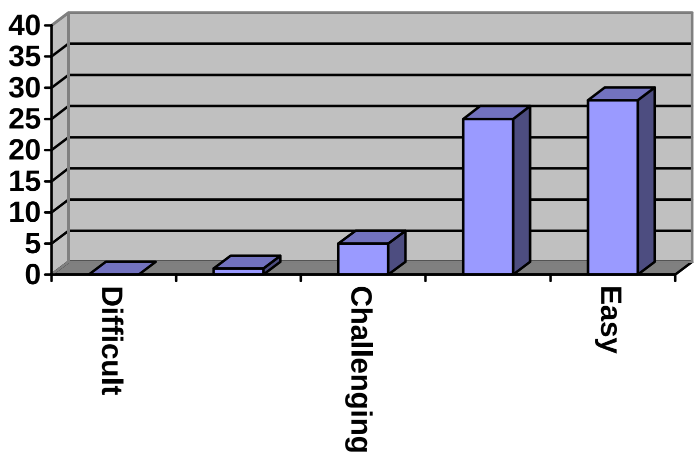
What was the height of the pin lock?



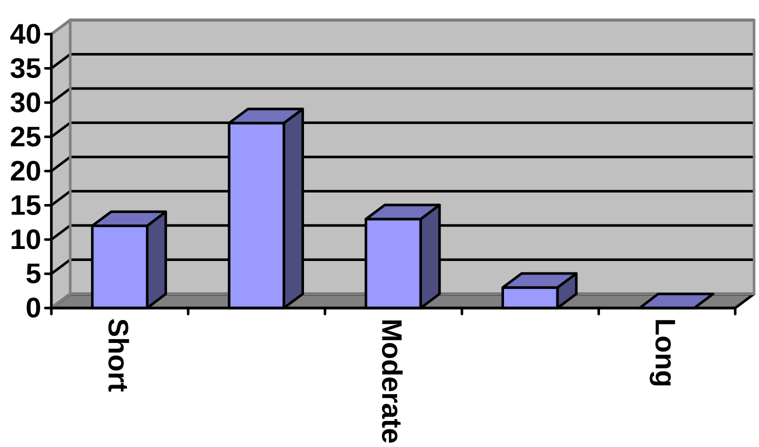
How durable was the pin lock?



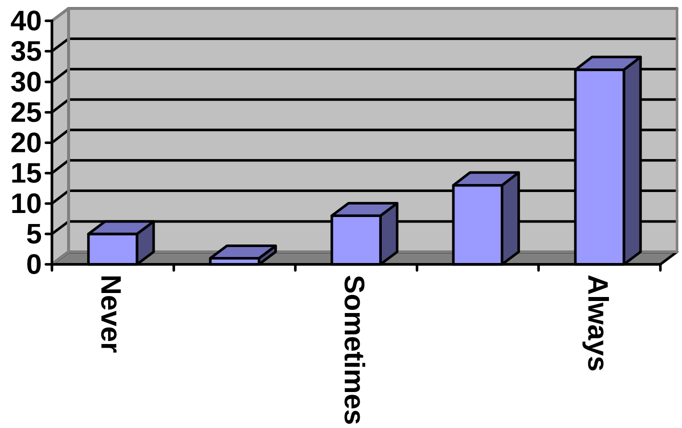
How difficult is it to fabricate the pin lock into the prosthesis?



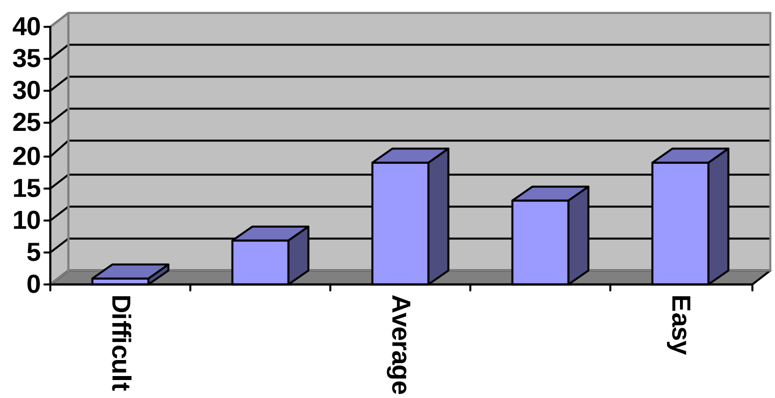
How long did it take to fabricate the lock into the prosthesis?



