13 Design Considerations for Carpometacarpophalangeal Joint Arthroplasty

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Introduction

The thumb is crucial for a patient's well-being, providing approximately 40% of hand function, and over 20% of body function [1]. In turn, this function depends on a thumb carpometacarpal (CMC) joint that is both stable and mobile, allowing for an impressive array of motion. The CMC is also tied intimately to the surrounding joints, including the trapeziotrapezioid, scaphotrapezial (ST), scaphotrapezial-trapezoid (STT), and trapezium-index metacarpal joints.

Epidemiology

The thumb CMC joint is the second most common site of arthritis in the hand (following the distal interphalangeal joints), and more commonly affects women than men, up to seven times as frequently [2]. Like other forms of arthritis, it is strongly associated with aging; advancing age is the strongest risk factor [3]. At age 75, the prevalence of the radiographic thumb CMC arthritis in women is at least 40%, compared with approximately 25% in men [4]. The severity also increases with age, and the prevalence of severe arthritis approaches 70% in women older than 80 years of age [2]. The gender differences may be due, in part, to the influence of ligamentous laxity and hormones, and less so anatomy [5, 6].

When affected by osteoarthritis, a number of treatment options exist, including CMC arthroplasty. While this term encompasses a large variety of procedures, from simple trapeziectomy, ligament reconstruction and tendon interposition, to prosthetic replacement, the goals remain the same: pain relief, motion to perform everyday tasks, preventing deformity at adjacent joints, and immediate and long-term stability [7].

Clinical Presentation

Symptoms typically include the insidious onset of progressive basilar thumb pain, worse with forceful pinch grasp. Physical exam demonstrates a positive CMC grind test, reproducing pain with passive joint motion under axial load; this test is quite specific (97%) but not very sensitive (30%). The traction-shift test, in which subluxation and relocation reproduces and then

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G. J. W. King, M. Rizzo (eds.), *Arthroplasty of the Upper Extremity*,
https://doi.org/10.1007/978-3-030-68880-6_13

lessens pain, is more sensitive (67%) and specific (100%) [8]. Tenderness at the CMC joint is common. A compensatory hyperextension deformity of the metacarpal (Z-deformity) may be present, especially in longer-standing CMC arthritis with limited abduction [9].

Eaton-Glickel Staging

In addition to the clinical symptoms, thumb CMC arthritis may be evaluated radiographically with the Eaton-Glickel classification system [10]. Stage I involves slight joint widening, while Stage II progresses to joint space narrowing and adds minimal subchondral sclerosis and joint debris <2 mm. Stage III demonstrates significant narrowing or obliteration of the joint space, along with joint debris >2 mm, sclerotic bone, cystic changes, and varying degrees of dorsal subluxation. Stage IV includes major subluxation, scaphotrapezial joint involvement, and significant sclerotic, cystic, and osteophytic formation. Although useful for discussion, the Eaton-Glickel classification has a poor correlation with symptoms and only poor-to-fair interrater reliability (Table 13.1) [11–13].

Table 13.1 The Eaton and Littler radiographic staging system for basal thumb osteoarthritis

Stage	Radiographic findings
I	Normal articular contours; slight widening of joint space (joint capsule distension)[a]
II	Slight narrowing of joint space; calcific/bony debris <2 mm in diameter; minimal sclerotic changes[a]
III	Marked joint space narrowing; sclerotic bone and cystic changes; varying degrees of subluxation; debris >2 mm in diameter; STT joint spared[a]
IV	Obliteration of TMCJ as in stage III with STT joint narrowing associated with sclerosis and cystic changes[a]
V	Pantrapezial arthritis[b]

From: Berger et al. [12] (with permission)
STT scaphotrapezial trapezoid, *TMCJ* trapeziometacarpal joint
[a]From Wajon et al. [16]
[b]From Tomaino [83]

Indications for Surgery

Initial treatment for basilar thumb arthritis is conservative, with activity modification, brace use, therapy, and oral (or topical) nonsteroidal anti-inflammatories [14–17]. If pain continues, injections of corticosteroids (or hyaluronic acid, although only preliminary data exist) may be considered [14, 18–22]. Pain and loss of function that is refractory to these conservative measures is the relative indication for surgery. Other considerations for the choice of surgical management include MCP joint instability and STT joint involvement.

History of CMC Arthroplasty

In 1949, Gervis et al. recommended simply removing the trapezium as treatment for painful basilar thumb arthritis [23]. One particular concern with simple trapeziectomy is the risk of metacarpal subsidence, with a potential loss of strength and first ray length. Although many techniques have subsequently been described and have increased in popularity, no one specific method had shown to have a convincing clinical benefit to justify extra surgical time, morbidity, and expense. The simple trapeziectomy is certainly not perfect, with a loss of strength, but does reliably restore motion and decrease pain [24]. A number of recent systematic reviews and meta-analyses, including a Cochrane Database review, showed no superior procedure with regard to pain, physical function, motion, or global assessment [16, 17, 25–27]. When considering new designs for CMC arthroplasty, simple trapeziectomy may be regarded as the standard.

