Anatomical Revelations in 1921 Kindled Operative Repair of the Orbit, Eyelids, and Periorbit over the Ensuing 100 Years: The Diuturnity of Ernest Whitnall (1876–1950) of Oxford, Montreal, and Bristol

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Abstract

Revelations of orbital, intraorbital, and periorbital anatomy by a single author in 1921 kindled attempts at operative repair of the orbit, eyelids, and periorbit over the ensuing 100 years. They are the lasting contributions—the diuturnity—of Samuel Ernest Whitnall (1876–1950) of Oxford, Montreal, and Bristol.

Keywords

- orbital anatomy
- intraorbital anatomy
- periorbital anatomy
- operative repair
- diuturnity
- Samuel Ernest Whitnall

Anatomy of the cranium and facial skeleton was given short shrift for centuries, largely because Ancients gave preference to the human hand as God's greatest creation.¹ Then dramatically and seemingly in intuitive concert, Rene Le Fort (1901), Jean-Leo Testut (1911), and Matthew H. Cryer (1916) (► **Fig. 1a–c**) published descriptions of human craniomaxillofacial form, to include buttresses,^{2–6} all 7 of which spanned the distance between the palatal platform and the cranial vault.

Their collective understanding of craniomaxillofacial form foretold, in a sense, Ernest Whitnall's published details of the anatomy of the orbit, eyelids, and periorbital soft tissue in 1921. In *The Anatomy of the Human Orbit and Accessory Organs of Vision*,⁷ Whitnall (► **Fig. 2**) describes features of the orbital rims, the bilges of the floor and roof of the orbit, plate-like alignment of the orbital walls, triangulation of the orbital apex, ligaments restraining intraorbital soft tissue, and the layered

(lamellar) architecture of the eyelids and adjacent periorbital soft tissue.

Samuel Ernest Whitnall (1876–1950)

Ernest Whitnall, son of Arthur W. Whitnall, was born on March 30, 1876, in Eccles, a conurbation of Greater Manchester (► **Fig. 3**), in North West England.

His early education was earned at Radley College (► **Fig. 4**), an independent boarding school, near Abington, Oxfordshire. The school, housed on an 800-acre campus in South East England, offered then, as it now does, a masterful curriculum.

After Radley College, Ernest became a student at Manchester University (► **Fig. 5**), closer to home, but then soon returned to the South East, to attend Magdalen College (► **Fig. 6a, b**), a constituent college of Oxford University.

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Fig. 1 (a) Photograph of Rene Le Fort (1869–1951), from *Orthopedique et reparatrice de l'appareil moteur. Revue de Chirurgie* 37: 117, 1951. (b) Photograph of Jean-Leo Testut (1849–1925) accessed May 20, 2012 (<http://livre.histoire.free.fr/fichiers/personne/testut.htm>). (c) Photograph of Matthew Henry Cryer (1840–1921), courtesy Ohio State University History Collections and Archives (<http://drl.ohsu.edu/cdm4>; accessed February 23, 2006).

Fig. 2 Photograph of Samuel Ernest Whitnall (courtesy: McGill University and Wikipedia; accessed July 6, 2018).

At Magdalen, the youngster was a recipient of a Welsh Memorial Award.

After receiving MD and BCh degrees from the Oxford University, Ernest Whitnall launched his clinical years by joining the staff at St. Thomas' Hospital, on the southern bank of the river Thames, near London Bridge (→ Fig. 7a, b).

Fig. 3 Manchester, England 1875 (courtesy: The Manchester Libraries and the Daily Mail; www.dailymail.co.uk/news/article.../incredible-photos-manchester-a-century-ago; accessed September 26, 2017).

Fig. 4 Radley College (courtesy: Radley College and Wikipedia; accessed September 26, 2017).

Fig. 5 Classroom, Manchester University (courtesy: Manchester University and Wikipedia accessed September 26, 2017).

Fig. 6 (a, b) Magdalen College, Oxford (courtesy: Magdalen College and Wikipedia; accessed September 26, 2017).

