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1 Title: Posterior approach white-line advancement ptosis repair: the evolving posterior
2 approach to ptosis surgery.

3

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22

23

24 Introduction

25

26 We describe a surgical technique for ptosis correction in moderate to good levator
27 function involving advancement of the levator aponeurosis via a transconjunctival
28 posterior approach without resection of Muller's muscle. We present our experience of
29 and the results from this method and review the evolution of posterior approach ptosis
30 surgery.

31

32 Purpose

33

34 To assess the efficacy and predictability of posterior approach white line advancement
35 ptosis repair.

36

37 Methods

38

39 Retrospective analysis of all patients with primary aponeurotic ptosis undergoing
40 posterior-approach repair using white-line advancement between December 2007 to June
41 2008. We describe a technique whereby after dissection of the Muller's-conjunctiva
42 composite flap, the levator aponeurosis is advanced with double armed sutures through
43 the white line, then through tarsus and out through skin.

44

45 Results

46

47 112 ptosis procedures in total during this period of which 71 eyelids of 41 patients were
48 eligible for inclusion. There were 14 males and 27 females. The mean age was 63.76
49 years (range 24 to 87 years). Minimum follow up was 3 months (12 weeks-43 weeks). Of
50 the 71 procedures, 42 were combined with a blepharoplasty. 62 achieved their desired lid
51 height, contour and symmetry (87.3% success rate). No patients were overcorrected.
52 Success rate in the phenylephrine positive group (42/71) was 88.1% compared to 100
53 % in phenylephrine negative group (4/71).

54

55 Conclusions

56

57 We present a modified approach to ptosis correction via a posterior approach. It has a
58 high success rate and good cosmetic outcome. It is technically straightforward and easy
59 to learn.

60

61 Keywords: aponeurotic ptosis, posterior approach

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70 **Introduction**

71

72 Surgery for aponeurotic ptosis has conventionally been directed upon the levator
73 aponeurosis complex, in the majority of cases, through an anterior approach¹. The
74 transconjunctival route was probably the first method of surgery employed to shorten the
75 levator muscle.²⁻⁶ Posterior approach surgery was further popularised utilising Muller's
76 muscle and tarsoconjunctival resection^{7,8}. Traditionally this posterior approach is
77 reserved for those with minimal ptosis and a positive response to phenylephrine test^{7,8,9}.
78 In 1961 Fasanella and Servat⁷ first described their technique initially describing a “
79 resection of Muller's muscle, levator, tarsus and conjunctiva.” Histological studies have
80 since shown that the tissue resected consisted of a predominately tarsoconjunctival
81 layer^{10,11} and we now regard the Fasanella servat technique as a tarsoconjunctival
82 resection. Muller's muscle conjunctival resection (MMCR) was first reported by
83 Putterman in 1975⁸, where he dissected Muller's blindly off its bed on the aponeurosis
84 with the aid of a special clamp. This was found to be effective in mild phenylephrine
85 positive ptosis cases. Further modifications to this technique include an open sky MMCR
86 and a conjunctival sparing muller resection^{12,13}. We describe a surgical technique
87 involving advancement of the posterior surface of the levator aponeurosis (the white-line)
88 via a transconjunctival posterior approach without resection of Muller's muscle.
89 Abraham Werb²⁹, working in our unit in East Grinstead, in the 1970's was the first to
90 highlight the importance of advancing the white-line via a posterior approach. The white-
91 line is best described as the distal levator aponeurosis viewed from posteriorly. Although
92 similar techniques have been reported¹³, to our knowledge, the outcomes of advancing

93 the posterior surface of the levator aponeurosis (white-line) through a transconjunctival
94 approach, without resection of Muller's muscle has not been reported.

95

96 **Materials and Methods**

97

98 This was a retrospective case series, in which the notes of all patients undergoing surgery
99 for primary involutional aponeurotic ptosis between December 2007 and June 2008 at the
100 Queen Victoria Hospital, East Grinstead, UK, were reviewed. Institutional review board
101 approval was obtained for this retrospective study.