To prevent subsidence, the metacarpal should be suspended or supported in some manner. Froimson suggested placing a ball of tendon (harvested from the forearm) into the space formerly occupied by the trapezium [28]. In 1973, Eaton described a ligamentous reconstruction, using a tendon (again harvested from the forearm) to reconstruct the ligaments between the first and second metacarpal bases to suspend the thumb metacarpal in two planes and reinforce the lax volar ligaments [29].

These two ideas were combined in 1986 by Burton and Pelligrini, with the ligamentous reconstruction and tendon interposition (LRTI) procedure, first performing a trapeziectomy, and then using a forearm tendon to reconstruct the ligament, and finally forming it into a space-occupying ball (Fig. 13.1) [30]. This has become the most commonly performed method of surgical management in the United States and has generally enjoyed a high rate of satisfaction, good pain relief, and minimal subsidence [14]. However, there remain concerns about the morbidity of tendon harvest, as well as operative time. This may also be achieved by a hematoma distraction arthroplasty, in which the thumb metacarpal is temporarily pinned to the second metacarpal for 4–6 weeks, and a hematoma is allowed to form and consolidate.

The thumb metacarpal may also be suspended through synthetic means. Suture suspensionplasty, in which the flexor carpi radialis (FCR) and abductor pollicis longus (APL) tendons are sutured together with nonabsorbable suture, has been recently described and popularized and may represent a cost-effective strategy to maintain ray length with minimal morbidity [31–33]. Suture-button suspensionplasty, using a suture-button implant (i.e., EndoButton, Arthrex, Naples, FL), has been another recent innovation. By providing a robust mechanism for suspending the thumb metacarpal to the second metacarpal, this may allow for earlier rehabilitation and loading of the joint with less subsidence (Fig. 13.2); however, there have also been early reports of metacarpal fractures through drill holes [34–37].

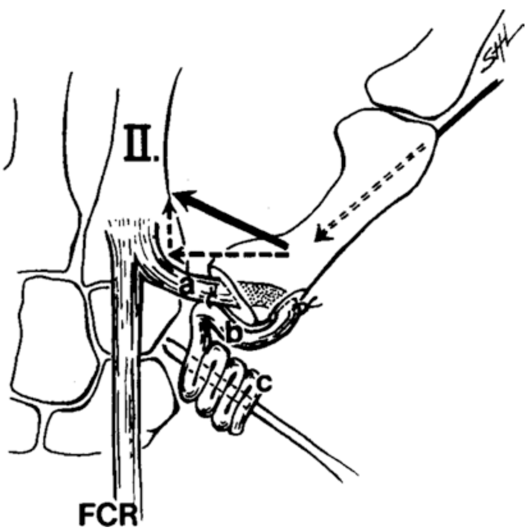

Fig. 13.1 Schematic representation of ligament reconstruction with tendon interposition arthroplasty. The forces in function producing proximal migration and radial subluxation of the metacarpal are neutralized by ligament reconstruction as indicated in the vector diagram. *Key: a,* ligament reconstruction, *b*, metacarpal resurfacing; *c*, tendon arthroplasty spacer. (From: Burton et al. [30] (with permission))

Management of basilar thumb arthritis does not necessarily demand a full trapeziectomy. For early-stage disease with normal articular surfaces and symptomatic volar ligament laxity, an isolated volar ligament reconstruction (using FCR or APL) may be appropriate. Arthroscopic debridement has shown to improve pain and satisfaction, albeit with no differences in objective measures; this technique is relatively new, and longer-term follow-up is needed for a full evaluation [38–40]. Metacarpal extension osteotomy, which may involve load transfer and diminished laxity by placing the thumb base in 30° of extension, may be useful for patients with mild to moderate disease [41, 42]. Arthrodesis of the CMC joint may be indicated for young patients with significant demands of their hands, such as laborers, and should not be used for patients with scaphotrapezial arthritis (as this transfers axial loading to the scaphotrapezial joint) [25, 38, 43, 44].

Lastly, a number of prosthetic implants have been designed, with varying degrees of success. These include interposition-type designs, hemiarthroplasty, and total joint arthroplasty. Please see section "Prosthetic Designs" for further detail. A recent systematic review and meta-analysis demonstrated a significantly higher incidence of failure for implant-based arthroplasties, when compared to non-implant procedures (simple trapeziectomy, LRTI, fusion) [45].

