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# Development of a cadaveric training model for pollicization of the index finger

## *Développement d'un modèle cadavérique humain pour l'apprentissage de la pollicisation de l'index*

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ABSTRACT

There are currently no surgical models for learning index finger pollicization. This led us to develop and evaluate a cadaveric model for index finger pollicization. Ten hands from fresh cadavers were used. In each case, we evaluated all the surgical steps, the appearance of the web space, the new thumb's position, and the model's advantages and disadvantages. Flap coverage was insufficient due to poor skin condition in 3 cases and the commissure was too short in 3 cases. The dissection and tendon transfer steps were performed correctly in 9 cases. In one case, the interosseous transfer was too proximal. The new thumb was positioned correctly in 6 cases, too proximally in 3 cases, and was insufficiently rotated in one case. Our model reproduces the haptic characteristics of the surgical procedure and is valuable for dissection and flap coverage training.


RÉSUMÉ

A ce jour, il n'existe aucun modèle d'apprentissage de la technique opératoire de la pollicisation de l'index. Nous avons évalué l'utilisation d'un modèle cadavérique de pollicisation de l'index. Dix mains de cadavres frais ont été utilisées. Nous avons évalué dans chaque cas l'ensemble des étapes, l'aspect de la commissure, la position du néo-pouce et précisé les avantages et inconvénients de ce modèle. Le drapage des lambeaux était partiel en raison d'un mauvais état cutané dans 3 cas et la commissure était trop brève dans 3 cas. Les étapes de dissection et les transferts tendineux étaient correctement effectués dans 9 cas. Dans un cas, le transfert des interosseux était trop proximal. Le néo-pouce avait une position correcte dans 6 cas, trop proximal dans 3 cas et pas assez de rotation dans un cas. Notre modèle présente essentiellement une fidélité pour le caractère haptique de la procédure chirurgicale et aussi pour l'entrainement au drapage des lambeaux et à la dissection.


## 1. Introduction

Pollicization of the index finger is a rarely used procedure that creates a new thumb by transposing the index finger, thus enabling pulp-to-pulp pinch grip [1,2]. The indications are congenital malformations of the hand, more specifically thumb aplasia or severe thumb hypoplasia. This is a demanding surgical procedure with many steps - each of which is important for obtaining a four-fingered hand with a cosmetically and functionally acceptable thumb. Buck-Gramcko proposed four basic principles for pollicization of the index finger:

- careful demarcation of the skin incisions to achieve optimal cosmetic and functional flap coverage;
- careful dissection of the veins and the neurovascular pedicle;
- readjustment of the bone skeleton, with preservation of the metacarpophalangeal joint (including the hyperextended position of the metacarpal head), and;

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- stabilization of the muscles, in particular the dorsal and palmar interossei muscles [3,4].

At present, there are no surgical models for learning index finger pollicization. Fresh human cadavers are frequently used to teach anatomy and surgical techniques [5,6]. Hence, we hypothesized that a human cadaver would be a valid tool for learning index finger pollicization techniques. The objective of our study was to evaluate the advantages and disadvantages of this cadaveric model.

## 2. Materials and methods

### 2.1. Surgical technique

We used the surgical technique described by Buck-Gramcko, with the skin incisions as modified by Dautel [3,4,7]. We also studied the YouTube video published by Dautel [8]. In Dautel's method, the dorsal and anterior incisions differ from those initially described by Buck-Gramcko, and go beyond the proximal interphalangeal joint (Fig. 1) [7].

### 2.2. Cadavers

We used 10 hands (5 left and 5 right) from fresh, non-injected cadavers (whole body: $n = 2$; whole upper limb: $n = 1$; hand alone: $n = 7$). We amputated thumb by making an incision on the anterior lateral edge. The thenar muscles and the trapezius were resected. The amputation wound was closed with overlocked stitches.