102

103

104 Primary involutional aponeurotic ptosis had been diagnosed in patients with ptosis that
105 was constant in all positions of gaze, moderate to good levator function (levator function
106 > 8mm) and a high or absent skin crease. Patients with congenital, myogenic, neurogenic
107 or traumatic aponeurotic ptosis, inadequate data, including post-operative follow up data
108 with photographs less than 3 months, and those who underwent anterior approach or
109 Muller's muscle excision were excluded.

110

111 A total of 41 patients undergoing 71 procedures for involutional aponeurotic posterior
112 approach ptosis repair were identified.

113

114 Data collected included age, gender, type of ptosis (primary or recurrent), details of any
115 previous ptosis surgery, preoperative upper eyelid margin-reflex distance (MRD), levator

116 function and skin crease height. Response to instillation of phenylephrine 2.5% was also
117 documented preoperatively, with an elevation in lid height deemed a positive result.

118

119 Patients were examined postoperatively at 2 weeks and 3 months. Post operative
120 measurements at the last follow up visit were used for comparison. Post operative
121 complications and follow up time were documented. Surgical success was defined as a
122 postoperative MRD of ≥ 2 mm and ≤ 4.5 mm, inter-eyelid height asymmetry of ≤ 1 mm, and
123 satisfactory eyelid contour.

124

125 ***Surgical technique:***

126

127 All cases were performed under local anaesthesia with 1ml subcutaneous infiltration,
128 both along the skin crease and in the mid-pupil pretarsal region and 0.5ml
129 subconjunctival infiltration upon eyelid eversion using 2% lignocaine with 1:80000
130 adrenaline (Figure 1A). Most patients also received a bolus injection of intravenous
131 sedation immediately prior to local anaesthetic infiltration, but were alert for the
132 remainder of the procedure.

133 The desired skin crease was marked and a 4-0 silk traction suture placed in the grey line
134 of the upper eyelid, which was then everted over a Desmarres retractor. Gentle diathermy
135 was applied prior to a conjunctival incision made with a no 15 Bard parker blade along
136 but above the superior border of the tarsus (Figure 1C). Muller's muscle and conjunctiva
137 was dissected off as a composite flap until the white-line, which represents the posterior
138 border of the levator aponeurosis, was identified (Figure 1D). A double armed 5-0 vicryl

139 suture was placed centrally through the posterior belly of the white-line (Figure 1E), in a
140 forehand manner and was then passed through the conjunctival surface of the tarsal plate,
141 1mm below its superior border (Figure 1F), and then through to the skin (Figure 1G). The
142 suture was captured through the skin in the region of the skin crease. The lid height and
143 contour was assessed after tying this first suture in a bow (Figure 1 H,I) and care was
144 taken to ensure there was no slippage of the suture. If the eyelid position was deemed to
145 be satisfactory, the suture was relaxed and a second suture was placed within 2-3mm
146 lateral to the first in the method described above. Both sutures were then tied. If the lid
147 height was too low after the first suture, it was then relaxed and a second suture was
148 passed higher through the white-line and again through the tarsal plate and skin. If the
149 upper eyelid contour appeared peaked after the first suture, then this was relaxed and a
150 second suture was placed more central to the location of the peak. Using this method of
151 altering the position of the second suture enabled minor adjustments to eyelid height and
152 contour without the undue delay of removing the first suture in the majority of cases. In
153 such situations, the first suture was gently tied so as to act a “support” rather than a
154 “cardinal” suture. In the post-operative period the absorbable sutures were not removed
155 and were left to dissolve spontaneously. Both Muller’s and conjunctiva were left to heal
156 spontaneously with no excision of these structures.

157

158

159 In those cases with significant dermatochalasis the procedure was combined with a
160 blepharoplasty. This was carried out prior to eyelid eversion and white-line advancement
161 (Figure 1B). The technique involved either a skin only or skin-muscle blepharoplasty.

162 The orbital septum and orbital fat were not violated and therefore the anterior surface of
163 the aponeurosis was never exposed. The double armed 5-0 vicryl sutures came out within
164 the wound but through the soft tissue overlying the anterior surface of the tarsal plate. By
165 tying the sutures here they remained buried when skin closure was carried out, usually
166 with continuous 6-0 vicryl rapide.