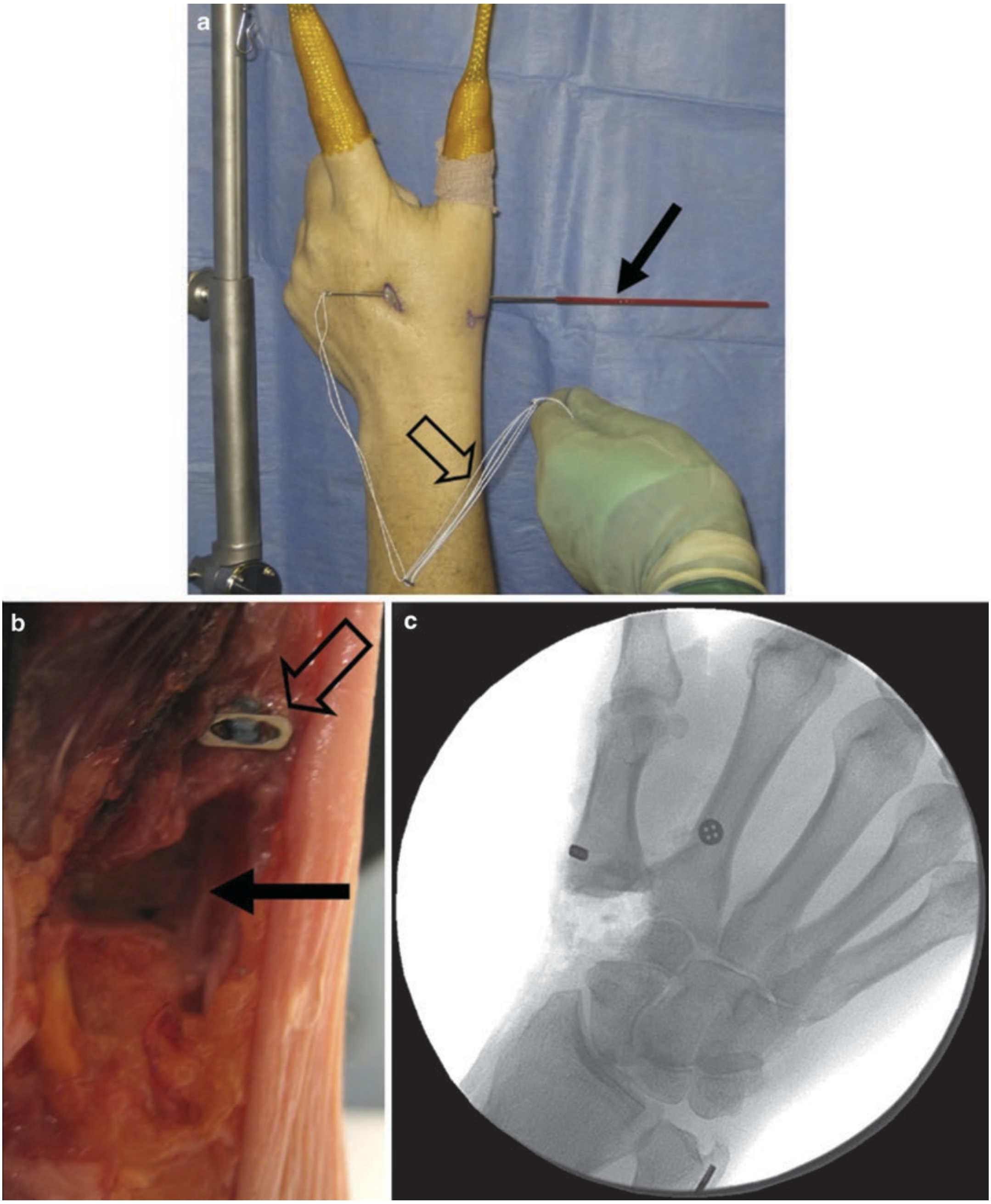

Fig. 13.2 (**a**) Clinical photograph. Solid arrow indicates suture passer passing through the base of the first metacarpal and exiting through the dorsal accessory incision. Open arrow indicates the suture button device. (**b**) Cadaveric photograph. Solid arrow indicates the trapeziectomy site. Open arrow indicates the suture button device implanted at base of the thumb metacarpal. (**c**) Fluoroscopic image of the suture button device in situ. The two stainless steel buttons are secured on the ulnar aspect of the second metacarpal diaphysis and the radial base of the thumb metacarpal. The radiolucent sutures are not visible. (From: Yao et al. [35] (with permission))

Anatomy

Bony Anatomy

The bony anatomy of the thumb CMC joint is complex, and although it has been studied and admired for thousands of years, novel aspects continue to be discovered. Noted by scholars dating back to Aristotle, the thumb drives prehension, primarily through opposition [46]. This mechanism, which positions the thumb tip opposite the tips of other digits, comprises rotation and translation along multiple axes.

The CMC joint has a biconcave-convex (reciprocal interlocking saddle) shape, which provides little inherent static stability. The articular surfaces are also not size-matched; the diameter of the trapezial surface is approximately 34% smaller than the metacarpal base diameter [47, 48].

The architecture of the trapezium dictates that the axis of the thumb at the CMC joint rests in pronation and approximately 80 degrees of flexion (relative to the plan of the finger metacarpals) [49]. This position in space optimizes the ability of the thumb to perform opposition. The unique bony morphology of the thumb allows motion including flexion, extension, abduction, adduction, hitchhiker, circumduction, and opposition. Opposition includes a screw-home torque rotation in its final phase, which greatly enhances the stability [50]. These motions combine to create functional movements, such as power grip, power pinch, and precision pinch.