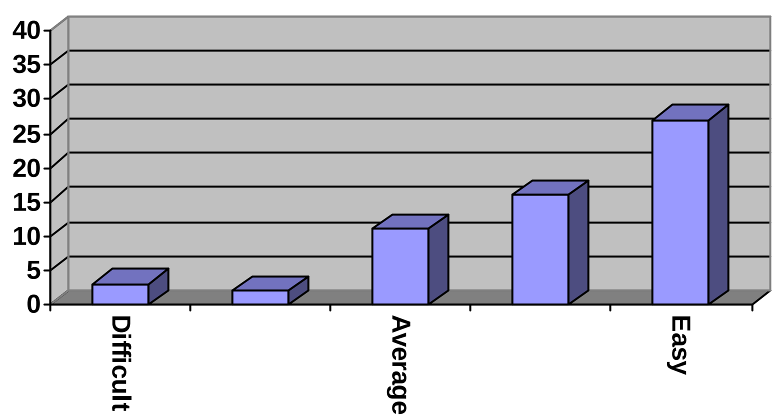
How often is a one shot/single lamination used when fabricating a socket with the pin lock?



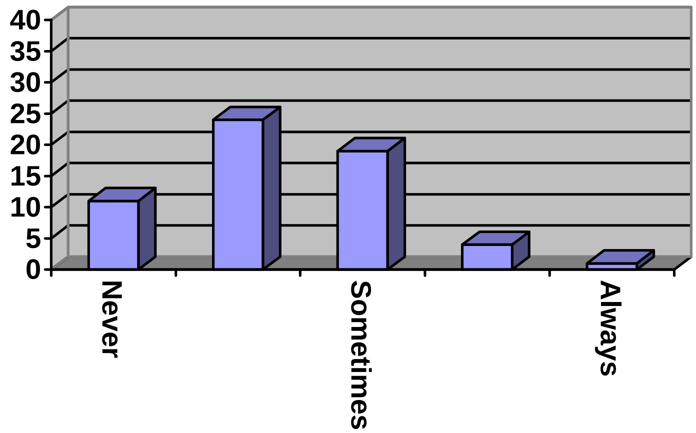
How difficult are alignment changes once the pin lock is incorporated into the prosthesis?



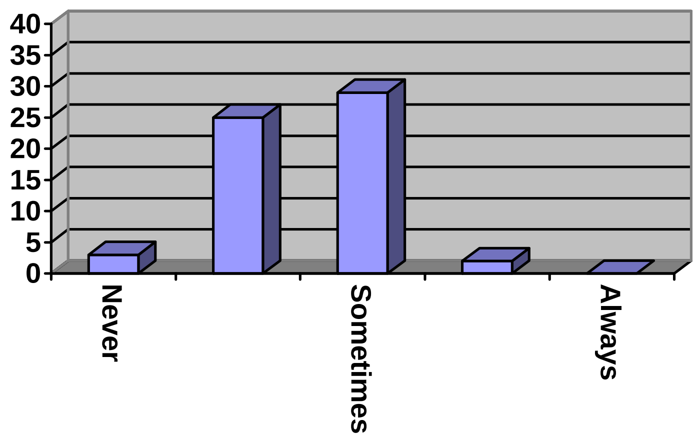
How difficult is disassembling the pin lock for repairs or replacing pin lock componentry?