167

168

169

170 **Results**

171

172 ***Patients:***

173 112 ptosis procedures in total during this period of which 71 eyelids of 41 patients were
174 eligible for inclusion. There were 14 males and 27 females. The mean age was 63.76
175 years \pm 14.9 (range 24 to 87 years).

176 All the procedures were performed for primary involutional ptosis. 41 procedures were
177 excluded as they didn't fit the inclusion criteria. The majority of procedures (84.5%)
178 were simultaneous bilateral ptosis repairs.

179

180 ***Additional upper eyelid/brow procedures performed:***

181

182 Blepharoplasty was simultaneously performed in 59% (42/71) of ptosis procedures.

183 Additional endoscopic (2/71) and pretricheal (4/71) brow lifts were carried out.

184

185 ***Preoperative findings:***

186

187 Mean MRD was 1.32 ± 1.23

188 59% (42/71) of cases were phenylephrine positive, 6% (4/71) were phenylephrine

189 negative and in 35% (25/71) it was not documented.

190

191 ***Outcomes:***

192 All patients had a minimum of 3 months follow up with a median post operative follow

193 up of 17 weeks and the mean follow up was $20.35 \text{ weeks} \pm 9.6$ (12-43).

194 The overall success rate was 87.3% (62/71). The mean MRD improved to 3.50 ± 1.06

195 All failures (9/71 eyelids of 9 patients) were due to undercorrection, rather than

196 unsatisfactory contour. The mean time to failure was $4 \text{ weeks} \pm 4.07$ (1-14 weeks).

197 The success rate in the phenylephrine positive group was 88.1% versus 100% in the

198 phenylephrine negative group.

199

200

201 **Discussion**

202

203 We describe a surgical technique for involutional ptosis involving advancement of the

204 posterior surface of the levator aponeurosis via a transconjunctival posterior approach

205 without resection of Muller's muscle or conjunctiva. Overall success rate was 87.3% and

206 all patients achieved a satisfactory contour. Of those that needed further surgery (9/71,

207 12.7%), all were undercorrected with eyelid height asymmetry and no patients were

208 overcorrected. Our technique differs from previous reports of posterior approach ptosis
209 surgery^{12,14,15} as we do not dissect septum to expose the anterior surface of the levator
210 nor is there any MMCR.

211

212 Advancement of a dehiscenced levator aponeurosis, as described in our technique, combines
213 achievement of a predictable post-operative height expected with aponeurosis re-
214 attachment and a predictable normal-looking eyelid contour seen with posterior-approach
215 Muller's muscle resection surgery, yet avoids the need to excise any tissue, namely
216 Muller's muscle or conjunctiva.

217

218 Although it would have been useful to compare the phenylephrine response positive with
219 the response negative group the numbers were not sufficient to do so. However the
220 principal of our technique is advancement of the posterior border of the aponeurosis
221 rather than MMCR. One would therefore expect it to be effective irrespective of the
222 response to phenylephrine.

223

224 Historically posterior approach ptosis surgery was first described by Blaskovic's^{2,3} in
225 1923. He described a technique of extensive dissection of levator from its surrounding
226 structures prior to its resection. Two sets of sutures were used, the first three were
227 through the levator and the cut edge of the conjunctiva and the second three were "fold-
228 forming" sutures through the levator only, and then both were passed anteriorly through
229 the tarsus and skin. This was combined with a tarsectomy in all cases. Posterior approach
230 surgery was further addressed by Agatston⁴ who stated in 1942 that this technique was