When considering the design of a CMC arthroplasty, this balance between a lack of inherent instability and wide range of motion much be carefully considered, balancing stability and mobility [9]. This may be particularly important with prosthetic implants, but also remain important concerns when designing a ligamentous reconstruction.

Ligamentous Anatomy

The ligamentous anatomy is critical to the stability of the CMC joint. As few as 3 and as many as 16 ligaments have been described as primary stabilizers of the joint and are generally thicker dorsally and thinner volarly (Fig. 13.3) [46, 50, 51]. Although the volar anterior oblique ("volar beak") ligament was previously thought to be a primary stabilizer, more recent studies have demonstrated that this is primarily a capsular structure, with a mean thickness of 0.71 mm [52].

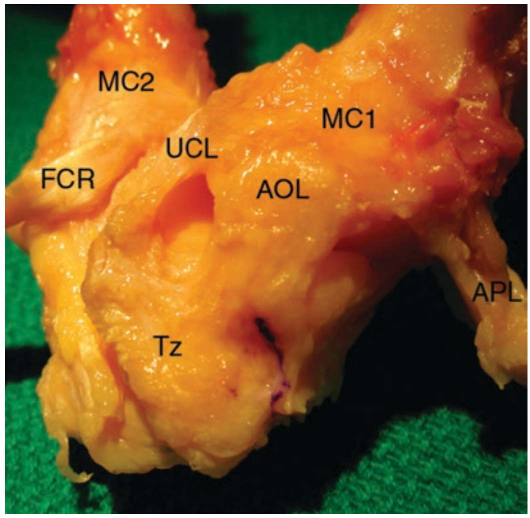

Fig. 13.3 The volar thumb CMC ligaments from a right hand, showing the attenuated volar anterior oblique ligament (AOL) and ulnar collateral ligament (UCL), which course from the trapezial ridge (Tz) onto the volar base of metacarpal 1 (MC1). Also seen are the abductor pollicis longus (APL) and the flexor carpi radialis (FCR) tendons, as well as the base of metacarpal 2 (MC2). (Courtesy of Amy Ladd, MD, and Stanford University, Palo Alto, CA)

In contrast, the dorsal deltoid (dorsoradial) ligament is comprised of three thicker (mean 1.85 mm) ligaments, with an ultrastructure of grouped collagen bundles, consistent with a role of primary stabilizer of the CMC joint [52, 53]. Arising from the dorsoradial tubercle of the trapezium and inserting broadly onto the dorsal base of the metacarpal, this ligament primarily resists dorsal and dorsoradial forces and plays an important role in any reconstructive procedure (Fig. 13.4). The thumb ulnar collateral ligament is extracapsular and acts to prevent volar subluxation of the metacarpal base [47, 52].

The intermetacarpal ligament, running between the thumb and index metacarpal, helps to stabilize the CMC joint if both the dorsal and volar ligament complexes are incompetent. This

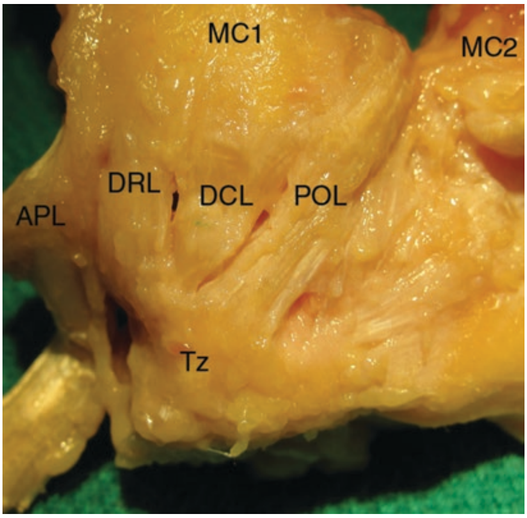

Fig. 13.4 The dorsal thumb CMC ligaments from a right hand showing the dorsal deltoid ligament complex consisting of the dorsal radial ligament (DRL), dorsal central ligament (DCL), and posterior oblique ligament (POL), all emanating from the dorsal tubercle of the trapezium (Tz). Also seen are the dorsal bases of metacarpal 1 and 2 (MC1, MC2) and the abductor pollicis longus (APL). (Courtesy of Amy Ladd, MD, and Stanford University, Palo Alto, CA)

ligament is recapitulated in a ligament reconstruction or suspensionplasty procedure after a trapezium excision, usually a tenodesis between the FCR and APL tendons.

Ligament physiology may differ between the sexes (unlike the bony morphology) and can be affected by systemic pathology. Various studies have shown a correlation between joint hypermobility, as with Ehlers-Danlos syndrome, and CMC arthritis [54, 55]. Reproductive hormones such as relaxin may influence ligamentous laxity (and therefore predispose to ligament attenuation and then arthritis), although this has not been fully demonstrated in the CMC joint [56, 57].