Fig. 7 (a) Saint Thomas's Hospital, London photograph 1069 by W.J. Bishop; <https://doi.org/10.1093/oxfordjournals.bmb.a73282>; accessed September 27, 2017. (b) London Bridge (courtesy: Cornell University Library and Wikipedia; http://en.wikipedia.org/wiki/London_Bridge; accessed September 27, 2017).

Doctor Whitnall was Demonstrator of Anatomy at Oxford under Arthur Thomson, from the time of his qualifications in 1910 until the outbreak of war in 1914. Early in this period of dissection and teaching, he generated two papers of considerable note; each was published in the 1911 volume of the journal of the Anatomic Society, the *Journal of Anatomy*:

- “On a tubercle on the malar bone ... [for] lateral attachment of the tarsal plate.”⁸
- “On a ligament acting as a check to the action of the *levator palpebral superioris muscle*.”⁹

Upon the outbreak of war, Ernest Whitnall accepted a commission in the Royal Army Medical Corp (RAMC) and was

Fig. 8 (a) 3rd Southern General Hospital, Oxford, Cowley Road; accessed September 27, 2017 (http://www.oxfordhistory.org.uk/war/military_hospitals/). (b) 3rd Southern General Hospital, interior; accessed September 27, 2017. (http://www.oxfordhistory.org.uk/war/military_hospitals/).

Fig. 9 (a) Advanced Dressing Station, 1916 in France (courtesy: National Army Museum; <http://army.mod.uk/firstworldwarresources>; accessed September 30, 2017). (b) Cavalry Field Ambulance service in France, 1918 (courtesy: The Royal British Legion, Ramsbottom Branch, and G. Pemberton; accessed September 30, 2017; <http://www.gpembertononline.co.uk/Legion/ww1Wounded.html>).

first assigned to the 3rd Southern General Hospital, located in the Somerville Section of Oxford, on Cowley Road (► **Fig. 8a**). The well-acred complex would eventually expand to 10 additional sites in Oxford, creating wards in several university and city buildings, before war-end (► **Fig. 8b**).

After his 3rd Southern General Hospital assignment, Whitnall served 3 years in France as a member of the Queen's Own Oxfordshire Hussars (QOOH) affiliated with the second Cavalry Field Ambulance Service¹⁰ (► **Fig. 9a, b**).

Doctor Whitnall briefly returned to Oxford after World War I, but, in 1919, was appointed Robert Reford Professor of Anatomy at McGill University, Montreal, Quebec, Canada. Arrival at McGill in 1919 could not have been more propitious: the University had been on a two-decade splurge, expanding the footprint of the University (► **Fig. 10**) by building the East Wing of McGill College (now called the Arts Building) in 1888; the Redpath Library, Physics, and Chemistry buildings in 1893–1896; and the Strathcona Medical Building in 1907. All were constructed with quebe-

Fig. 10 McGill University campus, 1900 (courtesy: McGill University).

Fig. 11 (a) Strathcona Medical Building 1907, within the next decade called the Strathcona Anatomy-Dental Building (courtesy: McGill University). (b) Dissection room, Strathcona Medical Building, McGill University.

Fig. 12 Cover, *The Anatomy of the Human Orbit and Accessory Organs of Vision*, as published by Henry Frowde and Hodder & Stoughton, in 1921.

the medical building was renamed the Strathcona Anatomy-Dentistry Building¹¹ (►Fig. 11a, b).

In 1921, Henry Frowde and Hodder and Stoughton of London published Whitnall's *The Anatomy of the Human Orbit and Accessory Organs of Vision* (►Fig. 12). Whitnall (►Fig. 13a) had begun the manuscript of the book in 1913,

Fig. 13 (a) Photograph of Samuel Ernest Whitnall (courtesy: McGill University Casual Archives accessed July 6, 2018). (b) Photograph of Arthur Thomson, Chairman, Department of Anatomy, Oxford University (courtesy: Wikipedia accessed September 27, 2017).

basing it on a series of his lectures to the students of the Oxford Diploma of Ophthalmology.

Whitnall's laboratory sketches were converted to line drawings by J. C. Simpson, an associate professor of histology and embryology. All but seven photographs in the book were taken at Oxford.^{7,10} The completed 428 pages were dedicated to Arthur Thomson (►Fig. 13b), the chief of anatomy at Oxford. Publication was facilitated by a grant from the McGill University Cooper Fund for Medical Research.