### 2.3. Methods

Two hands were operated on during the same surgical session. The operating time (excluding the thumb amputation time) was calculated for each hand. For each pollicization, a senior surgeon evaluated the following points: suitability of the incisions, draping (complete, partial or incorrect), appearance of the commissure (short or correct), and reasons for failure. We evaluated the dissection steps, the preservation of dorsal veins (Fig. 2A) and radial and ulnar pedicles (Fig. 2B), and the extent of interossei muscles exposure. We then assessed the readjustment of the bones, the osteotomy, and the hyperextension of the head of the second metacarpal (incorrect, partial or correct). Furthermore, we assessed the position of the tendon transfers (incorrect or correct) and the new thumb's overall position using the cosmetic portion of the Percival score [9]. We assessed the thumb's position (considering tip to within 0.5 mm proximal interphalangeal joint index as correct) and thumb's rotation (considering 90°–160° rotation as correct). Lastly, we noted general problems associated with the use of cadavers.

## 3. Results

The pollicization was achieved in all 10 cases. In two cases, the skin incisions were incorrectly marked; the italic "S" was too distal, which resulted in partial flap coverage. In three other cases, partial flap coverage resulted from poor skin condition (cardboard-like skin in one case and brittle skin in two cases). The commissure was too short in three cases.

The dissection steps were always performed correctly, although the procedure was challenging for a hand with Dupuytren's disease. All the dorsal veins were present and were preserved in 9 of the 10 cases (Fig. 2). Osteotomy was always easy to perform, and the head of the second metacarpal was correctly placed in hyperextension in 7 cases. In three cases, the head of the second metacarpal was only partially extended because it was difficult to obtain a stable position by bone suturing. The tendons were transferred in all cases and were correctly positioned in 9 cases. In the remaining case, the dorsal interosseous attachment was too proximal, and the muscle did not take on its new function as a short abductor. The general position of the new thumb was correct in 6 cases, up to the proximal interphalangeal joint distal in 3 cases, and insufficiently rotated in one case (Figs. 3,4). The mean (range) operating time per hand was 1.25 hours (0.75–2). We encountered technical difficulties with our first two hands (taken from a whole body) because rigor mortis limited pronation and supination movements of the forearm.