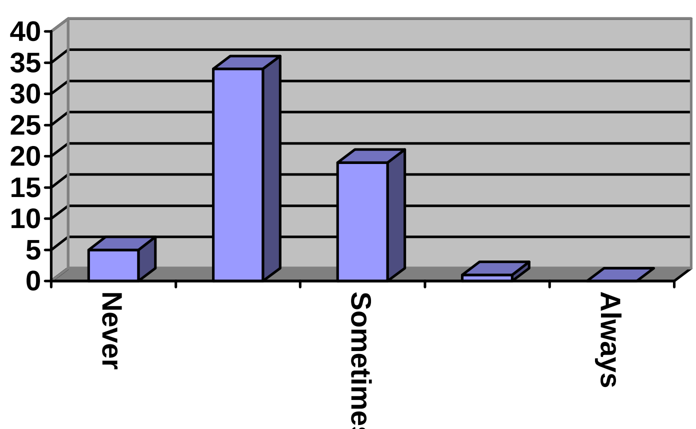
Does the pin lock make undesirable noise when your patients ambulate (prior to repairs or modifications to the lock)?



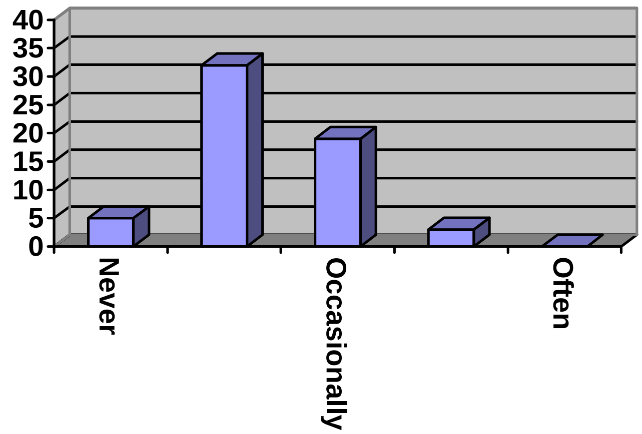
Do your patients find it difficult to engage the pin with the locking mechanism?



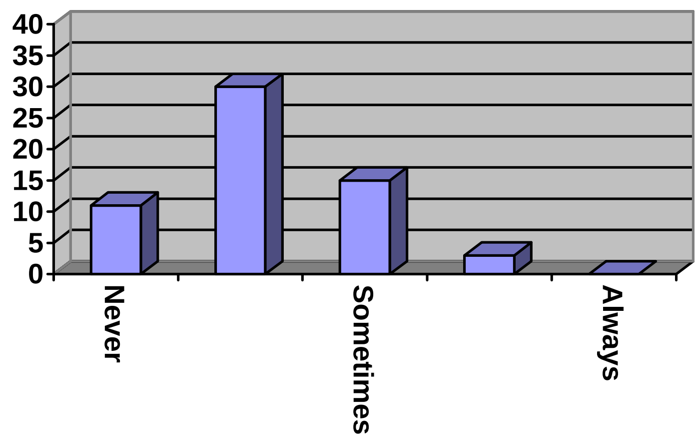
Do your patients experience pistoning of the socket when engaged in the pin lock?



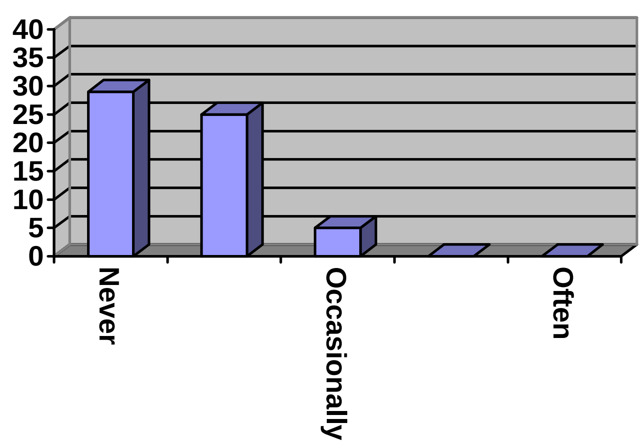
Do your patients experience difficulty disengaging the pin from the lock because of fabric catching on the pin or other reasons?