Doctor Whitnall (1876–1950) remained in Canada for 16 years, until, in 1935, he returned home to accept the Chair of Anatomy at Bristol University, Bristol (►Fig. 14a, b). He held the post in South West England until retirement, in 1941.

His travels from North West England to South East England; to Montreal, Canada; and (to cap his career) to South West England (►Fig. 15a, b) were not as peripatetic as cursory review might suggest.

Fig. 14 (a) Bristol, South East England, ca. 1935. Oldukphotos.co.uk (accessed May 10, 2018). (b) Bristol, ca. 1940. Bristolpost.co.uk.1939 (accessed May 1, 2018.)

Fig. 15 (a) Eastern Canada (courtesy: Wikimaps; accessed April 31, 2018). (b) Regions of England, Wikipedia (accessed April 31, 2018).

Eastern Canada: Montreal,
North West: Manchester,
South East: Oxford,
South West: Bristol, England

Discussion

Ernest Whitnall began writing the manuscript of *Anatomy of the Human Orbit*, we would again note, in 1913, in the midst of revelations of craniomaxillofacial form by Rene Le Fort (1901), Jean-Leo Testut (1911), and Matthew Cryer (1916).²⁻⁶ Lectures to Oxford University ophthalmology candidates, interrupted by war, formed the basis for publication of his book in 1921. The first surgeon to utilize Whitnall's anatomical insights appears to have been Julien Bourguet (—Fig. 16), in 1924. The Parisian retracted (and thus bypassed) the anterior lamella of the lower eyelid and made an incision deep in the lower fornix to remove herniated fat of the orbit.^{12,13}

Surgeons over the ensuing century, to include Converse, McCoy, Dingman, Tenzel, Tessier, Rowe, Merville, Manson,

Fig. 16 Photograph of Julien Bourguet (1876–1952) Paris, France (courtesy of Bulletin Academy National Medicine, Paris, France, 1924).

Gruss, Jackson, McCord, Gossman, and Pollock, assuredly in the operating theater and in their publications, also applied the orbital, intraorbital, and periorbital anatomy unearthed by Whitnall.^{14–41} In the case of trauma, thanks to Whitnall, exemplary orbital repair became possible in the presence of untoward polycommunion, dislocation, and fragment instability, even when underlying structure had been “rent asunder, splayed, and distorted.”⁴² Exemplary outcomes follow the combined (canthofornix) approach, attributable to bypassing (and protecting) the anterior lamella.^{39,43}

The diuturnity of Ernest Whitnall is rivetingly dramatized by (1) citing a few of his key 20th century descriptions of the anatomy of the orbit (in bold)⁷ then by (2) matching the selected passages with current 21st century admonishment, photography, and/or illustration germane to successful orbital repair:

1. **“In each lid and canthus, four layers or planes of tissue are identified: cutaneous, muscular, fibrous (the tarsal plate and *septum orbitale*), and conjunctival.”**

“The conjunctival fornix ... is the circular cul-de-sac formed by the ... reflection of the surface membrane from the eyelids to the globe In the diagonal regions of the fornix, that is in the intervals between the muscle sheath expansion, the connective tissue behind the membrane abuts the orbital fat” Whitnall (1921).

Access to the inferior orbital rim, its periosteum, and the lower orbit is efficiently gained by way of an incision in the lower fornix, as the eyelid is draped over the inferior orbital rim. In cases that are certain to require greater exposure, a lateral canthotomy is first achieved (► Fig. 17a–d).

2. **“The brain is slightly hollowed by the domed roof of the orbit and presents ... a composite fissure termed the**

Fig. 17 (a) Anatomy of the lower fornix (labeled “F”), courtesy of M.J. Hawes, K.K. Dortzbach, and permission of the Archives of Ophthalmology and the American Medical Association. (b) Lateral canthal incision, illustrated by Bill Winn, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (c) Lower fornix eyelid incision, bypassing the anterior lamella and granting access to the orbit, illustrated by Bill Winn, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (d) Repair of the lateral canthus after the canthofornix incision, illustrated by Bill Winn, copyright Richard A. Pollock and Thieme Medical Publishers, Inc.

sulcus orbitalis. The olfactory tract crosses obliquely the extreme posterior end of the roof on its medial side The orbital floor surface is slightly concave anteriorly and convex posteriorly, owing to the upward expansion of the maxillary sinus, ... and each orbit has the shape of a pear.” Whitnall (1921).