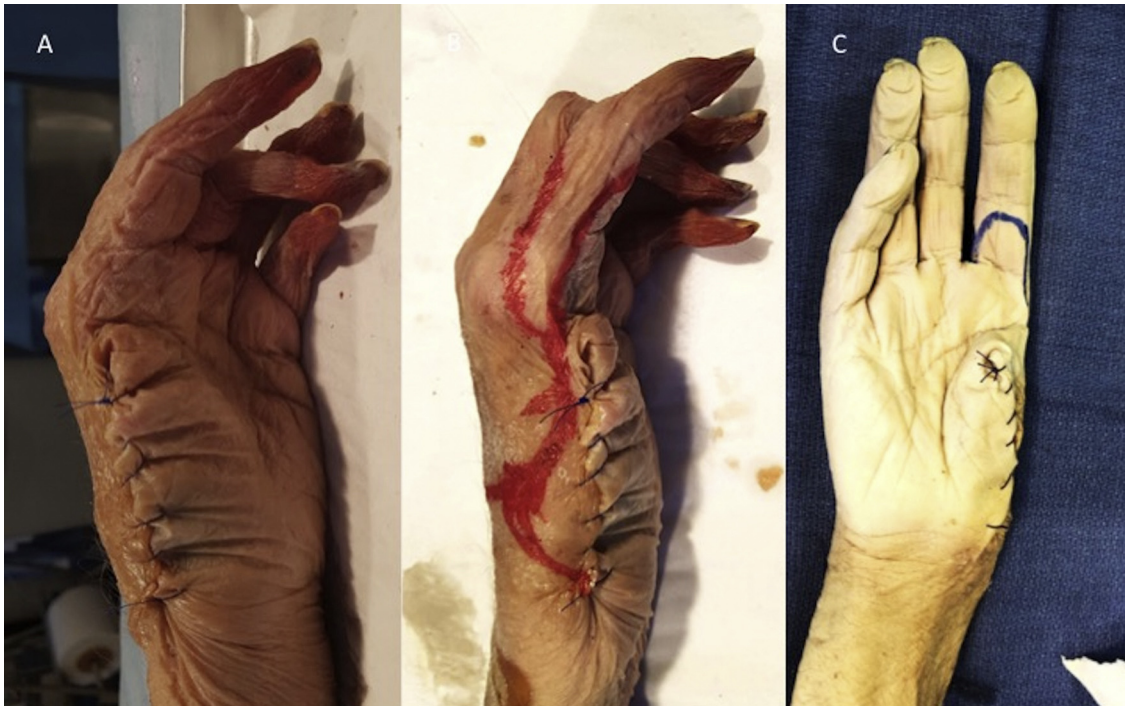


**Fig. 1.** A cadaveric four-fingered hand, with the amputated thumb (A). Lateral skin incision markings (red) (B). Anterior skin incision (blue) (C).