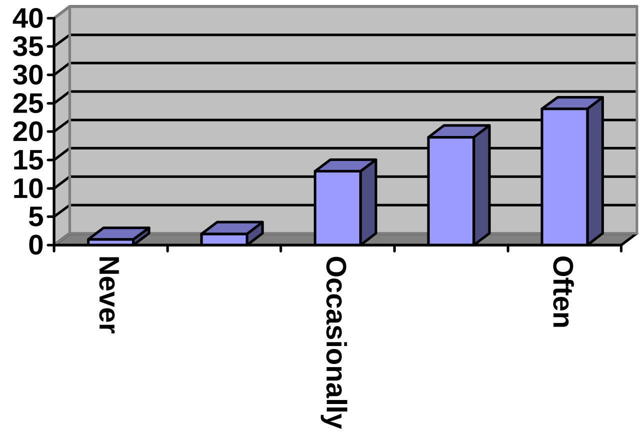
Do your patients show evidence of distal tissue stretching as a result of prolonged use of the pin lock (aka. "milking")?



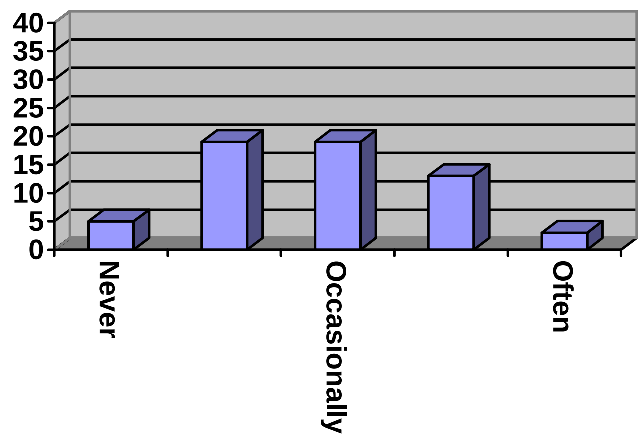
Do your patients experience involuntary disengagement of the pin from the lock?



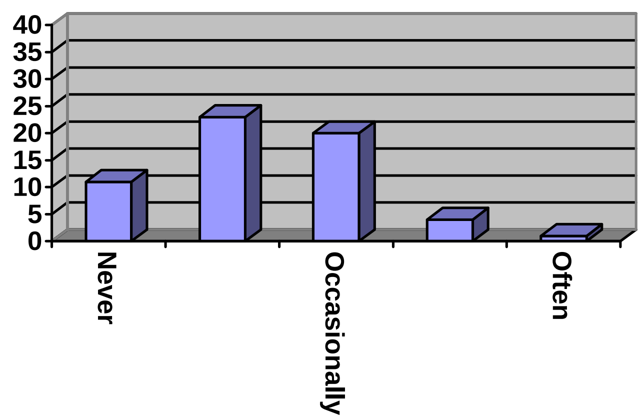
<u>How often do you use a pin lock, made by any manufacturer, on a below knee patient?</u>



<u>How often do you use a pin lock, made by any manufacturer, on an above knee patient?</u>



<u>How often do you use a pin lock on an upper extremity patient?</u>



Although the responses to the survey varied remarkably, what is particularly fascinating is the prosthetists' general level of satisfaction regarding the pin lock used most frequently in their practices. For instance, several practitioners simply responded "none" when asked what they considered to be the greatest disadvantage of the pin lock used most frequently in their practice. Also, the respondents answered positively, for the most part, on a variety of issues concerning pin locks, such as durability, patient complications, ease of fabrication, and ease of alignment. For example, few prosthetists responded that the pin lock they used most frequently was too flimsy, difficult to fabricate into the socket, difficult to repair, or difficult to align.

Despite the generally positive viewpoints held by the prosthetists towards their pin locks, interpreting the data remains difficult. As is the case with any survey, each participant assimilates his or her own biases and degree of criticism when responding to questions. While some of the prosthetists who answered the survey may have been under-critical, others may have been comparatively over-critical.

Conclusion

The wide variety of pin locks available gives prosthetists the ability to fit nearly all of their patients with this form of suspension. As has been discussed, prosthetists should consider several factors before selecting a pin lock for a patient. Pin lock selection should not be dictated predominantly by price. Prosthetists must also avoid falling into the trap of using the same pin lock patient-after-patient, as convenient as this may seem. The same can be said for most other prosthetic components. What is right for one patient is not necessarily right for another patient.