The bilges of the floor and roof cause the orbits to appear pear-shaped, as dramatized by removal of cribriform plate and much of the ethmoid with cutting burs (–Fig. 18a) and by medical art (–Fig. 18b).

Small-to-moderate defects of the bony orbital floor after trauma (in which the floor is displaced inferiorly and present as orbital “blow-out” injuries) are repaired using commercially available polyethylene implants imbedded with malleable titanium. The polyethylene–titanium implant is manipulated by thumb-and-digit, to mimic the bilge of the orbital floor, and secured to the inferior orbital rim with screw(s). Large defects glean better postoperative results after use of split-cranial bone, from the temporo-parietal outer table above the temporal line. The inherently

Fig. 18 (a) Spectacle-format dramatizes the pear-like shape of the orbits, after removal of the cribriform plate and much of the ethmoid with cutting burs, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (b) Analogy of the orbit as fruit (a pear), as suggested by Whitnall and illustrated by Bill Winn, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (c) Art depicting split-cranial bone grafts (two) mimicking the contours of the orbital floor, one of which is secured at the inferior orbital rim, illustrated by Bill Winn, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (d) Photograph depicting key prealignment and plating of the inferior orbital rim, then insertion of split-cranial “bone assembly” (bottom) secured at the orbital rim, to reconstruct the orbital floor (top), copyright Richard A. Pollock and Thieme Medical Publishers, Inc.

contoured bone grafts mimic the bilge (concavity) of the anterior orbital floor and the convexity of the apex posteriorly (►Fig. 18c, d). Bone grafting remains the “gold standard” in the repair of complex injuries.^{27–32,37,38,40}

3. “The orbital floor ... is formed in greater part by the orbital plate of the maxilla, ... and completed anterolaterally by part of the orbital surface of the zygoma and posteriorly by a small triangular area (the *processus orbitalis*) of the palatine bone.” Whitnall (1921).

The three bones in the floor of the apex are often preserved after high-velocity impact, even when the orbital frame and

bilge of the floor of the orbit are disrupted. Preserved apical floor provides structure upon which a split cranial bone graft may rest and is referred to as the “posterior ledge”³⁴ and the “pre-annular shelf”^{33,40} (►Fig. 19a). Most basilar and frontobasilar fracture lines traverse the roof of the ethmoid, then deviate laterally upon reaching the roof of the sphenoid sinus, to end at the carotid canal or the foramen ovale, lacerum, or spinosum⁴⁴ (►Fig. 19b). Even with such extreme skull-base injury,^{43,45–48} the pre-annular shelf (in the floor of the apex) skirts injury and is consistently available (in a survivor cohort)⁴⁸ as a stable platform to facilitate pan-orbital repair.

Fig. 19 (a) The pre-annular shelf in the posterior floor of the orbit is most often preserved despite high-impact injury; the shelf varies in size and bone density and is the key for pan-orbital repair, photograph copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (b) Art depicting the classic location of a frontobasilar fracture skirting the pre-annular shelf of the apical floor to terminate in one of several skull-base foramina, illustrated by Bill Winn, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (c) Facial force equilibrium circuits (FFEC) according to Rudderman, Mullen, and Phillips and speculated extension of circuits to orbital apex, occiput, and vertebrae of the upper cervical spine,²⁶ illustrated by Bill Winn, copyright Randal H. Rudderman, Robert L. Mullen, John H. Phillips and Thieme Medical Publishers, Inc.

Rudderman et al have demonstrated distribution of facial force equilibrium circuits (FFEC) to and from the cranium⁴⁹ and, we have speculated the presence of circuits to and from “the microbuttresses of the apex of the orbit, posterior skull base (occiput), and the vertebrae of the upper cervical spine” following impact (►Fig. 19c),⁵⁰ even though the shelf in the surviving cohort is most often spared fracture, upon frontal impact.