231 becoming increasingly popular in the United States. In 1953 Berke⁵, operating mainly on
232 congenital cases, further simplified Blaskovic's technique. His technique still involved
233 extensive dissection of levator from its surrounding structures however only one set of
234 sutures was used and no tarsal excision was carried out. Following the early papers
235 demonstrating the technique of anterior approach ptosis repair, posterior approach
236 surgery was preferred when focussing on the posterior lamellar structures; tarsus,
237 conjunctiva and Muller's muscle. MMCR is traditionally performed in patients who show
238 eyelid elevation following instillation of topical phenylephrine. In 1961 Fasanella and
239 Servat⁷ described a procedure for patients with minimal blepharoptosis in which they
240 applied two curved haemostats to the everted superior tarsus, ran a suture above them,
241 and excised the tissues held by them. The Fasanella-Servat procedure is suitable for mild
242 ptosis and involves a blind approach with predominately tarso-conjunctival resection. In
243 1975 Putterman and Urist⁸ described their technique of MMCR. After separating the
244 Muller's and conjunctiva from the surrounding structures a modified clamp was used and
245 the tissue excised. They found that in most patients the upper eyelid was elevated to a
246 normal level following instillation of 10% phenylephrine and an 8 mm MMCR produced
247 a similar result. The authors recommended a 9mm resection if the phenylephrine test
248 demonstrated a lower eyelid reponse, or a 7 mm resection if the response was higher than
249 desired. At the same time, in Europe a technique for Muller's muscle resection was being
250 popularized by Abraham Werb in our unit. This involved an incision at the superior
251 border of the tarsal plate, dissection and excision of a conjunctival-Muller flap and
252 advancement of the white-line to the tarsal plate and through to the skin crease. To our
253 knowledge, Mr Werb²⁹ was the first to emphasise the importance of advancing the

254 white-line in this technique. His findings paved the way for others who had worked with
255 Mr. Werb, namely Mr. Collin , to develop techniques in posterior approach levator
256 advancement which are described later in the discussion.

257

258

259 Subsequent modifications to the MMCR technique describe a wide variety of algorithms
260 to determine the appropriate amount of tissue resection to correct a given degree of ptosis
261 ^{16,17}. Weinstein and Berger ¹⁶ suggest that a linear relation may exist between the
262 resultant eyelid elevation and quantity of Muller's muscle resection. This technique
263 begins with 8mm of resection to correct 2mm of ptosis, then adds or subtracts 1mm of
264 resection to affect the final eyelid position by 0.25mm.

265

266 Dresner ¹⁷ describes a further modification of the MMCR technique whereby the amount
267 of resection depends on the response to phenylephrine testing. When phenylephrine
268 testing results in at least 2mm of eyelid elevation, Dresner applied the following
269 algorithm: 4mm of resection for 1mm of ptosis, 6mm of resection for 1.5 mm of ptosis,
270 10mm of resection for 2mm of ptosis, and 11 or 12mm of resection for >3mm of ptosis.

271

272 It appears that widely disparate amounts of resection may yield acceptable surgical
273 results for similar degrees of ptosis. Buchman et al ¹⁸ analysed histological specimens
274 from 40 Fasanella-Servat cases which revealed 88% of cases had absent to minimal
275 smooth muscle resection. However these patients had equally successful results in
276 comparison to patients with moderate or large amounts of smooth muscle resection. Perry

277 et al ¹⁹ concluded that the success of this technique may result from either vertical
278 posterior lamellar shortening, secondary contractile cicatrisation of the wound, or
279 advancement of the Muller's muscle-levator aponeurosis complex on the tarsus. Perry et
280 al ¹⁹ devised a new algorithm based on this theory whereby 9mm of Muller's resection
281 should result in the same elevation that is produced by maximal stimulation with
282 phenylephrine. If phenylephrine testing results in an undercorrection then tarsus was
283 added to the resection.

284

285 More recently Lake et al ¹² and Baldwin et al¹⁴ reported their series of open sky MMCR
286 in both phenylephrine test positive and negative groups. Their technique allowed direct
287 visualization of Muller's muscle before its subtotal resection. Double-armed sutures were
288 passed through the Muller's muscle stump, and the upper border of the tarsus through to
289 the skin crease. They suggested that the success with the procedure lay, not from the
290 degree of resection of Muller's muscle, but from the consequent advancement of the
291 levator. As the sutures are passed through the stump of Muller's muscle (which originates
292 at the distal edge of the inferior surface of the levator muscle) and then through the
293 tarsus, one is in effect advancing the levator and attaching it to the tarsal plate and skin
294 crease. This theory was further supported by the success of the procedure in
295 phenylephrine negative patients. ¹⁴ More recently the authors have also reported a
296 conjunctival sparing technique. ¹³

297

298 Our technique is similar to that reported by Khooshabeh¹²⁻¹⁴ in so far as it involves initial
299 dissection of the composite flap of Muller's muscle and conjunctiva with direct