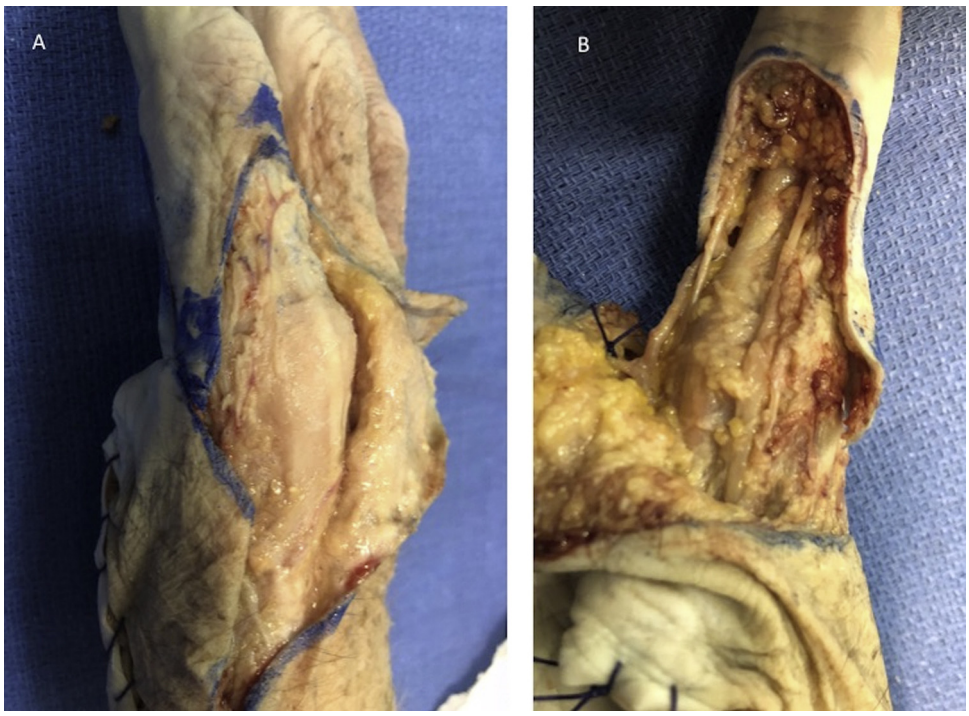


**Fig. 2.** Vein dissection (A). Anterior dissection (B).

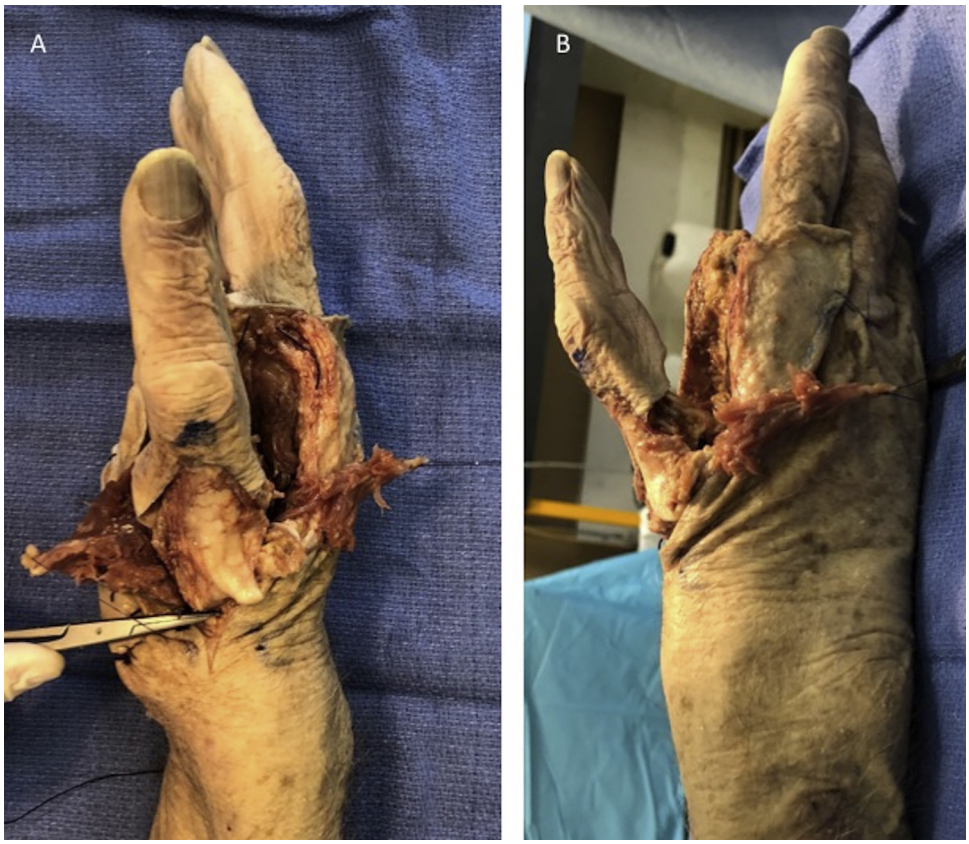


**Fig. 3.** Lateral view of the new thumb's position (A). Posterior view of the new thumb's position (B).

## 4. Discussion

Our results show that a human cadaveric model can be used to learn the surgical technique for index finger pollicization. It is widely acknowledged that surgical companionship (in line with Halstead's "see one, do one, teach one") is an excellent teaching method; however, this approach is not always possible or sufficient [10]. Human cadavers have long been used as models for practical training in anatomy and surgery [5,6]. To date, surgical techniques for the correction of congenital malformations of the