4. “The lateral wall is ... [linear], save for a slight concavity just behind the margin and is triangular in shape....”

“The lateral wall is formed chiefly by two bones, the greater wing of the sphenoid in its posterior thirds and the upper surface of the zygomatic in its anterior third” Whitnall (1921).

To restore the lateral orbital wall and maintain orbital volume, the orbital plate of the zygoma must realign with the orbital plate of the sphenoid (►Fig. 20a). The realignment would further be in line with the optic strut of the apex (►Fig. 20a, b), although intraoperatively visualization of the strut in the live patient is precluded by the mass of the globe.

Proper realignment of lateral wall components avoids inadequate rim-and-malar projection and disallows postoperative orbital expansion (manifest as enophthalmos).^{32–34,36,38,40}

5. “The roof is formed in greater part by the frontal bone and, at the apex, by the lesser wing of the sphenoidal bone ...; the roof presents in outline the shape of an isosceles triangle.”

“The roof ... is separated from the medial wall in great part by the fronto-ethmoidal suture; a backward prolongation of this line passes just below the optic foramen.”

“The roof presents more variation in its thickness than any other wall ... [but is most often delicate and thin] in the posterior two-thirds ...; dehiscences due to atrophy ... may be present, [and then] the periorbita is in contact with the dura mater.” Whitnall (1921).

Fracture of the orbital roof tends to be displaced inferiorly as a “blow-in” fracture. The displaced roof reduces orbital volume and may cause exophthalmos.^{25,26,28,30,33,34,37,44,45,50}

Anterior roof fractures are repaired with a commercial implant or a bone graft secured at the superior orbital rim. Posterior roof fractures, the most common because of relative thinness of the bone posteriorly, are usually medial and are best repaired with the so-called top-hat split-cranial bone graft placed by way of a combined neurosurgical approach (►Fig. 21a, b). The size and shape of the graft varies according to the defect to be filled.

6. “The ...medial wall alone is quadrilateral in shape; the others are triangular [It] is formed by 4 bones (the lacrimal, the body of the sphenoid, the ethmoid, and the frontal)”

“The medial wall is the thinnest of the four orbital boundaries The orbital plate of the ethmoidal bone has paper-like delicacy ... [and, it is thus appropriately] termed the *lamina papyracea*.”

“The surface of the medial wall is ... convex about the centre and concave in front in harmony with the contour of the eyeball, though these curves are but slightly marked” Whitnall (1921).

The middle and posterior ethmoid cells project *into* the orbit, reducing subtly the posterior and middle orbital volume. The inward projection is apparent in oblique views (►Fig. 22a) but most obvious from above, after the orbital roof has been drilled away with cutting burs (►Fig. 22b).

Fig. 20 (a) Photograph depicting the linearity of the orbital plates of the lateral orbit, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (b) Art by Bill Winn depicting the linearity of the anatomy of the lateral orbit, in line (white arrow) with the optic strut, a 45-degree micro-buttruss (of the lesser wing of the sphenoid) that separates the optic canal and the superior orbital fissure, copyright Richard A. Pollock and Thieme Medical Publishers, Inc.

Fig. 21 (a) Art by Bill Winn depicting split-cranial bones grafts, one secured at the superior orbital rim and one not, resting in the defect of the fractured orbital roof, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (b) Photograph split-cranial bone "top hat" graft for orbital roof repair, copyright Richard A. Pollock, and Thieme Medical Publishers, Inc.

Fig. 22 (a, b) Photographs depict the "ethmoid jut" projecting into the mid- and posterior medial orbit; in b, the orbital roof has been removed with cutting burs to more fully reveal the inward curvature of the ethmoid jut as the orbital apex is approached, copyright Richard A. Pollock and Thieme Medical Publishers, Inc. (c) The inherent contour of split-cranial bone from the temporoparietal skull mimics the contour of the mid- and posterior medial orbit; the graft often snaps into place without rigid fixation when the margins are tapered with cutting burs (copyright Richard A. Pollock and Thieme Medical Publishers, Inc.).

Fig. 23 Cover of April 16, 1916 issue of *Punch* magazine (*The London Charivari*). <https://en.wikipedia.org/wiki/Punch>; accessed May 18, 2018.