300 visualization of the tissues concerned. However once the posterior border of the levator
301 aponeurosis is identified (the “white-line”), double armed sutures are passed through
302 this white-line and then through the superior tarsus and skin. Only the aponeurosis is
303 therefore advanced and neither Muller’s muscle or conjunctiva are excised. Although our
304 current technique involves passing the suture through the epithelial surface of the
305 superior border of the tarsal plate, since presenting this technique to colleagues it has
306 been suggested that gentle diathermy of this area and scraping away of the epithelium
307 with a 15-blade may provide better, more reliable long-term adhesion between the white-
308 line and the tarsus by elimination of intervening epithelium. We have since included this
309 step and have not encountered any adverse events since doing so.

310

311 We know from previous reports^{20,21} that the levator aponeurosis particularly in asian
312 eyelids comprises two layers, of which the anterior layer is thick with less smooth muscle
313 fibres, and reflects superiorly a few millimeters above the tarsus to become contiguous
314 with the orbital septum. The posterior layer is thin with more smooth muscle fibres, and
315 becomes confluent with the lower one third of the tarsal plate and subcutaneous tissue.
316 Occasionally, after placement of sutures in what appears to be a white line, there can be
317 an undercorrection of ptosis. We have found that this usually arises from erroneous
318 placement of sutures into the orbital septum (anterior layer of levator) that can
319 occasionally appear as a white line. In such cases, the levator aponeurosis is often
320 significantly thin and can be found by further dissection closer to the conjunctiva beyond
321 a thin Muller’s muscle. As Muller’s muscle disappears, a thin white line can be
322 identified. Following this, further dissection between this white line and the conjunctiva

323 can reveal a more healthy white sheet, that of the posterior surface of the levator
324 aponeurosis. Placement of sutures into this white sheet, that is to say the healthier
325 posterior surface of levator aponeurosis, will achieve the desired correction by a more
326 effective advancement than simply plicating orbital septum to the tarsus.

327

328 The anatomical reasons for the success of Muller muscle conjunctival resection has been
329 a matter of debate for some time now. Increasingly, it has been felt that the success of the
330 procedure is due to advancement of the levator muscle itself, along with the aponeurosis.
331 The mechanism by which Muller's muscle resection alleviates ptosis would therefore be
332 by transmitting the contraction force of the levator muscle directly to the tarsal plate
333 instead of through its aponeurotic attachment.

334

335

336 Levator advancement through a posterior approach has been previously reported. Collin
337 et al ¹⁵ reported a technique in 1979 of reinserting the aponeurosis via a posterior
338 approach. However their technique involved exposing the anterior surface of levator by
339 dissection of the orbital septum and retraction of the preaponeurotic fat pad, effectively
340 converting a posterior approach to the familiar anatomical view of an anterior approach
341 ptosis repair. The initial posterior incision was recommended to be made 2 mm below the
342 superior border of the tarsus in order to enter a tissue plane anterior to Muller's muscle.
343 Consequently, although conjunctiva was largely preserved, the distal 2mm of Muller's
344 muscle and 2mm of superior tarsus were excised. It is noteworthy that any degree tarsal

345 resection will further contribute to eyelid elevation regardless of muscle resection or
346 levator advancement.

347

348 Ichinose et al ²² more recently used a similar technique to Collin et al without resecting
349 Muller's muscle. The initial incision was 1mm below the superior border of the tarsus.
350 Their technique also involved dissection of the orbital septum and exposure of the
351 anterior surface of the levator. The aponeurosis was advanced down and sutured to the
352 frontosuperior part of the tarsus. In addition Muller's muscle was reattached to the
353 superior edge of the tarsal plate. Both of these techniques involved dissection of the
354 levator anteriorly from its surrounding structures before its advancement.

355

356 Our technique differs in several ways. We do not dissect septum to expose the anterior
357 surface of levator. We simply pass the sutures through the distal posterior border of the
358 aponeurosis. Our initial incision is just above the superior border of the tarsus as opposed
359 to below, avoiding any excision of tarsus. There is no excision of Muller's or conjunctiva
360 and the Muller's-conjunctiva composite flap we create is simply replaced without the
361 need for resuturing.