Biomechanics

With the length of the thumb as a lever arm, thumb CMC joint experiences a considerable amount of force. Compared with the pinch force at the thumb tip, the CMC joint undergoes a force that is up to 13.4× greater, while the shear stresses are 2.5× the applied force [50]. Normal grasping activities can have an applied force of 20 kg, while power grasp may generate a deforming force of 120 kg.

The unique morphology of the CMC joint dictates that the mechanical load transmission are complex, are dynamic through the range of motion, and may change with abnormalities of structure (i.e., arthritis) or physiology (i.e., hyperlaxity). Cantilever bending produces forces that are directed dorsally and radially at the base of the metacarpal, which results in shear forces. An increased load is borne by the volar surface, which correlate to the radiographic, surgical, and cadaveric findings of the "cirque" pattern of preferential volar wear [9, 46, 58–64].

Kinematics

The thumb CMC joint facilitates a variety of motions important for day-to-day function. The arcs of motion include flexion-extension, abduction-adduction, and pronation-supination (Fig. 13.5). In healthy adults, key pinch involves volar translation of the metacarpal, as well as internal rotation, and flexion relative to the distal trapezial surface. For object grasp, the thumb metacarpal progresses through ulnar translation of the metacarpal, flexion, and abduction on the distal trapezial surface. For each of these tasks, it is important to appreciate a coupling of the flexion-extension and abduction-adduction arcs; extension of the thumb metacarpal is associated with adduction, while flexion is associated with abduction [9, 63, 65, 66].

During the "screw-home" mechanism in terminal opposition, the dorsal ligament complex tightens and the volar ligament complex becomes lax, compressing the volar beak of the thumb metacarpal into the recess area of the trapezium (the pivot point, Fig. 13.6) [50]. Anatomically, this compression changes the CMC joint from incongruous to congruous and, functionally, from unstable to stable. This screw-home mechanism is therefore the key to opposition and in turn permits such other motions as power pinch, lateral pinch, thumb-to-tip pinch, three-jaw chuck

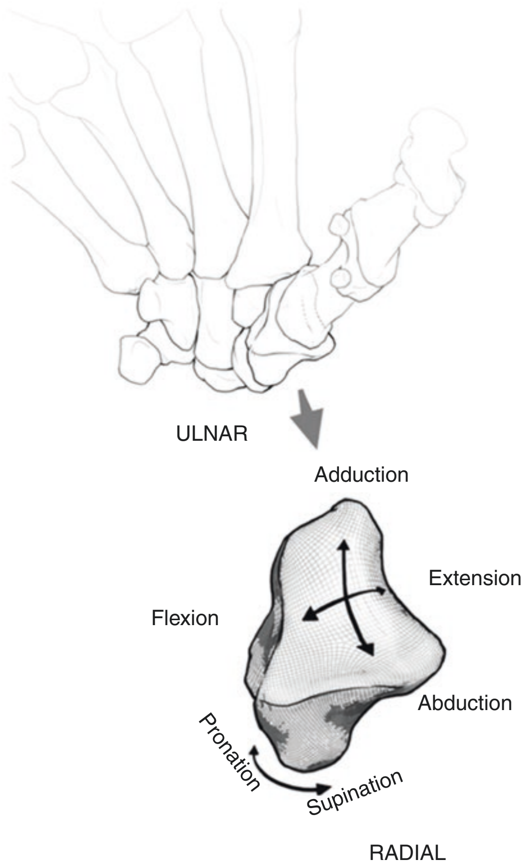

Fig. 13.5 Arcs of motion about the trapezium. (Published with kind permission of S. Hegmann 2014. All Rights Reserved)

pinch, power grip, as well as precise touch. Even if the volar beak ligament is incompetent, the screw-home mechanism remains effective.

In considering the design for a proposed arthroplasty, there is an inherent tension between range of motion and stability, so the objectives must be carefully considered and matched to patients' needs.

Pathomechanics of Disease

Pathology of the CMC joint is a function of both anatomy and pathophysiology. Ligamentous laxity of the basal joint leads to abnormal joint contact forces and which can result in articular damage; this becomes a self-reinforcing cycle.

Recent studies have demonstrated no differences between the architecture of CMC joints of men and women (when corrected for sex-related size differences), but have noted that when the CMC joint becomes plagued with osteoarthritis, its architecture changes in a number of possible disparate ways [5, 6, 68]. The "saddle" configuration preserves convexity in the volar-dorsal plane and concavity in the radioulnar plane, while the "dish" morphology demonstrates eburnation of the entire trapezial articular surface (with extensive rimming osteophytes) and is associated with a more severe Eaton stage [58, 59]. "Cirque" morphology, which demonstrates a concave volar slope and variably sized volar osteophytes at the metacarpal beak articulation, often shows minimal scaphoid or trapezoidal wear.

These may be distinct pathways, with the normal saddle shape progressing to either a "saddle" end-stage pattern, or progressively to a "dish" (concentric wear) or "cirque" (eccentric wear) pattern. Alternatively, the normal physiologic shape may degrade first to a "cirque" pattern and finally to a "dish" [59].