Fig. 24 Cover of the Whitnall-as-Tingle book, *Astonishing Anatomy*, 1913. Courtesy: Bernard Becker Medical Library, Washington University School of Medicine; accessed May 18, 2018.

Labeled the “ethmoid jut,”^{33,40} the degree of inward curvature varies among individuals.

Upon impact, the inward jut of the medial wall tends to be displaced medially into the ethmoid sinus, as its cross-struts (septa) collapse. The orbital expansion is challenging to reconstruct, but the inherent convexity of temporoparietal, split-cranial bone offers an excellent anatomical solution.⁴⁰ When the edges are tapered with a cutting burr (► **Fig. 22c**),

the medial wall graft clicks into position and does not require rigid fixation.

An Afterword

Ernest Whitnall enjoyed satire and the humor of parody, as evident in his biweekly contributions to the London-based magazine *Punch* (*The London Charivari*) during the years before the Great War. He authored the numerous columns under the pseudonym “Tingle”¹⁰ (► **Fig. 23**).

Astonishing Anatomy, an 80-page spoof, was published by Isaac Pittman & Sons of London in 1913⁵¹ (► **Fig. 24**). The witty tome, also written before the War under Whitnall’s pseudonym, was the subject of much fun, distortion of anatomical fact, and rather tangential, descriptive inaccuracy. One underlying premise of *Astonishing Anatomy* was the then-perceived need for 2-year, hands-on anatomical dissection and prosection in the education of medical students. Such posturing was a forerunner of similar arguments by John Skandalakis against ongoing erosion of student-laboratory experience by computerized learning in a 1980 issue of *American Surgeon*.⁵² *Astonishing Anatomy* was most briefly reviewed in the inaugural issue of the *British Medical Journal*, on March 29, 1913.^{51,53}

Conflict of Interest
None.

Acknowledgments

► **Fig. 17a** is reproduced with permission granted as “Licensed Material” 05–23–18 from MJ Hawes, RK Dortzbach, JAMA, and the Archives of Ophthalmology 100: 1313–1318, Copyright 1982.

The orbital photographs and ► **Fig. 17b** through ► **Fig. 22c** enhance one’s understanding of the diuturnity of Samuel Ernest Whitnall (1876–1950). The photographs are from the collection of the first author, some of which were taken at the Department of Anatomy, University of Michigan, Ann Arbor, MI, during residency in plastic surgery, prior to the millennium. The art is the work of Bill Winn of Atlanta, GA, now of Bluffton, SC, and we remain grateful for his long-term approval granting its use. All were originally published in *Craniomaxillofacial Buttresses: Anatomy and Operative Repair* in 2012. The authors are beholden to Timothy Y. Hiscock, executive editor, and the staff of Thieme Medical Publishers, Inc., New York, NY.

► **Fig. 13a** is reprinted with permission granted as “Licensed Material” 07–06–18 by the Casual Archives, McLennan Library, McGill University.

References

- 1 Shin EK, Meals RA. The historical importance of the hand in advancing the study of human anatomy. *J Hand Surg Am* 2005; 30(02):209–221
- 2 Le Fort R. Etude experimental sur les fractures de la machoire superieure. *Rev Chir Paris* 1901;23:208–227
- 3 Testut JL. *Traite d'Anatomie Humaine*. 2nd ed. Paris: Doin; 1911
- 4 Testut JL. *Anatomica Humanica*. 3rd ed. Torino, Italy: Doin; 1943