362

363 Although it has been suggested that advancement of the levator muscle may be the reason
364 for the efficacy of the open sky MMCR ¹⁴, this is the first reported series whereby the
365 principle goal is to identify and advance the lower border and posterior surface of the
366 aponeurosis without any exposure of the anterior surface of the levator and without
367 excision of any tissue. Conventional ptosis surgery in the presence of a functioning

368 levator muscle is now predominately on the aponeurosis of the levator complex via an
369 anterior approach. There are some concerns regarding unpredictability of lid height but
370 perhaps more so, contour with this procedure. This is particularly so for the medial
371 undercorrection that occurs more commonly in anterior approach ptosis surgery.^{23,24}
372 Levator aponeurosis surgery was first advocated by Jones, Quickert and Wobig¹ for the
373 treatment of involutional ptosis. They achieved a success rate of 89% in 57 patients in
374 their original paper describing their technique.¹ In 1979 Anderson and Dixon²⁵ achieved
375 a 83% success rate in acquired ptosis using the criteria of 1mm or less of residual ptosis
376 as a success. In 1983, Older²⁶ reported a series of cases of aponeurotic repair for
377 acquired ptosis and had a 95 % success rate within 1mm of the desired height in 113
378 patients with a minimum of 6 months follow up. However, Berlin and Vestal²⁷ reported
379 for aponeurotic ptosis a 74% success rate within 1mm of desired height in 116 patients. A
380 recent large representative study²⁸ of anterior levator advancement has shown that 77%
381 of eyelids were symmetrical to within 1mm of the fellow eye after one operation, with
382 8.8% eyelids requiring further surgery to obtain this outcome. Bilateral cases were twice
383 as likely to require reoperation.

384

385 Reports of Muller's muscle resection would suggest a higher success rate compared to
386 that for anterior approach levator advancement. Putterman⁹ published a study showing
387 90% of eyelids achieving within 1.5mm symmetry of the fellow eye. However these
388 results were for predominately mild phenylephrine positive ptosis and if applied to our
389 success criteria would result in a success rate of 75%. Dresner¹⁷ reported 85% of eyelids
390 being within 0.5 mm symmetry. Lake et al¹², describing their open sky technique in

391 phenylephrine positive patients, showed 98% were within 1mm symmetry with the fellow
392 eye. In their second study ¹⁴ looking at phenylephrine negative patients all were within
393 0.5mm symmetry of the fellow eye.

394

395 Our Muller's muscle-conjunctival sparing technique results in a predictable degree of lid
396 height and contour. In our series there was an 87% success rate and all patients had a
397 good contour. Our criteria for success was somewhat more stringent than other reports in
398 the literature where only an improvement in MRD is defined as success. The procedure
399 can also be combined with a blepharoplasty and this was the case in the majority of our
400 patients. We feel that a posterior approach is still justified in these cases because the
401 septum has not been disturbed following a blepharoplasty. We feel it can be used in the
402 majority of ptosis patients with moderate to good levator function.

403

404 This technique is easy to teach and learn. The anatomy is easily identifiable, there is
405 minimal dissection and unlike the anterior approach there is little chance of losing your
406 'anatomical bearings'. We have demonstrated here its predictability and excellent success
407 rate in involutional ptoses with moderate to good levator function.

408

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509

510 Figure Legend:

511

512 Figure 1 : Surgical Technique

513 A. local anaesthetic infiltration, B. blepharoplasty if indicated and grey line suture prior
514 to everting the lid, C. Diathermy and conjunctival incision along but above the superior
515 border of the tarsus, D. Muller's muscle and conjunctiva dissected off as a composite flap
516 until the white-line is identified: long arrow highlighting white line, short arrow
517 highlighting desmarres retractor showing, but not breaching, through a thin septum E. A
518 double armed 5-0 vicryl suture is placed centrally through the white-line, F/G. suture
519 passed through the conjunctival surface of the tarsal plate, 1mm below its superior
520 border, and then through to the skin, H/I. Lid height and contour assessed after tying
521 suture in a bow.

522

523 Figure 2:

524

525 Pre and postoperative photographs at 3 month follow up of three patients who underwent
526 bilateral posterior approach white line advancement for aponeurotic ptosis.