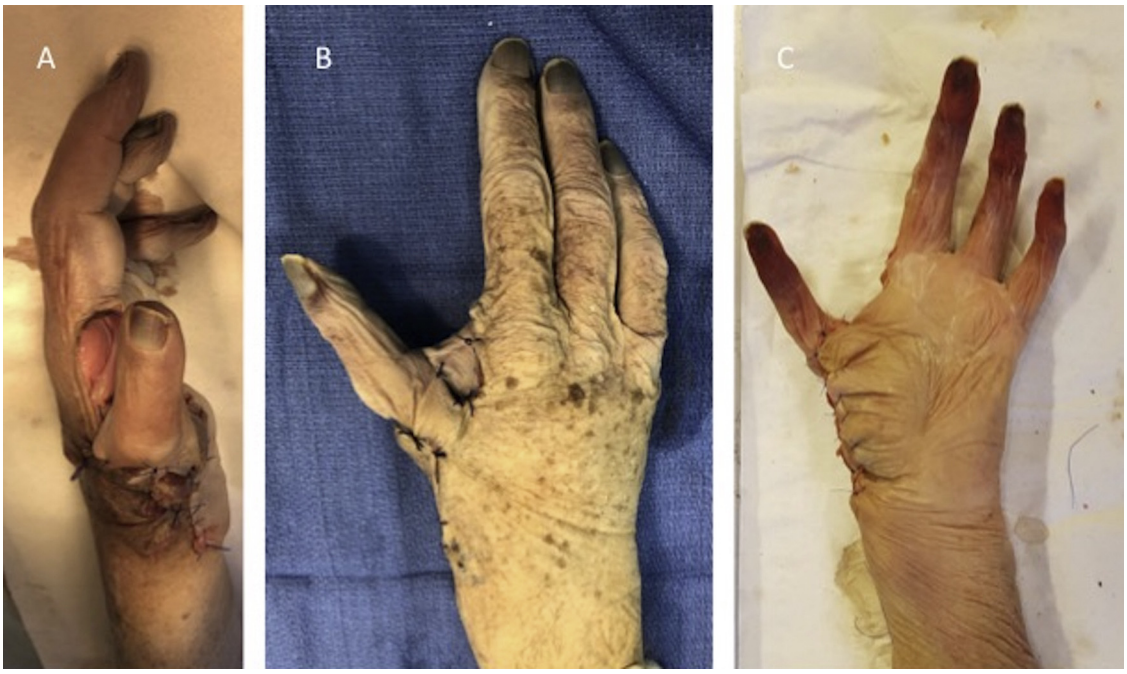


**Fig. 4.** Insufficient skin flap coverage (A). Posterior view of sufficient skin flap coverage (B). Anterior view of sufficient skin flap coverage (C).

hand (such as thumb aplasia) have been taught by master surgeon educators and from books. To the best of our knowledge, a human cadaver model has not been developed for these indications.

Recently, Delgove and Dautel described an anatomical model for comparing different skin incisions for pollicization; it is based on the use of resin molds of a cadaver's two hands (one with the thumb resected, and the other with a pollicized index finger) [11]. A surgical glove is placed first on the mold of the thumbless hand so that skin incisions can be marked and then on the mold of the pollicized hand. This model can be easily created in an anatomy laboratory to supplement the dissection model and can thus compensate for cadaveric skin problems.

The main advantages of a cadaveric training model for pollicization are that it reproduces the surgical procedure's haptic nature and can accelerate learning through the planning and repetition of a multistep process. This is likely to improve technical skills and surgical outcomes and reduce operating and tourniquet times. Planning and repeating procedures can also reduce the surgeon's levels of stress and anxiety. Lastly, the cadaveric model helps to optimize flap coverage, vessel and nerve dissection, bone and tendon repositioning, and muscle transfers.

Our model is not perfect and has a number of limitations. Firstly, it is not suitable for teaching surgical anatomy. Indeed, the main indication for pollicization of the index finger is agenesis or hypoplasia of the thumb; this usually corresponds to a congenital malformation in which the hand completely lacks the first ray, the thenar muscles, and the carpal bones of the radial side [2,4]. In contrast, all the cadaveric hands studied in our study had a normally formed thumb. However, our model may also be of value for reconstructing thumbs damaged by trauma or tumors [12]. Secondly, our use of cadaveric hands from adults does not allow training in the microsurgery required for pollicization of an infant's hand. Similarly, cadaveric rigidity in the hands obtained from a whole body prevented correct pronation-supination movement. Thirdly, our model is dependent on the cadaver's skin condition (cardboard-like or brittle); this is not the case with the thick skin on children's hands, for which excess skin often has to be removed. Lastly, use of our model requires access to a nearby anatomy laboratory and the purchase of cadavers, which can be expensive. Furthermore, one of the most notable limitations of this study is the subjective evaluation of the thumb outcomes.

## 5. Conclusion

Our human cadaveric model appears to be a valid training tool for index finger pollicization and its constituent surgical procedures. A number of approaches for training in pollicization could be developed; they range from resin molds of a child's hand with thumb agenesis to the simulation of a hand with congenital malformation on a four-finger mannequin.

**Disclosure of interest**

The authors declare that they have no competing interest.

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