- 5 Cryer MH. Internal Anatomy of the Face. Philadelphia, PA: Lea & Febiger; 1916
- 6 Pollock RA. Buttresses of the craniomaxillofacial skeleton. In: Pollock RA, ed. Craniomaxillofacial Buttresses: Anatomy and Operative Repair. New York: Thieme; 2012
- 7 Whitnall SE. The Anatomy of the Human Orbit and Accessory Organs of Vision. London: Henry Frowde and Hodder & Stoughton; 1921
- 8 Whitnall SE. On a tubercle on the malar bone, and on the lateral attachments of the tarsal plates. *J Anat Physiol* 1911;45(Pt 4):426–432
- 9 Whitnall SE. A ligament acting as a check to the action of the levator palpebral superioris muscle. *J Anat Physiol* 1911;45(Pt 2):131–139
- 10 In memoriam: Samuel Ernest Whitnall, M.A., M.D., B.Ch. (Oxon), M.R.C.S., L.R.C.P. (Lond.). *J Anat* 1950;84(04):395–396
- 11 Hanaway J, Cruess RL. McGill Medicine: The Second Half-Century, 1885–1936. Vol 2. Montreal, Canada: McGill-Queen's University Press; 2008
- 12 Bourguet J. Les hernies graisseuses de l'orbite: Notre traitement chirurgical. *Bull Acad Natl Med* 1924;92:1227–1232
- 13 Marchac D, Julien Bourguet. The pioneer in aesthetic surgery of the neck. *Clin Plast Surg* 1983;10(03):363–365
- 14 Converse JM, Smith B. Reconstruction of the floor of the orbit by bone grafts. *Arch Ophthalmol* 1950;44(01):1–21
- 15 McCoy FJ. Management of the orbit in facial fractures. *Plast Reconstr Surg* (1946) 1957;19(03):236–245
- 16 Smith B, Converse JM. Early treatment of orbital floor fractures. *Trans Am Acad Ophthalmol Otolaryngol* 1957;61(05):602–608
- 17 Smith B, Regan WF Jr. Blow-out fracture of the orbit; mechanism and correction of internal orbital fracture. *Am J Ophthalmol* 1957;44(06):733–739
- 18 Dingman RO, Natvig P. Surgery of Facial Fractures. Philadelphia, PA: WB Saunders; 1964
- 19 Dingman RO, Grabb WC, Oneal RM. Management of injuries of the naso-orbital complex. *Arch Surg* 1969;98(05):566–571
- 20 Stranc MF. Primary treatment of naso-ethmoid injuries with increased intercanthal distance. *Br J Plast Surg* 1970;23(01):8–25
- 21 Tenzel RR, Miller GR. Orbital blow-out fracture repair, conjunctival approach. *Am J Ophthalmol* 1971;71(05):1141–1142
- 22 Tessier P. The conjunctival approach to the orbital floor and maxilla in congenital malformation and trauma. *J Maxillofac Surg* 1973;1(01):3–8
- 23 Rowe NL. Fractures of the orbit. *Acta Stomatol Belg* 1975;72(04):681–685
- 24 Stranc MF, Robertson GA. A classification of injuries of the nasal skeleton. *Ann Plast Surg* 1979;2(06):468–474
- 25 Tessier P, Rougier R, Hervouet F, et al. Plastic Surgery of the Orbit and Eyelids (Translated by Wolfe SA). New York, NY: Masson USA; 1981
- 26 Merville LC, Real JP. Fronto-orbito nasal dislocations. Initial total reconstruction. *Scand J Plast Reconstr Surg* 1981;15(03):287–297
- 27 Morgan RF, Manson PN, Shack RB, Hoopes JE. Management of naso-ethmoid-orbital fractures. *Am Surg* 1982;48(09):447–450
- 28 Gruss JS. Naso-ethmoid-orbital fractures: classification and role of primary bone grafting. *Plast Reconstr Surg* 1985;75(03):303–317
- 29 Gruss JS. Complex nasoethmoid-orbital and midfacial fractures: role of craniofacial surgical techniques and immediate bone grafting. *Ann Plast Surg* 1986;17(05):377–390
- 30 Paskert JP, Manson PN, Iliff NT. Nasoethmoidal and orbital fractures. *Clin Plast Surg* 1988;15(02):209–223
- 31 Jackson IT. Classification and treatment of orbitozygomatic and orbitoethmoid fractures. The place of bone grafting and plate fixation. *Clin Plast Surg* 1989;16(01):77–91