Prosthetic Designs

Thumb CMC prostheses are conceptually categorized into a number of groups: total joint arthroplasty, hemiarthroplasty, and interposition arthroplasty [69]. Within each, there are a variety of shapes, materials, and fixation strategies, but all pursue the same overall goal: a thumb CMC joint that successfully balances mobility with stability. Many prosthetic implants have showed initial promise, but disappointing longer-term results (or unable to be replicated); many devices have been removed from the market.

Total Joint Arthroplasty

With separate trapezial and metacarpal components, these implants have a good potential to replicate the native biomechanics of the CMC joint and possible improved strength compared with less anatomic configurations. These are

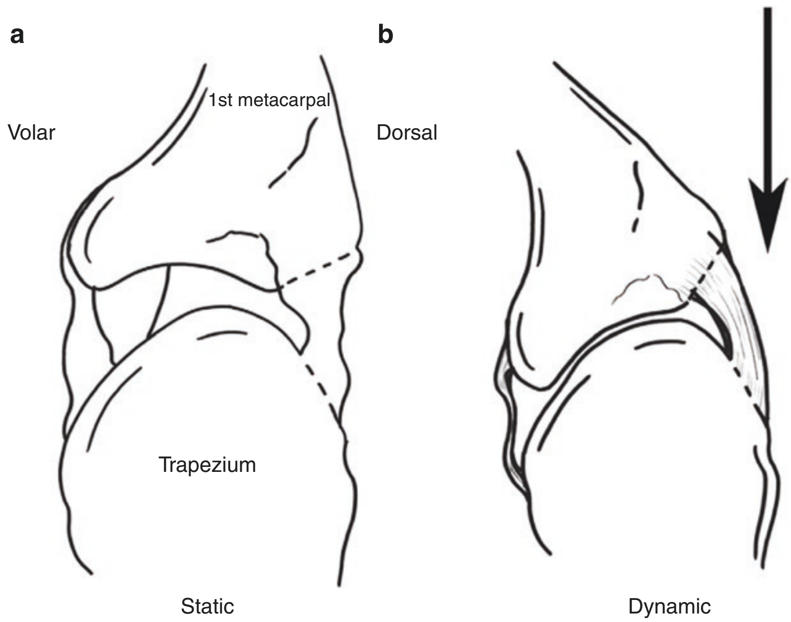

Fig. 13.6 Dynamic force couple. (**a**) The trapeziometacarpal (TM) joint in the static resting position. The volar beak of the thumb metacarpal is disengaged from its recess in the trapezium, the TM joint space is large, and both the volar beak ligament and the dorsal ligament complex are lax. (**b**) The dynamic TM position of power pinch or power grip with screw-home torque rotation, in which the dorsal ligament complex tightens, the volar beak ligament becomes even more lax, the TM joint is compressed, and the volar beak of the thumb metacarpal is compressed into its recess in the trapezium. This forms a dynamic force couple that changes the TM joint from incongruity and laxity to congruity and rigid stability. (From: Edmunds [67] (with permission))

typically ball-and-socket designs, with the metacarpal stem articulating with the trapezial socket. Constrained (linked) implants are more stable, but have a higher risk of loosening, as there are considerably higher stresses placed on the bone-implant interface.

Notable total CMC joint implants include the de la Caffiniere prosthesis, a cemented ball-and-socket design that is likely the most commonly used (Fig. 13.7b). There has been considerably study of this prosthesis, and it has enjoyed better outcomes when performed for indications of pain and instability, rather than stiffness [26, 70, 71]. However, some series have found unacceptably high rates of loosening (approximately 40%), with both cemented and noncemented options [72]. Other total joint implants include the Elektra prosthesis, which has been fairly well-studied, although has very high failure rates from non-design surgeons [26, 73]. The Braun-Cutter prosthesis (SBI/Avanta Orthopaedics, San Diego, CA) is a cemented ball-and-socket design, although with limited results; this maybe reliable for use in elderly, low-demand patients [26]. The Avanta CMC prosthesis (Stryker, Mahwah, NJ) is a resurfacing articulation that aims to replicate the anatomy of the saddle joint, with cemented cobalt-chrome (CoCr) pegged trapezial and UHMWPE metacarpal components [26, 74]. There are many other similar designs, but none with results that demonstrate consistent safety, efficacy, and freedom from loosening/revision (Table 13.2); total joint arthroplasty has mostly fallen out of favor in the United States [26].