Advancements in pin lock design have come a long way over the past several years. They are generally more durable, lighter, reliable, serviceable, and easier to engage and disengage. The incorporation of suction suspension into some pin locks has also augmented their suspension capabilities.

How will pin locks develop in the future? Will the development of suction/pin lock hybrids increase significantly? Will pin locks be used at all in several years, or will their use dwindle over the next few years? No matter the case, at the present I hope this manual assists prosthetists in their selection of pin locks so that they may better serve their patients.

Bibliography

http://eurointl.chainreactionweb.com/catalog/default.php?cPath=141

http://rehabtech.eng.monash.edu.au/techguide/manuf1g.idc

http://www.bauerfeind.com/html_gb/aktuelles_news_artikel.php4?IDArtikel=1136

http://www.bauerfeind-prothetik.de/

http://www.bionixps.com/Pages/ProsFrameset.html

http://www.bulldogtools.com

http://www.cascade-usa.com/

http://www.coyotedandm.com/

http://www.easyliner.com/sections/sec-locks/locks.htm

http://www.endolite.com/resources/prosthetics_products.pdf

http://www.fabtechsystems.com/pdf/fts_Cfab_catalog_A.pdf

http://www.fillauer.com/products/index.html

http://www.fillauer.com/products/locks/index.html

http://www.fillauer.com/products/mightymite/mightymite.html

http://www.healthcare.ottobock.com/info_download/sites/bein_o.php

http://www.jimsmithsales.com/pdfs/components.pdf

http://www.kiss-suspension.com

http://www.lists.ufl.edu/cgi-bin/wa?A2=ind0010&L=oandp-l&F=&S=&P=9343

http://www.lists.ufl.edu/cgi-bin/wa?A2=ind0307&L=oandp-l&F=&S=&P=1034

http://www.lists.ufl.edu/cgi-bin/wa?A2=ind9912&L=oandp-l&F=&S=&P=15791

http://www.medexinternational.com/htm/prost/locks.html

http://www.monash.edu.au/rehabtech/unique/shuttle.htm

http://www.monash.edu.au/rehabtech/unique/unique.pdf

http://www.mtb-amputee.com/ProstheticSuppliers&Manufacturers.htm

http://www.oandp.com/news/jmcorner/2002-07/3.asp

http://www.ortho-europe.com/productshow/premier_products/prem_p1.htm

http://www.ortholite.co.uk/productshow/eco_products/ecoprod1.htm

http://www.orto-ped.com/pdf/AirLock.pdf

http://www.orto-ped.com/pdf/GrommetLock.pdf

http://www.ottobockus.com/products/patient_comfort/shuttle_locks.asp http://www.owwco.com/CategoryList.aspx?Key=8

http://www.owwco.com/pdf/PM/PM1999_Fall.pdf

http://www.seattlesystems.com/products/catalog_app/index.cfm?catSelect=1&subCatSelect=3

http://www.spsco.com/press/09-13-02b.html

http://www.talkaboutsupport.com/group/alt.support.amputee/messages/5420.html

http://www.virginiaprosthetics.com/files/30_37.pdf

Kruger, Leon M. *"Lower-Limb Deficiencies: Chapter 35A/Surgical Management."* Atlas of Limb Prosthetics: Surgical, Prosthetic, and Rehabilitation Principles (Second Edition). Ed. John H. Bowker & John W. Michael. (St. Louis: Mosby-Year Book, 2002)

I would like to thank a number of individuals for their assistance and encouragement during the course of this project. Without their help, I could not have successfully completed the manual: Thomas Sandy II, Thomas Sandy III, Randy Graham, Jeff Cole, Jeff Kuehn, all respondents to my survey, all customer service representatives, engineers, prosthetists, other employees from the various manufacturers that helped me gather the data for my pin lock chart, the NCP staff (particularly Bob Lin, Matthew Parente, and Paul Armstrong), and of course…Pops. Thank you very much!