- 32 Jackson IT. Orbital wall trauma. In: Mustarde JC, ed. Repair and Reconstruction in the Orbital Region. Edinburgh: Churchill Livingstone; 1991:361–375
- 33 Gossman MD, Pollock RA. Acute orbital trauma: diagnosis and treatment. In: McCord CD Jr., Tanenbaum M, Nunery WR, eds. *Oculoplastic Surgery*. 3rd ed. New York, NY: Raven Press; 1994: 515–552
- 34 Manson PN. Orbital fractures. In: Prein J, ed. *Manual of Internal Fixation in the Cranio-Facial Skeleton*. Berlin: Springer-Verlag; 1998:139–147
- 35 Pollock RA, Gossman MD. The canthofornix incision (lower eyelid “bypass”) in the management of orbital and zygomatic fractures. *Craniomaxillofac Trauma* 2001;7:13–22
- 36 Hollier LH, Thornton J, Pazmino P, Stal S. The management of orbitozygomatic fractures. *Plast Reconstr Surg* 2003;111(07):2386–2392, quiz 2393
- 37 Manson PN. The orbit after Converse: seeing what is not there. *J Craniofac Surg* 2004;15(03):363–367
- 38 Martin M, Rodriguez E, Grant M, Vanderkolk C, Manson P. Three-point fixation of orbitozygomatic fractures: the lateral orbit. *Plast Reconstr Surg* 2005;116:605–612
- 39 Wolfe SA, Ghurani R, Podda S, Ward J. An examination of post-traumatic, postsurgical orbital deformities: conclusions drawn for improvement of primary treatment. *Plast Reconstr Surg* 2008;122(06):1870–1881
- 40 Pollock RA, Gossman MD. The lateral orbital frame, orbitozygomatic complex (upper lateral face), and orbit. In: Pollock RA, ed. *Craniomaxillofacial Buttresses: Anatomy and Operative Repair*. New York, NY: Thieme; 2012:150–193
- 41 Stanwix MG, Rodriguez ED. Naso-orbital-ethmoid fractures. In: Marcus JR, Erdmann D, Rodriguez ED, eds. *Essentials of Craniomaxillofacial Trauma*. St. Louis, MO: Quality Medical; 2012
- 42 Pollock RA. Current principles of repair. In: Pollock RA, ed. *Craniomaxillofacial Buttresses: Anatomy and Operative Repair*. New York, NY: Thieme; 2012:29–46
- 43 Manson PN. Fronto-basilar fractures. *Plast Surg Forum* 1981;4:14
- 44 Pollock RA. The cranial vault and cranial base (frontal, sphenoid, temporal, and occipital bones). In: Pollock RA, ed. *Craniomaxillofacial Buttresses: Anatomy and Operative Repair*. New York, NY: Thieme; 2012:106–125
- 45 Gruss JS, Pollock RA, Phillips JH, Antonyshyn O. Combined injuries of the cranium and face. *Br J Plast Surg* 1989;42(04):385–398
- 46 Stanley RB Jr. Management of severe frontobasilar skull fractures. *Otolaryngol Clin North Am* 1991;24(01):139–150
- 47 Burstein F, Cohen S, Hudgins R, Boydston W. Frontal basilar trauma: classification and treatment. *Plast Reconstr Surg* 1997;99(05):1314–1321, discussion 1322–1323
- 48 Manson PN, Stanwix MG, Yaremchuk MJ, Nam AJ, Hui-Chou H, Rodriguez ED. Frontobasal fractures: anatomical classification and clinical significance. *Plast Reconstr Surg* 2009;124(06):2096–2106
- 49 Rudderman RH, Mullen RL, Phillips JH. Implications of finite analysis. In: Pollock RA, ed. *Craniomaxillofacial Buttresses: Anatomy and Operative Repair*. New York, NY: Thieme; 2012:19–21
- 50 Pollock RA. Pancraniomaxillofacial injury. In: Pollock RA, ed. *Craniomaxillofacial Buttresses: Anatomy and Operative Repair*. New York, NY: Thieme; 2012:194–207
- 51 Whitnall SE (as Tingle). *Astonishing Anatomy*. London: Isaac Pittman & Sons; 1913
- 52 Skandalakis JE. The rape of anatomy. *Am Surg* 1980;46(04):197–200
- 53 Brander B. A Touch of Medical Humor. Becker Briefs, Bernard Becker Medical Library, Washington University School of Medicine, August 12, 2016. Available at: <https://becker.wustl.edu/about/news/touch-medical-humor>. Accessed September 26, 2017