Hemiarthroplasty

Hemiarthroplasty prosthesis designs are separated into anatomic and non-anatomic designs and are made in a variety of materials. The NuGrip (formerly PyroHemiSphere, Integra LifeSciences, Plainsboro Township, NJ) is a partial trapezial resurfacing design, with a stem in the metacarpal,

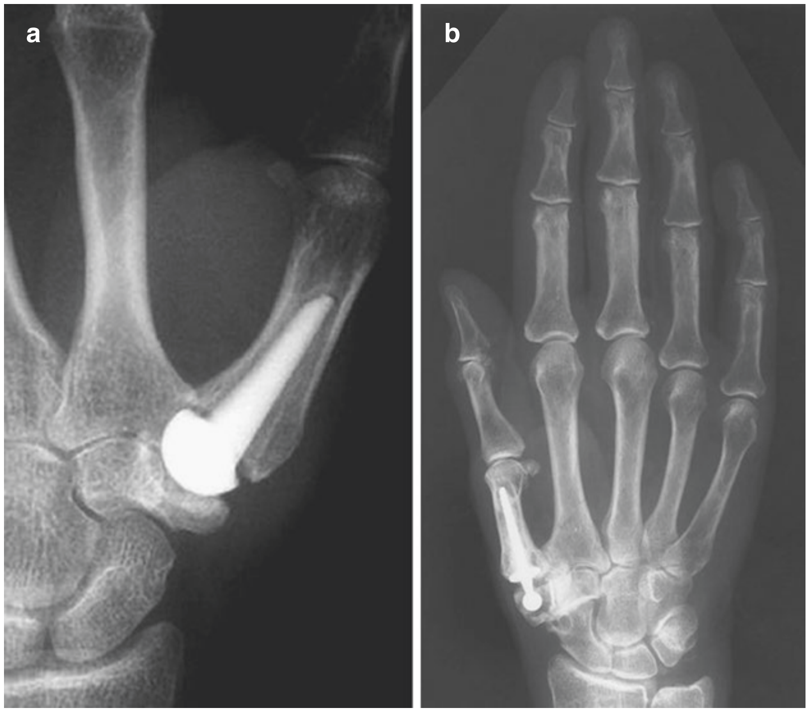

Fig. 13.7 (**a**) A pyrolytic carbon hemiarthroplasty seen on posteroanterior radiograph at 17 months postoperatively. (From: Martinez de Aragon et al. [75] (with permission)). (**b**) Posteroanterior radiograph of de la Caffiniere prosthesis at 15 years postoperatively revealing loosening of both cup and stem with dislocation. Note the vertical position of the metal ring of the cup and dislocation of the components. Despite the radiographic appearance, this patient had excellent clinical and subjective scores. (From: van Capelle et al. [76] (with permission))

which articulates with the reamed surface of the trapezium (Fig. 13.7a) [26, 69]. These hemiarthroplasty configurations are inherently less constrained than total joint arthroplasties, which may improve the rate of trapezial component loosening with less stress and the bone-implant interface. However, the lesser constraint at the CMC articulation may require ligamentous stability, and several series have been plagued by metacarpal subluxation [69]. The Swanson titanium condylar hemiarthroplasty demonstrated excellent results by the design surgeon group, although these were not able to be reproduced (Vitale). Other examples include the PyroCarbon Saddle (Integra LifeSciences, Plainsboro Township, NJ) and CMI Carpometacarpal Implant (Wright/Tornier, Memphis, TN) (Table 13.2).

Interposition Arthroplasty

Interposition arthroplasty designs seek to maintain trapezial height with a synthetic spacer, following either a partial or total trapezial resection. Unconstrained designs following partial resection include Pyrocardan (Wright/Tornier, Memphis, TN), a biconcave pyrocarbon spacer inserted into the CMC joint after minimal resection. Constrained designs following partial trapezial resection include Artelon (SMI, Morristown, NJ), a T-shaped biodegradable spacer intended to work as both an interposition spacer and an augment to the dorsal capsule, to prevent dorsoradial subluxation of the metacarpal (Fig. 13.8). Despite the theoretical benefits of this design, longer-term results have shown that patients treated with an Artelon were less satisfied and had lower grip strength than those treated with LRTI [69, 77]. Other interposition prostheses include the PyroDisk (Integra LifeSciences, Plainsboro Township, NJ), a biconcave disk with a central hole to permit stabilization; follow-up remains short, and the results have not been shown to be convincingly better than the alternatives (LRTI, etc.; Table 13.2) [69].

Interpositional arthroplasty designs may also be total trapezial replacements, made of varied material such as silicone (Swanson, Wright/Tornier, Memphis, TN), metallic (TrapEZX, Extremity Medical, Parsippany, NJ), and pyrocar-

Table 13.2 Review of thumb CMC implants and outcomes

Prosthesis	No. of implants	Mean follow-up (mo)	Implant survival at last follow-up (%)	Complications	Study
Elektra	39	48	56	Loosening	Klahn et al. 2013 [84]
ARPE	65	60	94	5 Nonfunctional; radiologic cup subsidence in 16%	Martin-Ferrero 2014 [85]
Artelon	32		63	37% Explantation	Blount et al. 2013 [86]
BioPro	143	72	94	6 Revisions	Pritchett et al. 2012 [87]
Ivory prosthesis	22	67	95	1 Revision because of polythene wear and instability	Goubau et al. 2013 [88]
Arex615R	68	36	87	8 Implants removed due to foreign body reaction	Semere et al. 2013 [89]
MA1A	74	6	100	6 De Quervain, 1 aseptic loosening	Jager et al. 2013 [90]
Moje arthroplasty	12	50	58	All patients had loosening	Kaszap et al. 2012 [91]
Pi2	18	20	94	6 Implants revised	Maru et al. 2012 [79]
Pyrocarbon spacer	70	24	91	6 Dislocations	Szalay et al. 2013 [92]
PyroDisk	19	68	90	2 Patients had symptomatic instability	Barrera-Ochoa et al. 2014 [93]
Suture-button suspensionplasty	21	34	100	CRPS and index metacarpal fracture in same patient	Yao and Song 2013 [94]

CRPS complex regional pain syndrome
From: Baker et al. [74] (with permission)

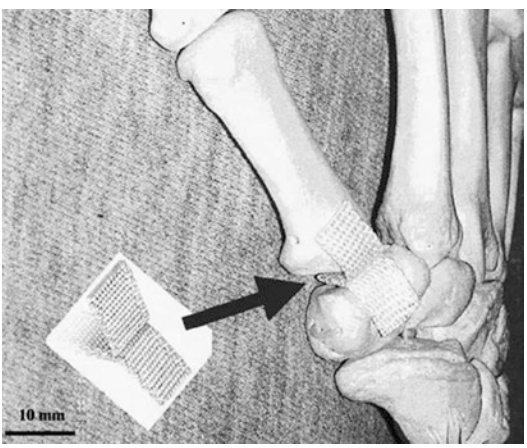

Fig. 13.8 Artelon spacer in the trapeziometacarpal joint in a model. (From: Nilsson et al. [78] (with permission))

bon (Pi2, Wright/Tornier, Memphis, TN). These may not be traditionally stabilized (although some have include suture attachment points), but act as a mobile spacer. The various designs have had a number of serious issues, including silicone synovitis (Swanson) and secondary instability, and have generally had poorer results when compared with non-implant reconstructive procedures (Table 13.2) [69, 72].

Prosthetic Materials and Fixation

Materials

Thumb CMC implants are made from a variety of materials, including cobalt-chrome (CoCr), titanium, pyrocarbon, silicone, and synthetic hydrocarbons, each with a particular set of advantages and disadvantages. An ideal implant material should have excellent biocompatibility, integration with the host bone, wear characteristics (including boundary lubrication and surface degradation), and similar mechanical properties to the cortical bone. Although metallic designs (especially CoCr) are extremely strong and make for robust implants, they are many times stiffer and stronger than cortical bone, and this modulus mismatch may contribute to local stress concentration, implant loosening, and subsidence. Pyrolytic carbon, a synthetic material formed by the pyrolysis of hydrogen gas, has a stiffness similar to cortical bone and may better recapitulate the native biomechanical properties of the thumb CMC joint [72, 79]. Additionally, pyrocarbon has excellent boundary lubrication characteristics, derived from the surface adherence of phospholipids. Although the use of pyrocarbon implants have been supported by good evidence elsewhere in the hand, this has not yet been borne out for thumb CMC use [80–82].

Silicone was the original arthroplasty material used by Swanson, but its use has been curtailed sharply by the development of silicone synovitis, radiographic osteolysis, and frequent need for revision surgery [69]. Hydrocarbon materials, such as ultrahigh molecular weight polyethylene (UHMWPE), Gore-Tex (polytetrafluoroethylene [PTFE], Gore, Flagstaff, AZ), and Artelon (polycaprolactone-based polyurethanurea) have been designed with controllable degradation and mechanical properties. UHMWPE finds particular use in bearing surfaces (especially coupled with metal), while Gore-Tex and Artelon have found more limited applications as spacers, limited by significant synovitis, foreign body reactions, and osteolysis [16, 25, 69].

Fixation

Prostheses may be cemented, may be cementless, or may have no bony fixation. Cemented designs allow for immediate range of motion and weight bearing, while cementless designs may allow for less bony resection, strong bone-implant interface (with either ingrowth or ongrowth surfaces, hydroxyapatite coating, and/or screw fixation), and a shorter operative time. The interpositional designs may either be free-floating (i.e., Swanson), or constrained (i.e., Artelon), which has the theoretical advantage of enhanced stability and decreased prosthetic instability [25, 69]. Any of the designs may be combined with soft tissue procedures to enhance ligamentous stability and may use other implants such as suture anchors, suture buttons, or staples.

Conclusion

Thumb CMC arthroplasty aims to recreate the balance of the stability and mobility found in the native joint, which provides improved function and pain control. The current gold standard for surgical management is trapeziectomy, with or without LRTI or suspensionplasty, which provides reliable pain relief and return of strength. Any new arthroplasty technique must improve upon these proven methods in order to justify the increased risk and cost. Many prosthetic implants have been designed, but none have been able to successfully improve upon (or even replicate) the results of the classic procedures. However, there is a paucity of randomized controlled trials to compare outcomes between the different interventions, or even high-quality prospective studies examining different techniques.

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